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CSE TECHNICAL PAPER

The MIST Journal of Computer Science and Engineering

Volume 01
June 2022

Department of CSE, Faculty of ECE, MIST
https://mist.ac.bd/department/cse

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The MIST Journal of Computer Science and Engineering

EDITORIAL BOARD

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PUBLISHER

Department of CSE, Military Institute of Science and Technology (MIST), Dhaka, Bangladesh

FOREWORD

Bismillahir Rahmanir Raheem,

Since its foundation in 1998, the Military Institute of Science and Technology (MIST) continues to play its role in creating and disseminating knowledge in the cutting-edge technology. MIST has always focused on conducting research on contemporary issues of science and engineering that affect national infrastructure development.

I am glad that the department of CSE is going to publish the first issue of CSE TECHNICAL PAPER, the MIST Journal of Computer Science and Engineering to provide a platform for publishing high quality research and review articles on all available aspects of computer science, information technology, and engineering. I believe, the articles covered in this journal will be of great interest to academics, researchers, scholars, and general readers.

Warmest felicitation to the editorial board for their tireless endeavor to make the publication a success. I wish every success to The MIST Journal of Computer Science and Engineering.

Major General Md Wahid-Uz-Zaman, BSP, ndc, aowc, psc, te
Commandant, MIST, Bangladesh
Chief Patron, CSE TECHNICAL PAPER, MIST

ADVISOR'S NOTES

The *CSE TECHNICAL PAPER* is a peer reviewed academic journal published from the Department of CSE, MIST, offers a unique platform to present and share research outcomes of the field of computer, communication, security, intelligence, information technology, and other related fields of science and engineering. The articles are selected through a rigorous process to guarantee the epistemic value, high standard, novelty, and originality of each research work.

We strive to maintain high standards regarding our journal management, credibility, and outreach with the continuous assistance of an experienced and intellectually vibrant Editorial Board, Editorial Advisors, and a dedicated Editorial team comprising Section, Language, and Publication editors. We rely on our national and international network of authors, advisory boards, academia, MIST CSE faculties, reviewers, and readers to help in identifying and exploring new areas of science and technology.

With such a broad, we are going to publish the first issue of *CSE TECHNICAL PAPER*, The MIST Journal of Computer Science and Engineering. This first volume has included scholarly and original articles focusing on military intelligence, military technological development, block chain, artificial intelligence, image processing, security, information retrieval, and other related fields of computer science and engineering. I would like to express my gratitude to the Chief Patron, and the Editorial Team for their invaluable support.

We are excited to continue working with all the intellectual individual to make the *CSE TECHNICAL PAPER* to a great success. We welcome submissions as well as inputs from the authors, readers, and reviewers.

Brig Gen Md Abdur Razzak, SUP, psc
Chief Advisor, CSE TECHNICAL PAPER, CSE, MIST

EDITORIAL

The *CSE TECHNICAL PAPER* is annually published academic journal of the Department of Computer Science and Engineering (CSE), MIST, Dhaka, Bangladesh. The journal provides an outstanding opportunity to the young scientists and researchers of the country as well as all over the world. The journal is a platform where contributors can participate with the evolving theories, engineering experiments, technological development, and beyond the boundaries. We rely on our national and international networks, advisory boards, academia, reviewers, and readers to help in identifying and exploring new areas of science and technologies.

We have experienced and intellectually lively Editorial Board, Advisors, and above all the great support of the Chief Patron. With the continued support of the boards, we seek to maintain high standards in all aspects of this journal management, credibility, and outreach. Henceforth, with such a broad base of support, we have published this inaugural volume, entitled as *CSE TECHNICAL PAPER*, which has included scholarly and original articles focusing on the recent trends of computer science, technologies, and engineering. We expect to receive more evidence-based and intriguingly inquisitive, analytical, and research articles for the next volumes.

Lt Col Muhammad Nazrul Islam, PhD
Editor in Chief, CSE TECHNICAL PAPER, CSE, MIST

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CSE TECHNICAL PAPER
The MIST Journal of Computer Science and Engineering

A Web based Application to Automate the Process of Officer Performance Report Management System for MIST Student Officers

Nafiun Nahar Polok[1], Nusrat Zahan[2], and Tasmiah Tamzid Anannya[3]

Department of CSE, Military Institute of Science and Technology (MIST), Dhaka, Bangladesh

emails: [1]*nafiun249@gmail.com;* [2]*ltnusrat@gmail.com, and* [3]*anannya.tasmi@gmail.com*

INFO

History:

Started: 19ht May 2021
Proposal defence: 30th June 2021
Final defence: 27th March 2022
Submitted: 30th March 2022
Published: 30th June 2022

Keywords:

OPR
Manual Approaches
Requirement Elicitation
Automation
Authorized Personnel

ABSTRACT

Every Officer performance report is managed manually in Bangladesh armed forces. MIST is also included in this process. The concerned officer is responsible to fill up his/her own OPR form and submit it to the authorized authority. For managing these OPR forms, manual approaches are followed. Documentations and calculations of OPR forms are done manually on paper which is very difficult to maintain, time consuming and a long process. Sometimes security is also hampered in this process. Thus, research on finding the solution for avoiding the manual management of the system and developing an automated OPR management system for storing, assessing and accessing OPR management system has a greater importance. The objectives of this project is to make an automated website which will ensure time management reduction, effectiveness and user satisfaction on the basis of requirement elicitation. Considering identified requirements, a conceptual framework was proposed and following that in the context of MIST, a web-based OPR management system was developed where student officers of armed forces study together. The developed automated system manages OPR forms in an organized way and also reduces calculation time and deliberation of OPR from one authorized personnel to another.

বাংলাদেশ সশস্ত্র বাহিনীতে অফিসারদের কর্মক্ষমতা প্রতিবেদন ম্যানুয়ালি পরিচালিত হয়। এমআইএসটিও এই প্রক্রিয়ার অন্তর্ভুক্ত। সংশ্লিষ্ট কর্মকর্তা তার নিজের ওপিআর ফর্মটি পূরণ করে অনুমোদিত কর্তৃপক্ষের কাছে জমা দেওয়ার জন্য দায়ী। এই ফর্মগুলি পরিচালনার জন্য, ম্যানুয়াল পদ্ধতি অনুসরণ করা হয়। ওপিআর ফর্মগুলির নথিপত্র এবং গণনাগুলি কাগজে ম্যানুয়ালি করা হয় যা বজায় রাখা খুব কঠিন, সময়সাপেক্ষ এবং একটি দীর্ঘ প্রক্রিয়া। অনেক সময় এই প্রক্রিয়ায় নিরাপত্তাও বিঘ্নিত হয়। এইভাবে, সিস্টেমের ম্যানুয়াল ম্যানেজমেন্ট এড়াতে এবং ম্যানেজমেন্ট সিস্টেম সংরক্ষণ, মূল্যায়ন এবং অ্যাক্সেসের জন্য একটি স্বয়ংক্রিয় ওপিআর ম্যানেজমেন্ট সিস্টেম বিকাশের সমাধান খোঁজার বিষয়ে গবেষণার একটি বৃহত্তর গুরুত্ব রয়েছে। এই প্রকল্পের উদ্দেশ্য হল একটি স্বয়ংক্রিয় ওয়েবসাইট তৈরি করা যা প্রয়োজনীয়তা প্রকাশের ভিত্তিতে সময় ব্যবস্থাপনা হ্রাস, কার্যকারিতা এবং ব্যবহারকারীর সন্তুষ্টি নিশ্চিত করবে। চিহ্নিত প্রয়োজনীয়তা বিবেচনা করে, একটি ধারণাগত কাঠামো প্রস্তাব করা হয়েছিল এবং এর পরিপ্রেক্ষিতে, একটি ওয়েব-ভিত্তিক ওপিআর ম্যানেজমেন্ট সিস্টেম তৈরি করা হয়েছিল যেখানে সশস্ত্র বাহিনীর ছাত্র অফিসাররা একসাথে অধ্যয়ন করে। উন্নত স্বয়ংক্রিয় ব্যবস্থা একটি সংগঠিত উপায়ে ওপিআর ফর্মগুলি পরিচালনা করে এবং একজন অনুমোদিত কর্মীদের থেকে অন্যের কাছে ওপিআরের গণনার সময় এবং বিবেচনার সময় হ্রাস করে।

1. INTRODUCTION

Officer Performance Reports (OPR) are reports by which officers are accessed for promotional aspects. The officers have to submit these reports annually or for other occasions. These reports may also be required when directed by Headquarters of Armed Forces or the officer's commander. According to the law, an officer's rater is notified that an OPR is due about 60 days before closeout date. The raters inform the officers that their OPR is due. Officers may have to contact their raters for giving necessary information for the assessment of OPR. For promotion process, officer performance reports are very critical. Therefore, the responsibility of an officer is to make sure that all the information and record given by him/her is correct. For promotional aspects, officers who are eligible for promotion should know about the criteria required for promotion and they should ensure the submission of their current OPR in officer selection record at HQ before the formation of board for the selection of officers eligible for promotion.

There are 12 departments in MIST containing about 2000 military student officers according to admin report in 2022. CSE department is the second largest department in MIST. Every year all officers have to fill up OPR. After filling up OPR, every officer goes to medical squadron for physical test and these test repots are reviewed by medical officer individually which is a difficult job. After that officer submit their OPR to their course coordinator. One course coordinator has to assess about 30-40 officers. Interacting with all officers and knowing all information about them is difficult for a course coordinator. They have to collect it through interviews or survey forms. After their assessment is done, OPR's are forwarded to department heads for their remarks. Department heads give remarks in OPR and forward it to Dean. After Dean's assessment is done, it is sent to army/navy/air headquarter. In army/navy/air headquarter final assessment of OPR is done and archived.

1.1 Motivation

Present OPR management system is a manual process. If automated officer performance report is implemented, it can perform a pivotal role in overcoming the time killing and long process of manually managed OPR. It can be observed that automated project can save time and work efficiency of an organization. It also ensures improved security of OPR management system. That is why an automated officer performance report management system will be a great help for Bangladesh Armed Forces.

1.2 Problem Statements

Officer performance report is managed manually in Bangladesh Armed Forces. The concerned officer is responsible to fill up his/her own form and submit it to the authorized authority. It is a time killing and a long process. Sometimes security is also hampered in this process. Research on finding the solution for avoiding the manual management of the system is focused. The current study is focused on discussing various problems arising for present OPR management and the contributions of the technological systems to make the system simple to use. One of the common steps need to be taken to solve this problem is to make an automated OPR management system. This can be implemented by a web-based system that will help managing the officer performance report.

1.3 Objectives

The aim or goal of the proposed project is to design and develop of a web application software for officer performance report management system. The goal of this project can be split into the following objectives:

(1) To understand and analyze the present OPR management system.
(2) To design and develop an officer performance report management framework using web based architecture.
(3) To increase time saving and efficiency of OPR management system.
(4) To eliminate manually managed OPR by introducing software based OPR.
(5) To achieve central control and maximum security by introducing web based architecture.
(6) To make the system efficient for maximum user satisfaction.

1.4 Research Methods

Use case diagram, ER diagram and process flow diagram can be shown to describe research methodology.

1.4.1. Use-case Diagram

Use case diagram can be shown in Figure 1.

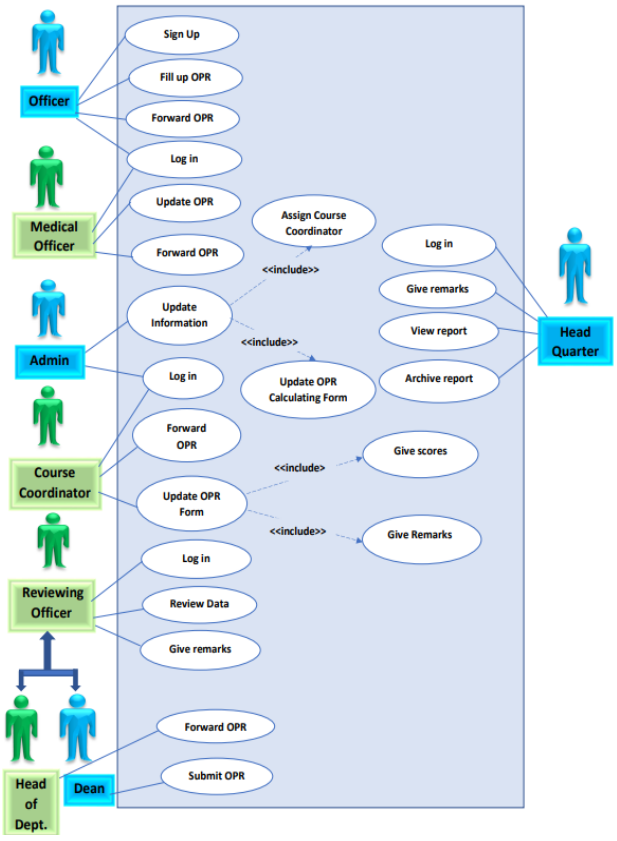

Figure 1: ***Use case Diagram***

1.4.2. ER Diagram

ER diagram can be shown in Figure 2.

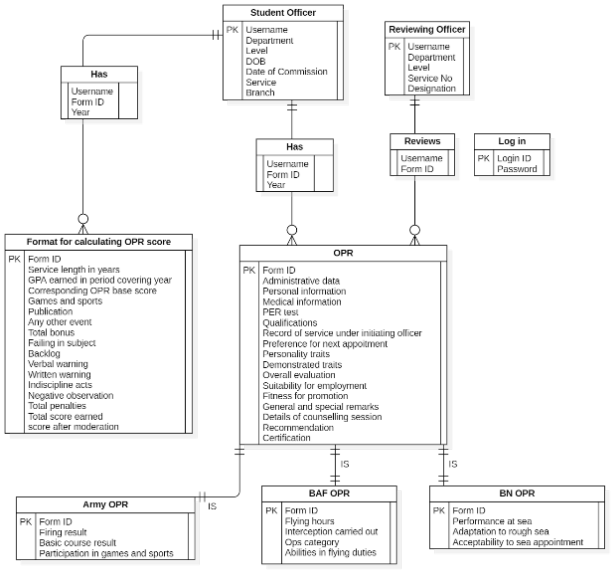

***Figure 2:* ER Diagram**

1.4.3. Process Flow Diagram

Process flow diagram can be shown in Figure 3.

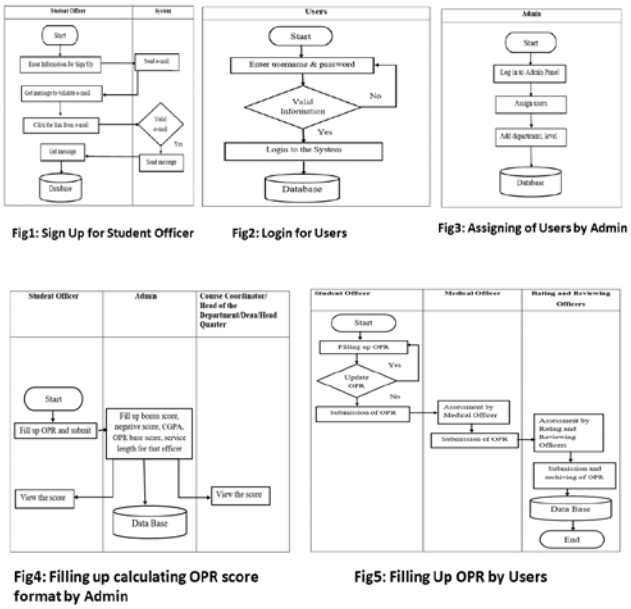

***Figure 3:* Process Flow Diagrams**

1.4.4. Flow Diagram

The proposed framework is aimed to design an automated OPR management system. The methodology we followed designing the project is a sequential process. In designing this framework

(1) Firstly, literature review and survey on existing system is conducted.
(2) Based on this, problem analysis and identification in current situation is done.
(3) After that solution statement and feasibility analysis is made. If the solution can solve the existing problems, system architecture and user interface will be designed.
(4) Afterwards, relational database, backend, and frontend are designed and developed.
(5) After that user experience testing is conducted basing on which system will be integrated.
(6) Efficiency, effectiveness and user satisfaction tests are done after that.
(7) If the test is successful, final documentation will be completed followed by release of the system.

The methodology flow diagram is projected in Figure 4.

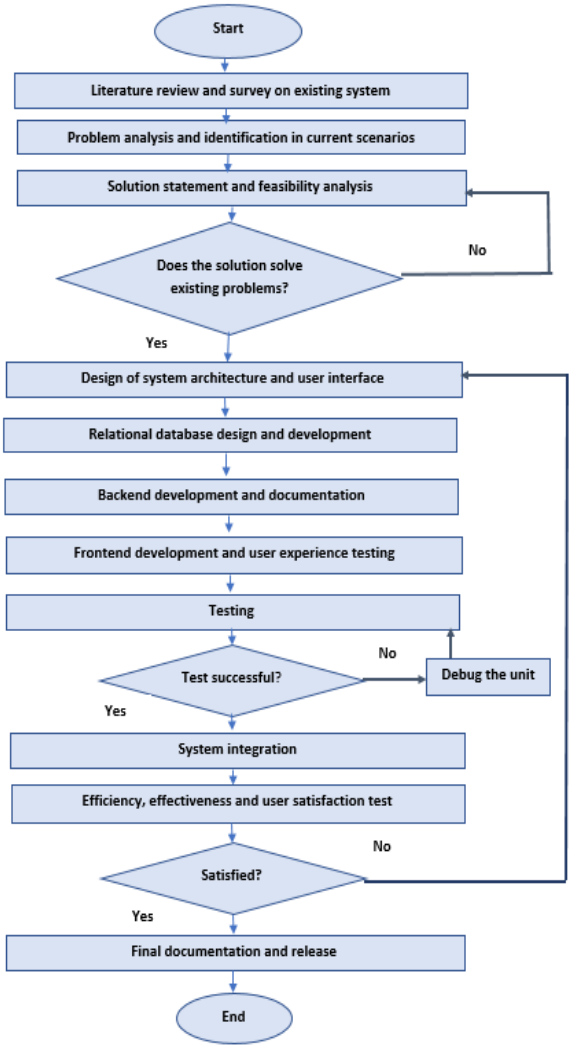

***Figure 4:* Flow Diagram**

1.5 Manuscript organization

This manuscript is organized in the following manner:

Section 1: Introduction and methodology
Section 2: Literature review
Section 3: Requirement analysis
Section 4: System design and result analysis
Section 6: Conclusion

2. LITERATURE STUDIES

The present study clarifies the discussion about OPR management system in Armed Forces. We have studied about OPR management system in Army, Navy and Air Forces. All the forces follow the same procedure. Officers fill up their OPR and give the hard copy to their commanding officer or the officer in charge. The commanding officer fill his/her opinion about that particular officer in that form. This is then signed by him and marked as confidential. After that it is sent directly to HQ where it is passed to the concerned authority.

China military manages OPR by rating manually and preserving it in file. Individual rater may preserve it in their own way. But there is no such system to preserve it in an automated way. India, USA, UK also follow the same rule. Each country has their own way of rating officer's performance.

For needed modifications of standards, employees are given with written list of standards which he/she needs to be rated successful at the end of the rating period. Many enlisted personnel may proceed through the evaluation period with no knowledge of what objectives their rater would like to see them accomplish and often with no idea of standards of evaluation to be used by the rater (Pelissero, 1984).

The exploratory evaluation of the merit pay system attempts to address some of the issues of performance management and merit pay. More specifically, it addresses the role of merit pay pool managers in the performance appraisal process, their attitudes about the merit pay system and problems and prospects of the performance management system. It also identifies questions for further evaluation. In general, the intent of the system was to improve individual productivity and performance, to improve product performance (Brown, 1982) .

Being on competitive edge, many companies plan to enhance their work performance in different areas. It is important to capture casual relationships among the key factors and their interactions in the dynamic environment. This study utilizes the system dynamics (SD) modelling approach to develop the dynamics model of the performance index, and progress through to higher performance maturity levels in the long-term. The study results show that the construction companies can progress through to higher levels of performance maturity with support from management level to improve time, cost, safety, health and client satisfaction (Soewin, 2020) .

Web based student information system provides the online interface for students, faculty etc. and increase the efficiency of college record management by creating a web-based structure to decrease time required to access and deliver student records and make the system more secure (Bharamagoudar, 2013) .

Student Record Management System (SRMS) gives a straightforward interface to support of student data. It manages all sorts of student details, academic related reports, college details, fee details, results, batch details, attendance details and other resource related details too. It tracks all details of a student from first moment to the end of course which could be utilized for all reporting purpose and these all will be available through a secure, online interface embedded in the college's Student Record Management System (walia2014framework, 2014).

Performance appraisal is clearly in line with the supervisor-employee interview, in which employees are usually assessed once a year with a set of measurements and score on that assessment (DeNisi & Murphy, 2017; DeNisi, 2017).

In addition, job evaluations have a long history of control, hierarchical management, and complex information technology processes, which has caused dissatisfaction among observers and staff alike (Adler, Campion, Kolkitt, Grubb, Murphy, Hollander Crane, and Hollander Crane). 2016) (Adler, 2016).

The Performance Management was introduced in the early 1990s to address well-documented work evaluation limitations. The PM process encompasses a broader range of management practices, including career management, training and development, regular response and compensation thinking (Aguinis, 2007) (Biron, 2011) .

The PM is a continuous process, as opposed to a case-by-case assessment of the workforce once a year. At the same time, "PM is seen as an integrated process in which managers work with their employees to set expectations, review and review results, and perform rewarding work" (Den Hartog, Boselli and Pau, 2004, p. 4) (Hartog, 2004).

Finally, we identify the "acceptance" of a prime minister's bad worker and may still be a valuable prime minister's place, despite its current negative popularity (Cappelli and Tavis, 2016; Buckingham and Goodall, 2015). current organization. Thus, this study leads to the "acceptance" of key issues identified by scientists, as well as the unresolved and unresolved issues. Repetition also leads to the creation of an empirically based model for future research, which rejects an exclusive but flawed approach to evaluating work and requires a return to an inclusive, systematic approach to PM research (Cappelli, 2016).

Differences in national cultures will contribute to differences in the way that management systems are implemented in organizations around the world (Paletorpe,2011) (Palethorpe, 2011) . In addition, Parker said (2013) that the main disadvantage of evaluating the performance of organizations around the world is that they are setting criteria for meeting the goals set by their organizations (Parker, 2013) .

Slavin et al. According to him, (2014) it is correct to assume that measures for broadband or PMS productivity would be appropriate for organizations around the world. Because the decision-makers did not know enough about the results of the goals until a thorough and thorough examination was carried out (Slavin, 2014).

A well implemented PMS would lead to higher employee engagement and a more committed workforce (Kapoor & Meachem, 2012). Employee engagement on the other hand has proved to have a significant impact on the employee performance (Anitha, 2014; Kataria, Rastogi, & Garg, 2013) (Kapoor, 2012) . An improvement in employee performance

would future lead to an increase in the organizational performance (Savaneviciene & Stankeviciute, 2010) The comprehensive framework suggested by Clardy, (2013) shows that any PMS survives at four levels i.e. executive leadership, organizational infrastructure, human resource policies and procedures, and workplace working conditions (Anthia, 2014).

3. REQUIREMENT ANALYSIS

Understanding requirements is a primary activity to develop an efficient and usable digital solution. Requirement's analysis is an interactive, iterative process in which the expectations and needs of each stakeholder are explored. The outcome must be a comprehensive statement that covers all aspects of project or task completion – not just what's happening on our side. There are many different ways to analyze the needs of stakeholders in a project. Requirement analysis helps organizations to determine the actual needs of users. At the same time, it enables the development team to communicate with users in a language they understand (like charts, models, flow-charts, forms etc.)

In this research, we have adopted the field visit and structured survey approach to collect the requirements. As part of our field-visit, we had visited CSE and AE department of MIST. Once there, we collected in-depth information about the current structure and examined the process of flowing of OPR from one authorized person to another authorized person. After that, we conducted a brief structured survey to learn more about the existing MIST student officers needs and views on digitalizing the OPR management system. The survey responses were collected from the officers of armed forces of MIST. The findings of requirement analysis are summarized and presented in Table I. The participants of survey were military faculties and student officers. Officers of armed forces responded in the survey.

The pie charts of survey participants from armed forces are shown in Figure 5 below.

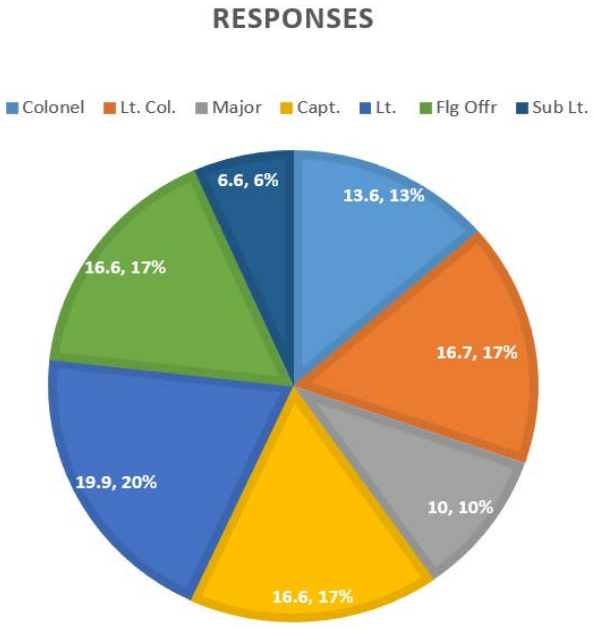

*Figure 5: **Response Chart of Officers***

The pie charts of survey participants from armed forces are shown in Figure 6.

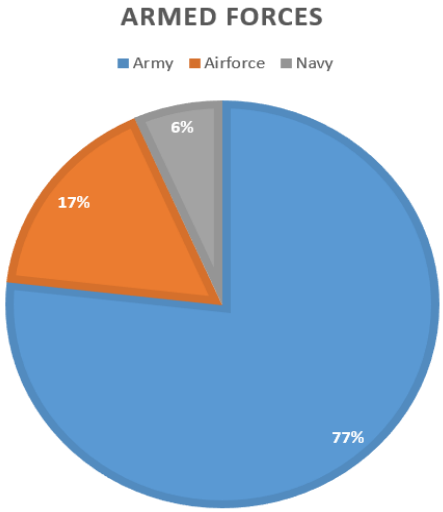

*Figure 6: **Percentage chart of Participants from armed forces.***

The functional and non-functional requirements can be shown in Table 1.

*Table 1: **Functional and non-functional requirements***

Types	Requirements
Functional Requirements	a) System should manage and store the information of the officers(name, rank, service no, course, date etc.) b) System should manage and store information related to format for calculating OPR score(games and sports, publication, backlog, warning, cgpa etc.) c) System should manage and store information of the course coordinators, heads, deans, headquarters (name, rank, service, service no, date, army/navy/airforce etc.) d) System should allow users necessary information to fill up OPR(height weight chart, format for calculating OPR score etc.) e) System should allow users to view the submitted OPR and its progress of update by the authorized personnel.
Non-functional Requirements	a) System should restrict access to all features as per user defined role. b) System should maintain a proper authorization process. c) System should be easily accessible and user friendly. d) system should meet maximum user satisfaction.

3.1 Actors of the System

The actors in the system are student officers, reviewing officers or organizations who are the users of this system and who are concerned about this automated system. The main users of the system and their roles are as follows:

(1) Student Officer: This refers to the individual who has to fill up OPR. They have to sign up using necessary information like service id, rank, name, department, level etc. Using unique id and password, they can log in the system and can fill up or edit information up to their allowed privileges.

(2) Medical Officer: Medical officer will be responsible for giving remarks about necessary information regarding physical tests like height, weight, vision etc. Only they can remark an officer as fit or unfit.

(3) Admin: Admin is that individual who is in charge of the system. Admin can add levels, departments, course coordinators, head of the departments, deans, headquarters etc. in the system and also can remove them from the system. They assign these users for functioning different tasks of the individual user.

(4) Course Coordinator: Course coordinators will be responsible for assessing an officer. They can view OPR calculating form filled up by admin and from that form they can have an idea regarding the officer in different aspects. They will be able to see the OPR form filled up by an officer and they will assess the officers accordingly. They will submit the OPR to head of department after assessing.

(5) Reviewing Officers: Reviewing officers are directly involved with assessing an officer. They review the student officer's OPR rated by a rater. The types of reviewing officers are as follows:

a. **Head of Department:** After submission by course coordinator, head of the departments will be able to assess the officer by giving remarks. They will be able to see the OPR filled up by student officer, medical officer, course coordinator etc. After assessing the officer in the OPR, they will submit the form to the dean of the respective department.

b. **Dean:** This refers to the reviewing officers who are responsible for assessing the officer after it has been assessed by their head of the departments. Dean of the respective department will be able to view the OPR updated up to the head of the departments. After assessing in the OPR, they will submit the OPR to the respective headquarters.

(6) Headquarters

a. **Army HQ:** OPR of army officers will be submitted to the army headquarter after assessed by dean of the respective departments. In army headquarter one authorized officer responsible for assessing the OPR will assess the OPR and archive it through printing or storing in database.

b. **Naval HQ:** OPR of naval officers will be submitted to the naval headquarter after assessed by dean of the respective departments. In naval headquarter one authorized officer responsible for assessing the OPR will assess the OPR and archive it through printing or storing in database.

c. **Air HQ:** OPR of air officers will be submitted to the air headquarter after assessed by dean of the respective departments. In air headquarter one authorized officer responsible for assessing the OPR will assess the OPR and archive it through printing or storing in database.

3.2 Conceptual Framework

This section is focused on the conceptual framework of our proposed system that represents the key concepts which can be used for knowing, understanding and simulating our system. Some of the key features that our system offers are as follows:

(1) Filling up OPR automatically: Officers will log into the system and initiate one OPR per year. They will fill up OPR and confirm submission. After submission, they will only be able to view the OPR but not updating OPR. By doing it automatically, time will be saved.

(2) Assessment of OPR by Medical Officer: After filling up OPR by an officer, medical officer has to write about physical condition of that officer. Physical condition includes height, weight, category and fitness of an officer.

(3) Assessment and Rating of OPR by Course Coordinator: After the assessment of medical officer, course coordinator will assess an officer in various sectors. For assessing an officer, first course coordinator will see different information like backlog, failing in any subject, no of publications, participation in games and sports, verbal warning, corresponding OPR base score according to length of service etc. which will be filled by admin. Basing on the information, the OPR of an officer will be assessed by the course coordinator in different sectors.

(4) Reviewing of OPR by Head of the Department: After the OPR of an officer is assessed by course coordinator, they will be reviewed by head of the respective department.

(5) Reviewing of OPR by Dean: After the OPR is reviewed by departmental head, it will be forwarded to dean of the respective department. Dean will review the OPR of the officer and submit it to army/naval/air headquarter.

(6) Reviewing of OPR by Army/Naval/Air Headquarter: The final OPR archiving will be done

by army/naval/air headquarter. Before archiving the OPR, one authorized officer will view the OPR and give remarks on it.

(7) Management of maintenance of the system: Admin panel will be responsible for adding or removing different level of users. They will be responsible to ensure the validity of the system. They will be responsible to assign user roles.

(8) Authorization: Any user of the OPR management system other than the student officer whose OPR has to be assessed will need to log in using their unique ID and password automatically generated by the system to access their profile. Thus, their personal information will only be accessible by them and their profiles will remain secured.

(9) Managing information of officers: Different information of officers related to their department, level, course coordinator, OPR calculating form etc. is maintained by this system. According to these details their OPR is forwarded to respective authorized personnel.

Figure 7 illustrates the conceptual framework of the work.

***Figure 7:* Conceptual Framework**

4. SYSTEM DESIGN

4.1 Platform

The platform of the whole project is a web-based platform. Only web platform has been used for data integration and processing the whole data and viewing and archiving of OPR report. Thus we have generated a web-based application till now. Our project is to develop an automated OPR management system for MIST student officers and admin panel to manage the system and assigning users and defining user roles on web-based platform.

4.2 Used Technologies

In the frontend of the website HTML, CSS, JS and Bootstrap have been used. In the backend Django has been used and SqLite database has been used to develop the website.

4.3 Available Features

Available features of the website are the following:

- Sign up and login processes
- Initiation of OPR form
- Viewing of OPR
- Updating of OPR before confirmation
- Confirmation of OPR for submission
- Medical officer's assessment
- OPR calculating form updating by admin
- OPR rating system by course coordinator
- OPR reviewing system by department head, dean and respective headquarter.

4.4 User Interface

The user interface (UI) is the point where human interact with computer, website, application or communicate in a device. This can include display screens, keyboards, a mouse and the appearance of a desktop. User interfaces allow users to practically control computer, website, application or device they are interacting with.

4.4.1 User End Website Demonstration

We have completed the entire web application in order to implement all of the features that have been discussed thus far. The following are a few examples of user-facing website demonstrations.

4.4.1.1 Homepage

Users will select login or sign-up option in the website which will direct themselves to their respective pages. Homepage of OPR management system is shown in Figure 8.

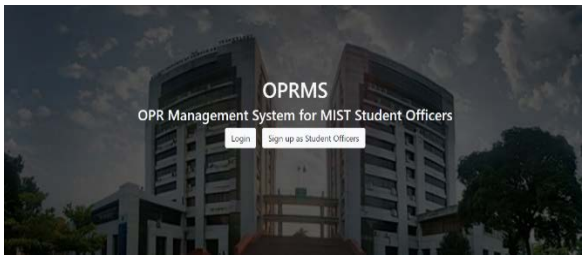

***Figure 8:* Homepage**

4.4.1.2 Sign Up page

Selecting sign up option from the homepage, new users will be able to create an account for themselves. Only one unique and valid email will be applicable for signing up a user. Before logging in to the system, the email will be validated by the system. A valid email user after signing up and filling necessary information will be able to log in to the system. Sign up page for officers is shown in Figure 9.

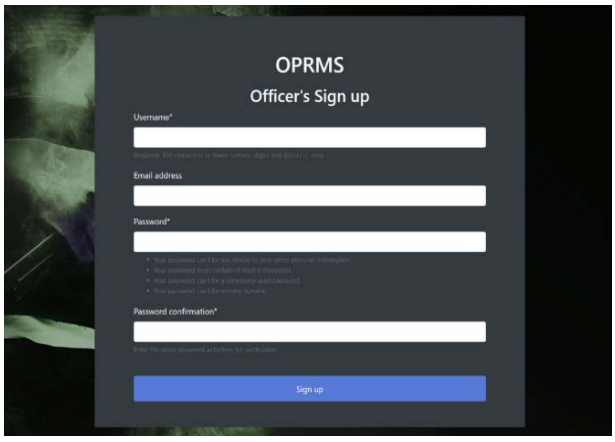

***Figure 9:* Sign Up page for officers**

4.4.1.3 Officer's Profile

Sign up page will direct newly signed users to fill up some details of the user's profile required for the system. Profile page for officers is shown in Figure 10.

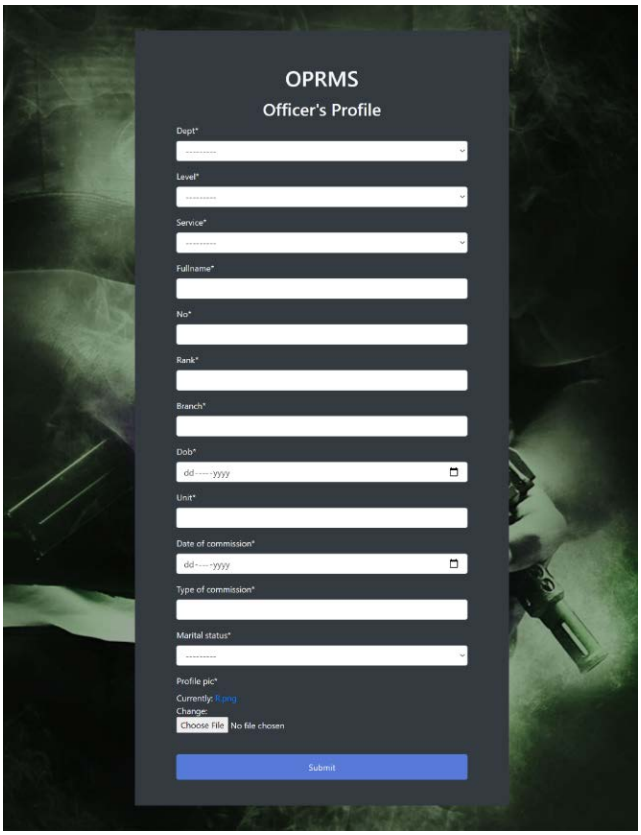

Figure 10: ***Profile page for officers***

4.4.1.4 Verification Message

After completion of signing up and filling up profile page for newly signed users, their email will be validated and after clicking on the message sent in the valid email, newly signed users will be directed to the login page where they will be able to log in to the system. Verification message sent to the newly signed user is shown in Figure 11.

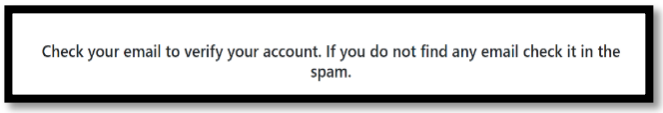

Figure 11: ***Sign Up page***

4.5 Discussion

In this study, three variables were considered to measure the effectiveness and user satisfaction of the website: Asked for help, System Error and Task Completion Time.

4.5.1 Effectiveness

From Table 5.1 and Table 5.2, it is seen that all the participants were able to complete all the given tasks without any system error. There were no tasks where participants felt difficulty. This is because all the participants were from armed forces and they had knowledge about the structure and procedure of the management of the system. Except for internet failure, no other system error was observed. The results from all three variables indicate that the participants completed their tasks effectively using the website.

4.5.2 Satisfaction

After using the website, participants gave positive feedback about the website. They express their comforts while using the website. The overall satisfaction level of the participants was comparatively high. They were all positive about using the system in the future. Their overwhelming feedback from table 5.1 and table 5.2 show that they were very satisfied with the website especially the officers from airf orce. Frequency of satisfaction is from 0.72 to 0.925 which is very high. During using the website, no participants asked for help and completion of time of task was also very less. From the open-ended questions, the study found that a vast majority of the participants thought that the website will provide an easy-to-use and convenient way to support the difficult and time consuming management of the system. A few of them also provided helpful suggestions; for example, adding features like using Bengali font to make OPR for army student officers, showing the state of the presence of OPR, showing mandatory and optional field etc.

5. CONCLUSIONS

We can draw some conclusions about the design and experiments. In this work, a research project which studies the current OPR management system in Bangladesh Armed Forces and efficient way to introduce a web based OPR management system is presented. Interviewing personnel active in present OPR management system and building a web based OPR management system is the main concern in this research project. We believe and hope this system will be of great help to the society and also for Bangladesh Armed Forces.

ACKNOWLEDGEMENTS

First, we would like to express our heartiest gratitude to The Almighty for His sacred blessings which made it possible for the successful completion of our thesis. Then we would like to express our grateful appreciation to Tasmiah Tamzid Anannya, BSc. in MIST, MSc. in BUET, Lecturer, Department of Computer Science and Engineering, MIST for being our supervisor and guiding us throughout the thesis work. Her suggestions, supervision, encouragement and motivation for this thesis have been indispensable. This research would not have been possible without her mentorship and constant support. Her valuable time, advices, constructive criticism and assistance provided throughout the study was of great help of completing thesis. We are truly grateful to her. We are especially grateful to the Department of Computer Science and Engineering of Military Institute of Science and Technology for providing their support throughout the thesis work.

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AUTHOR BIOGRAPHY

Nusrat Zahan has passed SSC from Vikarunnesa School and College in 2012 with CGPA 5 out of 5 and passed HSC from Vikarunnesa School and College in 2014 with CGPA 5 out of 5. She enrolled BSc. in CSE, in the Military Institute of Science and Technology (MIST), one of the prestigious organizations of Bangladesh, in 2017. She successfully completed her graduation in 2022.

Nafiun Nahar Polok has passed SSC from Joypurhat Girls' Cadet College in 2014 with CGPA 5 out of 5 and passed HSCfrom Joypurhat Girls' Cadet College in 2016 with CGPA 5 out of 5. She enrolled BSc. in CSE, in the Military Institute of Science and Technology (MIST), one of the prestigious organizations of Bangladesh, in 2018. She successfully completed her graduation in 2022.

Tasmiah Tamzid Anannya is a Lecturer in the department of Computer Science and Engineering of Military Institute of Science and Technology. She has published extensively as author and co-author of 18 papers in different international conferences and journals. Her research interest is mainly focused on Ad Hoc Networking, Block chain, HCI, IoT. Her research interests are primarily in Ad Hoc Networking, Block Chain, HCI, and IoT. She is presently monitoring multiple projects and researches in her field of interest.

CSE TECHNICAL PAPER
The MIST Journal of Computer Science and Engineering

Design and Develop of a Transformable Wheel Mechanism for A Military Surveillance Robot

Md Isfar Sayeed[1], Syeda Nafiza Anjum Tanha[2], and M. Akhtaruzzaman[3]

Department of CSE, Military Institute of Science and Technology (MIST), Dhaka, Bangladesh

emails: [1]*isfarsayeed@gmail.com;* [2]*nafizatanha96@gmail.com, and* [3]*akhter900@cse.mist.ac.bd*

INFO

History:

Started: 04th April 2021
Proposal defence: 10th June 2021
Final defence: 27th March 2022
Submitted: 03rd April 2022
Published: 30th June 2022

Keywords:

Surveillance
Military surveillance
Surveillance robot
Mobile robot
Transformable wheel

ABSTRACT

Surveillance is the process of monitoring a situation, an area, or a person. In a military combat scenario, surveillance systems provide a great advantage to the troops in terms of monitoring, perceiving, understanding, and decision making. To facilitate autonomous surveillance for Bangladesh military, this project focuses on the design and development of a small-sized, light weight, two-wheeled mobile robot. These characteristics of the robot will make it unique in terms of hiding, silent mobility, and portability. One of the biggest challenges of the system is ensuring its mobility in any kind of terrain, which will be solved by designing novel transformable wheels and implementing intelligent localization and mobility sensing techniques. The objectives of this project are, a) to design and develop a two-wheeled small-sized robot, b) to design and develop a transformable wheel mechanism to ensure mobility on rough terrain, and c) to construct and implement a chassis framework that will hold the entire system. Curve cam mechanism, also known as Plate cam mechanism, is a widely used machine component with the continuous contact motion between cam and follower. Despite all the advantages like fewer links, simple structure, compact design, the cam setup produces heavy vibration, noise, consumption of excess power and can decrease the overall efficiency of the robot. Proper utilization of component materials, accurate and specific design of the grooves, circular rack and pinion gear will ensure the correct implementation of the overall setup. The traditional military force will be digitalized by the introduction of this robot during on field operations. Moreover, Life threatening missions which are too risky for troops can be successfully completed by this robot. The innovative expansion mechanism will facilitate maneuver over rugged terrain so that the robot is fit to serve under all surface conditions. The robot is designed following the standards provided by Occupational Safety and Health Administration (OSHA) which governs the overall robot development around the world. OSHA determines rules and regulations to maintain a healthy working environment ensuring the safety of man and material involved with the overall process of surveillance and monitoring.

নজরদারি হল একটি পরিস্থিতি, একটি এলাকা বা ব্যক্তিকে পর্যবেক্ষণ করার প্রক্রিয়া। একটি সামরিক যুদ্ধের পরিস্থিতিতে, নজরদারি ব্যবস্থা সৈন্যদের পর্যবেক্ষণ, উপলব্ধি, বোঝা এবং সিদ্ধান্ত নেওয়ার ক্ষেত্রে একটি বড় সুবিধা প্রদান করে। বাংলাদেশ সেনাবাহিনীর জন্য স্বায়ত্তশাসিত নজরদারি সহজতর করার জন্য, এই প্রকল্পটি একটি ছোট আকারের, হালকা ওজনের, দুই চাকার মোবাইল রোবটের নকশা এবং বিকাশের উপর দৃষ্টি নিবদ্ধ করে। রোবটের এই বৈশিষ্ট্যগুলি এটিকে লুকিয়ে রাখা, নীরব গতিশীলতা এবং বহনযোগ্যতার ক্ষেত্রে অনন্য করে তুলবে। সিস্টেমের সবচেয়ে বড় চ্যালেঞ্জগুলির মধ্যে একটি হল যে কোনও ধরণের ভূখণ্ডে এর গতিশীলতা নিশ্চিত করা, যা অভিনব

রূপান্তরযোগ্য চাকার ডিজাইন এবং বুদ্ধিমান স্থানীয়করণ এবং গতিশীলতা সেন্সিং কৌশল প্রয়োগ করে সমাধান করা হবে। এই প্রকল্পের উদ্দেশ্যগুলি হবে, ক) একটি দুই চাকার ছোট আকারের রোবট ডিজাইন এবং বিকাশ করা, খ) রুক্ষ ভূখণ্ডে গতিশীলতা নিশ্চিত করার জন্য একটি রূপান্তরযোগ্য চাকা প্রক্রিয়া ডিজাইন এবং বিকাশ করা, এবং গ) একটি চ্যাসিস ফ্রেমওয়ার্ক তৈরি এবং বাস্তবায়ন করা যা পুরো সিস্টেমকে ধরে রাখবে। কার্ভ ক্যাম মেকানিজম, প্লেট ক্যাম মেকানিজম নামেও পরিচিত, ক্যাম এবং ফলোয়ারের মধ্যে ক্রমাগত যোগাযোগের গতি সহ একটি বহুল ব্যবহৃত মেশিন উপাদান। কম লিঙ্ক, সাধারণ কাঠামো, কমপ্যাক্ট ডিজাইনের মতো সমস্ত সুবিধা থাকা সত্ত্বেও, ক্যাম সেটআপ ভারী কম্পন, শব্দ, অতিরিক্ত শক্তি খরচ করে এবং রোবটের সামগ্রিক দক্ষতা হ্রাস করতে পারে। উপাদান সামগ্রীর সঠিক ব্যবহার, খাঁজগুলির সঠিক এবং নির্দিষ্ট নকশা, বৃত্তাকার র্যাক এবং পিনিয়ন গিয়ার সামগ্রিক সেটআপের সঠিক বাস্তবায়ন নিশ্চিত করবে। ফিল্ড অপারেশনের সময় এই রোবটটি প্রবর্তনের মাধ্যমে ঐতিহ্যবাহী সামরিক বাহিনীকে ডিজিটাল করা হবে। অধিকন্তু, সৈন্যদের জন্য অত্যন্ত ঝুঁকিপূর্ণ জীবন-হুমকি মিশনগুলি এই রোবট দ্বারা সফলভাবে সম্পন্ন করা যেতে পারে। উদ্ভাবনী সম্প্রসারণ প্রক্রিয়া রুক্ষ ভূখণ্ডের উপর কৌশলগুলিকে সহজতর করবে যাতে রোবটটি সমস্ত পৃষ্ঠের পরিস্থিতিতে পরিবেশন করার জন্য উপযুক্ত হয়। রোবটটি অকুপেশনাল সেফটি অ্যান্ড হেলথ অ্যাডমিনিস্ট্রেশন (OSHA) দ্বারা প্রদত্ত মান অনুসরণ করে ডিজাইন করা হয়েছে যা সারা বিশ্বের সামগ্রিক রোবট উন্নয়নকে নিয়ন্ত্রণ করে। OSHA একটি স্বাস্থ্যকর কাজের পরিবেশ বজায় রাখার জন্য নিয়ম ও প্রবিধান নির্ধারণ করে যা সামগ্রিক প্রক্রিয়ার সাথে জড়িত মানুষ এবং উপাদানের নিরাপত্তা নিশ্চিত করে।

1. INTRODUCTION

Military interest in terrain surveillance is not new. The process plays a vital role in border areas to keep eyes on the enemy. These tasks are generally difficult and risky for soldiers, so unmanned robots are preferable to accomplish the task (Sanaullah, Akhtaruzzaman, & Hossain, 2022). The ability to cross rough terrain conditions and successfully collect information about the opponents whereabouts has made these surveillance robots very popular in recent times. The simplified design structure and effective use of Plate cam mechanism has allowed this robot to meet its requirements.

1.1 Motivation

Bangladesh shares land borders with India to the west, north, and east, and Myanmar to the southeast. To the south it has a coastline along the Bay of Bengal. The present situation along the border areas has been volatile and the Border Guards of Bangladesh (BGB) are regularly losing a lot of troops everyday while conducting patrol operations along the boundary. To address the situation, research and analysis on surveillance robots are held to come up with a solution to this problem. Rather, modern day Armies around the globe are popularly using these sorts of unmanned vehicles for tackling these conditions. Surveillance robots are made robustly and ensure survival and safety of their own. They are capable of capturing audio, video, and geographical information when deployed and successfully transmit back information to the control station. Wireless long distance controlling mechanism allows these robots to be efficiently used in various operations. The swift and minimalistic approach towards designing these robots allow maintenance of secrecy and concealment which results in the robot being undetected to enemy radars. But having all these qualities, yet they face difficulty in maneuvering over rough terrains, resulting the failure of the operation. As Bangladesh is advancing in all sectors and for reaching the dream goal of Digital Bangladesh, introduction of robots of this kind will be greatly necessary.

1.2 Problem Statements

The most important aspect of Surveillance robots is ensuring the safety of manpower. The overall idea is to conduct reconnaissance and maneuver operations without direct involvement of troops but ensuring the task is completed properly. The system has basically four technical problems to be addressed, 1) Ensuring long distance wireless communication, 2) Tough and compact design to sustain harsh environments, 3) maintain secrecy and must be energy efficient by simplification of circuitry to reduce wastage so that the robot can work longer away without recharge, and 4) the system must be able to gather information from the environment using its sensory devices and send back data towards the control station. The system must be online throughout the span of operation. It must be monitored and properly guided to avoid failure of operation. Using so much equipment together can become clumsy and designing the system minimally is a challenge. There are options of adding more equipment and the important decision of choosing the right set of devices plays a key role here. The development of these types of robots will change the dimension of military surveillance completely. Besides these, few of the other notable challenges are:

- To design a wheel that can transform in certain situations to cross obstacles and again come back to normal form in plain land.

- Creating enough power into the wheels will play a vital role in determining the success of the project.
- Monitoring the movement of the robot in these types of missions is a great challenge.
- As the external environment will be harsh and designing a simple but effective structural design will be a prime factor in the development of the robot.

1.3 Objectives

Write There are numerous problems in developing a surveillance robot. Each robot is designed independently based on the set of skills to be accomplished. To attain complete effectiveness, it is vital to identify which objectives must be met so that they fulfill the requirements. As a result, extensive comparative analysis is required, as well as prior discussion of the benefits and drawbacks of each trait. It will be possible to determine the components that should be added or removed based on the objectives. The proposed transformable two-wheeled surveillance robot has the following goals:

- To design and develop a two-wheeled small-sized robot.
- To design and develop a transformable wheel mechanism to ensure mobility on rough terrain.
- To construct and implement a chassis framework that will hold the entire system.

1.4 Research Methods

The first step is requirement analysis and literature study. At this stage, necessary components are selected and necessary papers and articles related to the project are studied for better understanding of the topic. Next step is to complete the initial design of the robot and find the appropriate components to build this robot. The components must be caparisoned to justify the right set of chosen ones. Next the transformable wheel prototype is designed which is one of the key features of this experiment. The sensors are calibrated and tested to achieve accuracy. All the components are together set up and circuit integration is completed. Now the system is fully functional, therefore it is tested under superficial conditions. If the performance is satisfactory, the project documentation is done. This was an overall brief about the methodological approach of the topic.

1.5 Manuscript organization

The paper covers literature review, requirement analysis and component selection, design, result analysis, and conclusion of the project undergone.

2. LITERATURE STUDIES

A literature review is a survey of scholarly sources on a specific topic. It provides an overview of current knowledge, allowing to identify relevant theories, methods, and gaps in the existing research.

Small mobile robots with high maneuverability are highly demanded in various uncertain, unreachable terrains such as narrow space in damaged buildings after disasters, radiation environments and complex working fields in wild terrains, etc. These robots enable researchers to obtain related information from far distances and improve reconnaissance efficiency and disaster handling ability (Hougen, 2000; Akhtaruzzaman, Shafie, & Khan, 2017; Akhtaruzzaman et al., 2020; Zaman et al., 2022).

Currently, wheeled mobility is the most common way for mobile robots since its high maneuverability and stability. However, this mobile mechanism is limited in climbing over obstacles. For example, the wheeled mobility can hardly overcome the obstacles higher than its radius of the wheel (She, 2015).

Various methods have been proposed to tackle these problems, for instance, special wheel configurations. The Epi.q series robots passively adapt their locomotion from rolling on wheels to stepping on rotating legs, according to ground conditions and obstacle presence, without an active control intervention (She, 2015).

The Lazaro robot consists of skid-steeled wheels plus a 2-DOF caster-leg to cross different surface discontinuities, and this configuration is useful for improving vehicle stability on slopes (García, 2015; 2017). However, most robots with special wheel configurations have complex mechanical structures and low mobility efficiency.

The robot ASGUARD is a hybrid quadruped outdoor robot which was inspired by insect locomotion. The robot is driven by four directly actuated pentagram-legs with one rotational degree of freedom. Experimental showed that by only using a proprioceptive torque feedback the robot can climb stairs (Eich, 2008).

A new type of obstacle climbing wheel with claws was designed by Bei hang University, and kinematic and dynamic simulations of the wheel were performed. The wheel can scale a step with a height that is 1.4 times larger than the wheel radius, and the wheel has strong crossing obstacle capabilities in uneven terrain environments. (Hellstrom, 2012).

Tao sun proposed a new type of transformable wheel-legged mobile robot that could be applied on both flat and rugged terrains. It integrates stability and maneuverability of wheeled robot and obstacle climbing capability of legged robot by means of a wheel-legged transformable mechanism. These two modes can be switched easily with two spokes touching terrain. In this paper, the motion analysis of the proposed robot under wheeled mode, legged mode and transformable mode are carried out after briefly introducing the concept and control system design. Then, the obstacle climbing strategies under wheeled and legged modes are obtained (Quaglia, 2013). Finally, a prototype of the proposed robot is designed and manufactured based upon the simulation analysis. The experimented results validate the effectiveness of the proposed transformable surveillance robot.

3. REQUIREMENT ANALYSIS & COMPONENT SELECTION

Eliciting requirements is a vital phase in the development of information systems, with substantial implications for software quality and costs (Akhtaruzzaman, Shafie, & Rashid, 2011). Eliciting requirements is a complex process requiring

multiple actions and a wide range of methodologies, approaches, and tools for doing so. The goal of the requirement elicitation study was to learn more about the field's breadth and conditions, as well as the characteristics that need to be included to design a system to investigate the need for a transformable surveillance robot and its features. The requirement elicitation process used in the study is discussed in this chapter.

3.1 Requirement Collections

Under the supervision of our respected supervisor, the student officers of CSE-18 of level 4 were interviewed and surveyed to find out the specification required to design an effective surveillance system. The interviews were semi-structured. A set of questionnaires were set for the participant keeping in mind the research objective. Participant's consent to ensure anonymity and confidentiality were collected through email or in printed form.

3.2 Requirement Analysis

After detailed discussion, study and requirement finding, a lot of important requirements have come to light. Analyzing the research studies, the most crucial specifications are selected which are to be covered in the domain of the objectives. Some of the notable features to be accomplished are as follows:

- Small, lightweight, robust, and compact design for surviving harsh environments and maintaining camouflage and concealment.
- Ensure such an arrangement of the wheels so that they can maneuver over difficult terrain without hassle.
- Having equipped with sensory devices for receiving, sending, and sensing environmental data persisting in the operation area.
- Must be capable of being monitored and controlled wirelessly over long distances.
- Must be provided with intelligent localization gadgets.
- Must have a powerful battery supply for prolonged mission tenure.

3.1 Component Selections

The components that facilitate the propagation of the multifunctional robot are discussed in this section. The robot can be divided into modules, each with its own set of capabilities. Because of technological improvements, these surveillance robots are now being used in far-flung locations.

***Table 1:* Selected Components**

Item	Descriptions
Motor Driver	1
Rechargeable lithium-ion battery	2
MG90S Micro Metal Gear Servo motor	2
50 RPM Geared Motor 25mm	2
5.5mm Motor mount & 3.5mm Hex coupler	2
Caster Ball	1

For achieving the total functionality of the robot, a set of specific components is required. The proper integration of all of these will facilitate the development of a fully functional surveillance robot with a transformable wheel. To achieve efficiency, the items were selected carefully based on the requirement and keeping cost effectiveness in mind.

4. TRANSFORMABLE WHEEL DESIGN & IMPLEMENTATION

The mechanical structure of the surveillance robot with a transformable wheel is shown below where there are 5 legs with traction surfaces attached to them. The 2 working mode is achieved by the transformable mechanism, thus the robot can roll as a normal wheeled robot and as an expanded wheeled robot. The triangular body is designed to support the control hardware.

The motors are attached with the rotating wheel and outside of the main frame. There are in total 4 motors used. Two motors for driving the vehicle and two motors for expanding the wheels. Rubber paddings are evenly embedded in the rim of the wheel to increase friction between wheels and terrain.

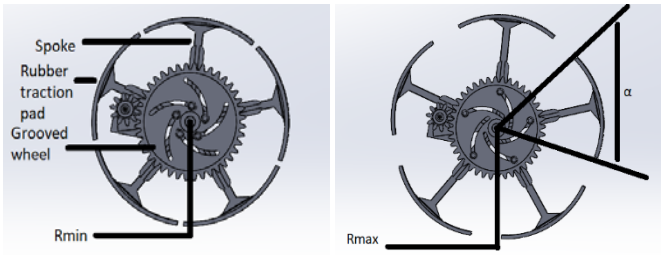


***Figure1:* Normal and expanded condition of wheel mechanism**

$R_{\min}$ is the radius of the wheel in normal mode. The wheel functions just like a normal wheel which is only functional for mobility on a flat surface.

The legs are expanded by gear and cam mechanism. The servo motor is programmed to rotate a fixed degree which initiates the expansion and contraction as per the requirement. R_{max} is the radius of the wheel after maximum expansion and α is the extreme arc of each spoke.

5. RESULT ANALYSIS

A lightweight evaluation study through users' feedback has shown good results in judging the outcome of the project. Moreover, testing the robot under different superficial environments to find out the efficiency of the robot has been an important part of this study.

5.1 System Usability

The student officers of CSE-18 participated in the survey conducted to test the robot interface and its usability. After using the robot and operating it, a set of questions were given to the participants. There were few criteria that were given emphasis on, and they were scaled out of 5, based on the user's satisfaction and observation regarding each criterion. The sample of the survey paper is given below:

***Table 2:* Sample of the Survey Questions and Scores**

Questions	Scores (Out of 5)
How much will you rate the control remote experience?	4
Score the systems overall promptness and response time?	3
Rate the effectiveness of the operations commanded?	4
Rate the complexity of the system? (Example 1=low, 5=high)	2
Rate the design of the model in maintaining camouflage and concealment?	3

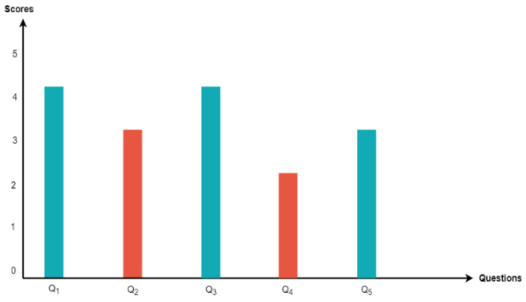


***Figure 2:* Statistical Feedback of User Experience**

5.2 Testing the Expansion Mechanism

The expansion of the wheels was tested after successfully 3D designing the transformable wheels. The sample photos are attached here as follows:

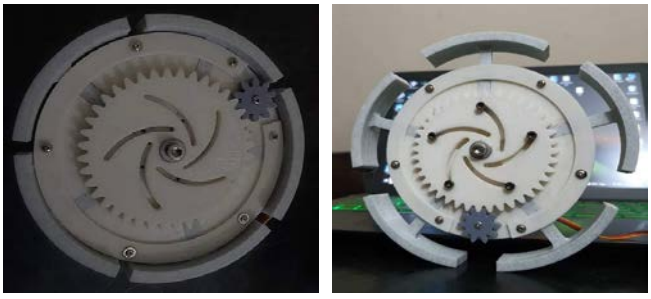
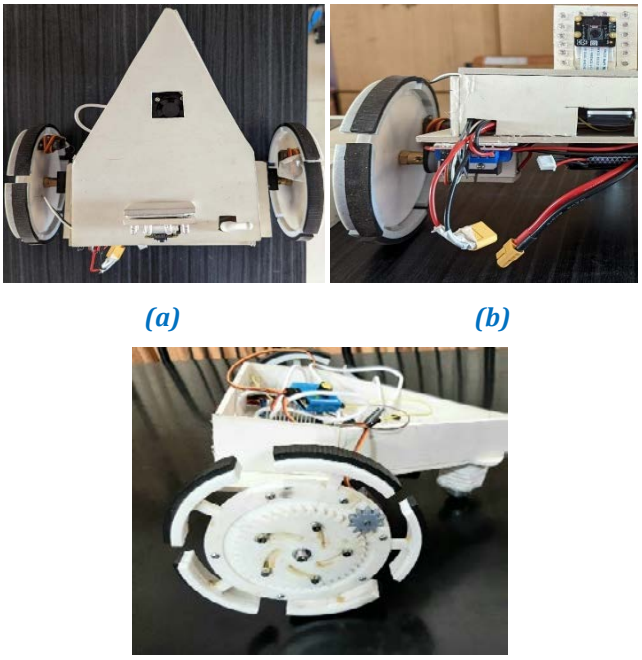


***Figure 3:* (a) Normal state of the Wheel, (b) Expanded state of the Wheel**

After the first set of wheels were printed, there was a problem with the grooves at the center wheel. The wheels couldn't expand to its maximum capacity, due to technical problems caused by faulty 3D printing of the wheels. Later in the second phase, the design was corrected to solve the problem.

5.3 Final design of the model robot

The chassis was designed using PVC hardboard, which is very user friendly, cost effective, and can be easily modified. The material is flexible yet tough enough to withstand the external factors. Rubber paddings were added to improve traction and the tail was constructed using a caster ball.



(a) ***(b)***

(c)

***Figure 4:* (a) Top View of Full Model, (b) Bisected Frontal View in Wheel Mode, and (c) Side View During Expanded Mode**

6. CONCLUSIONS

The outcome of the project will contribute to the development of a transformable robot which will play a vital role in carrying out critical military surveillance operations and ensure safety of soldiers by performing risky tasks without the direct involvement of soldiers. The contributions worth mentioning are discussed consecutively. The outcomes are the results that were targeted to be achieved by the course of action of the project. The outcomes of the project are:

- A transformable wheel mechanism for a small sized surveillance robot.
- A simple and light-weight chassis design for the robot with the intension of preserving secrecy.
- A workable prototype framework for military surveillance robot.

There are several points that must be accounted for when assessing reliability of this analysis. Firstly, testing of the robot was done under supervised conditions which don't depict the real environment. The maximum coverage of communication between controller and robot was about 500 m while the tests were conducted, but the real surveillance operations are carried out from miles away. There is also a deficiency of electric power supply because these operations can take days and this limited stock of electric backup isn't enough.

ACKNOWLEDGEMENTS

We are thankful to Almighty Allah for his blessings for the successful completion of our thesis. Our heartiest gratitude, profound indebtedness and deep respect go to our supervisor,

Dr. M. Akhtaruzzaman, Department of Computer Science and Engineering, Military Institute of Science and Technology, for his constant supervision, affectionate guidance and great encouragement and motivation. His keen interest on the topic and valuable advice throughout the study was of significant help in completing the thesis. We are especially grateful to the Department of Computer Science and Engineering (CSE) of Military Institute of Science and Technology (MIST) for providing their all-out support during the thesis work. We would like to sincerely thank the 24 participants who spared their valuable time to share their valuable opinion on designing this advanced military system. Finally, we would like to thank our families and our course mates for their appreciable assistance, patience, and suggestions during our thesis.

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AUTHOR BIOGRAPHY

Md Isfar Sayeed has passed SSC from Cantonment English School and College in 2014 with CGPA 5.00 out of 5.00 and passed HSC from Rajuk Uttara Model College in 2016 with CGPA 5.0 out of 5.0. He enrolled BSc. in CSE, in the Military Institute of Science and Technology (MIST), one of the prestigious organizations of Bangladesh, in 2017. He successfully completed his graduation in 2022. During his graduation, Isfar participated in different project making in MIST and other sporting events. He showed keen interest in robotics and in development of modern warfare. He wants to utilize his knowledge in contributing to the development of Bangladesh Army.

Syeda Nafiza Anjum Tanha has passed SSC from Rajuk Uttara Model College in 2013 with CGPA 5.0 out of 5.0 and passed HSC from Rajuk Uttara Model College in 2015 with CGPA 5.0 out of 5.0. She enrolled BSc. in CSE, in the Military Institute of Science and Technology (MIST), one of the prestigious organizations of Bangladesh, in 2017. She successfully completed her graduation in 2022. During her graduation, Tanha participated in different programming contests around the country. She also achieved outstanding results in various cultural competitions. She wants to utilize her knowledge in contributing to the development of Bangladesh Army.

Dr. M. Akhtaruzzaman is an Assistant Professor in the Dept. of Computer Science and Engineering, Military Institute of Science and Technology, Bangladesh. He is also associated with DREAM Robotics Ltd., Dhaka, Bangladesh as a Consultant and Research scientist. He was awarded the PhD and MSc. from IIUM, Malaysia, and the BSc. from IIUC, Bangladesh. He has published 50+ research articles and awarded several Gold Medals as the recognition of his research works. His field of interest includes robotics, mechatronics systems, control engineering, AI, fuzzy systems, and quantum computing.

CSE TECHNICAL PAPER
The MIST Journal of Computer Science and Engineering

Automation Project for Inventory Management of Ration to Include Demand, Collection of Fresh/Dry Ration and Generation of Associated Reports

Erteka-Ur-Rahman[1], Rizwanul Hoque[2], Sharifa Rania Mahmud[3], and Zinia Sultana[4]

Department of CSE, Military Institute of Science and Technology (MIST), Dhaka, Bangladesh

emails: [1]*erteka.rahman@gmail.com;* [2]*rizwanul10465@gmail.com;* [3]*sraniamahmud@gmail.com; and* [4]*sultana.hiramony@gmail.com*

INFO

History:

Started: 9th October 2021
Proposal defence: 15th January 2021
Final defence: 27th March 2022
Submitted: 4th April 2022
Published: 30th June 2022

Keywords:

Ration
Ready Reckoner
Fresh Calculation
Food Distribution
Reports and Return
Inventory Management
Military Administration

ABSTRACT

Defense services provide food, known as 'Ration' to its member through Supply Depot via Unit (smallest administrative military component). In military, ration refers to specific food items both non-perishable (dry) and perishable (fresh) which are provided in a specific quantity to feed members of the armed forces. The current systems for inventory management of ration and its related systems are manual, paper-based, backdated, time consuming and prone to errors and malpractices, which if modified will become more efficient. The proposed project endeavours to develop web-based application software to automate the components related to food distribution system for the defense services specifically, demand and collection procedure, reports and return, inventory management, fresh calculation and ready reckoner. A handful related works were studied to learn available knowledge on the topic as well as to understand the existing system. The V-Model was followed during the implementation of the project. Requirement elicitation was carried out intensively by means of visit, interview, online survey, and ground survey and field study. The user requirements indicated layered system architecture to be followed and Django was used for developing the web-site and storing the data in SQLite database. The proposed project was evaluated by both expert and user only to find that the system satisfied the users mostly with few limitations as well. The existing system takes away more time, require more efforts to maintain and possess many loopholes which needed attention, on contrary the proposed project will bring together everything related to ration in a more efficient, organized, secured and fastest way.

সামরিক বাহিনীতে, ডিপো হতে ইউনিট সমূহে (ছোটতম প্রশাসনিক সামরিক সংগঠন) তার সদস্যদের খাদ্য সরবরাহ করা হয়, যা 'রেশন' নামে সুপরিচিত । সামরিক বাহিনীতে, রেশন বলতে অপচনশীল (শুকনো) এবং পচনশীল (তাজা) উভয় ধরনের নির্দিষ্ট কিছু খাদ্য সামগ্রীকে বোঝানো হয়, যা তার সদস্যদের একটি নির্দিষ্ট পরিমাণে বণ্টন করা হয়। রেশন মজুদ ব্যবস্থাপনা এবং এর সাথে সম্পর্কিত প্রক্রিয়াগুলি বর্তমানে সম্পূর্ণরূপে হস্ত-চালিত, কাগজ-ভিত্তিক, সেকেলে, সময়সাপেক্ষ এবং ত্রুটি ও অসদাচরণ প্রবণ- যা পরিকল্পিত সংশোধনীর মাধ্যমে আরও কার্যকারী করে তোলা সম্ভব। প্রস্তাবিত প্রকল্পটিতে, সামরিক পরিষেবাগুলির জন্য খাদ্য বিতরণ ব্যবস্থার সাথে সম্পর্কিত উপাদানগুলিকে স্বয়ংক্রিয় করার লক্ষ্যে একটি ওয়েব-ভিত্তিক অ্যাপ্লিকেশন সফ্টওয়্যার তৈরি করার চেষ্টা করা হয়েছে। যেটিতে সমন্বয় করা হয়েছে- রেশনের চাহিদা এবং সংগ্রহ পদ্ধতি, এ সম্পর্কিত বিশদ বিবরণী, রেশন মজুদ ব্যবস্থাপনা এবং রেশন চাহিদার হিসাব। প্রকল্প বাস্তবায়ন করার তাগিদে তথ্য-উপাত্ত সংগ্রহ, যাচাই ও অনুধাব-

নের পাশাপাশি বর্তমানে প্রচলিত পদ্ধতিটি যাচাই-এর জন্যে কয়েকটি জরিপ করা হয়েছে । প্রকল্পটি বাস্তবায়নের সময় V-Model অনুসরণ করা হয়েছে। পরিদর্শন, ইন্টারভিউ, অনলাইন জরিপ, মাঠ-পর্যায়ের জরিপ এবং ক্ষেত্র সমীক্ষার মাধ্যমে প্রকল্পটির প্রয়োজনীয়তা নিবিড়ভাবে যাচাই করা হয়েছে । ব্যবহারকারীদের প্রয়োজনীয়তা বিচারে, Layered System Architecture অনুসরণ করা হয়েছে এবং SQLite ডাটাবেসে তথ্য সংরক্ষণ এবং ওয়েব-সাইট নির্মানের জন্য Django ব্যবহার করা হয়েছে। প্রস্তাবিত প্রকল্পটিতে সীমাবদ্ধতার খুঁজে বের করা এবং ব্যবহারকারীদের সন্তুষ্টি যাচাই করার লক্ষ্যে প্রকল্পটি, বিশেষজ্ঞ এবং ব্যবহারকারী উভয়ের দ্বারা মূল্যায়ন করা হয়েছে। বর্তমানে প্রচলিত ব্যবস্থাটি সময় সাপেক্ষ এবং এর ফাঁক-ফোকর ও ত্রুটি-বিচ্যুতি যাচাই ও নির্মূলের জন্যে আরও সময়, মনোযোগ এবং কঠোর প্রচেষ্টার প্রয়োজন। অন্যদিকে, প্রস্তাবিত প্রকল্পটি আরও অনেক বেশী দক্ষ, সংগঠিত, সুরক্ষিত এবং দ্রুততম উপায়ে রেশন সম্পর্কিত ব্যবস্থাপনাকে ত্রুটিমুক্ত ও তরান্বিত করবে।

1. INTRODUCTION

Like any disciplined force, armed forces of Bangladesh also draw ration for its outfit. If the defense services are apathetic for a single day, it will be because of the interrupted flow of ration and its related management. Thus a well-coordinated and organized ration and inventory management system will help the armed forces to increase their efficiency.

1.1 Motivation

The current system of ration management is manual and possess elements that are backdated. If the current system can be automated it will become more feasible for the stakeholders. Bangladesh Army currently relies upon the age-old procedure of ration demand and accountability which is more time consuming and prone to errors and malpractices.

1.2 Problem Statements

The inventory or ration storage system resembles primitive warehouse. The record keeping or database procedure are manuscript, paper based and depends on ledger and register. The demand and collection procedure is based on authoritative correspondence and physical presence of the unit representative at the depot.

1.3 Objectives

The aim of the proposed project is to automate the current ration and its associated system. The objective of this project is to analyze current inventory management system for ration (area of interests: inventory, demand calculation, demand and collection procedure between Unit and Supply Depot, documentation, database, ready-reckoner), to design a system as framework for the project, to implement the designed system and finally to evaluate the project to verify and validate the aim.

1.4 Research Methods

Selection of proper lifecycle model to complete a project is very important task. It can be selected by keeping the advantages and disadvantages of various models in mind. The V-model is a type of Software Development Life Cycle (SDLC) model where process executes in a sequential manner in V-shape. It is a type of Waterfall that implements development phase and validation phase while doing testing simultaneously. The next phase starts only after completion of the previous phase i.e. for each development activity, there is a testing activity corresponding to it. So V-Model contains *Development* phases on one side of the *Validation* phases on the other side. Development and Validation phases are joined by coding and implementation phase in V-shape, thus it is called V-Model. Presence of technical resources with technical expertise and clearly defined and fixed user requirements are the prerequisite to adopt the V-model. After the requirement elicitation and requirement analysis it was found that we could fulfill almost all the criteria to follow the V-model and this model would be handy for us to execute. Thus V-model was selected and followed in the proposed project.

1.5 Manuscript organization

Rest of the paper will be unfolded as follows: The literature review will be done in the literature studies. Next, requirement analysis will be discussed with requirement collection followed by requirement analysis. Afterward, the system design will be discussed with system architecture followed by the system model. The, result analysis will elaborately portray the software implementation. Afterwards the system evaluation will be discussed and finally the paper will end with conclusion.

2. LITERATURE STUDIES

A number of researches focused on Inventory Management. For example, Talmale et al. (*2018*) developed Inventory Management System, which is helpful for the businesses operate hardware stores. Moreover, Chih-Chin Liang (*2013*) identified key issues associated with inventory management in food-processing and distribution industry.

Some research highlighted the Online Shopping Management System. Among them Anas et al. (*2020*) has developed a mobile web online grocery ordering system for Asia Pacific University students. Similarly, Zulaikha et al. (*2019*) stressed the unmistakable tradeoffs in online shopping between cost savings, privacy and convenience, and choice.

Online Food Ordering Management on the other hand has been emphasized by many. Anjali et al. (*2018*) stressed that the existing system of food ordering lacks the feature to use

Remote GPS tracker. Varsha et al. (*2015*) developed "Food Pre-Order System using Web Based Application" in which customer can be able to create the order before they approach the restaurant. Similarly, Sunidhi (*2020*) proposed an Online Food Ordering Management System designed an effective way in which the customer selects favorite food items, place the order, also mention the quantity and finally can make the payment. Shweta et al. (*2013*) aimed to automate the food ordering process in restaurant. Likewise, Patel et al. (*2015*) discussed about the design and implementation of automated food ordering system with two different departments that is cashier department and kitchen department.

On the other hand, Rabiu et al. (*2017*) discussed Customer integration, firm performance, efficiency performance, supply chain risk, reverse logistics practices linking Supply chain management systems with Firm performance. Similarly, Raffaele et al. (*2020*) investigated the link between technical inconveniences and sustainable supply chain operations.

3. REQUIREMENT ANALYSIS

Requirement analysis portrays the need and expectation of the end-user. This help the developer to design the software as per the guideline of the user. The process starts with Requirement elicitation followed by analyzing and then improving the requirements to make a model which is finally reviewed by the end-user.

3.1 Requirement Collections

We have collected related documents on existing system from different units. The strategy we followed was at first we had few Visit. We had considered few key personnel from the visited unit as well as related organization to be our primary user and had interview with each of them followed by question and answer session. We have used the Snowball Sampling method created by Philip (*2013*) and Goodman (*1961*) to gather more participants. We created an online survey using google docs for this project and circulated it to various military units. We had arranged a ground survey where we provided a set of questionnaires to the users. Finally, the field study was also very effective for requirement elicitation.

3.2 Requirement Analysis

The inventory management system had the subsequent requirements. There should be a digital inventory management system for ration store. The system to have restriction on ration store-man or store keeper to make input on the inventory. There should be two-layer authentication by allowing, Junior Commissioned Officer Responsible for Dry Ration (JQM) to give input and the Quarter Master (QM) to verify the input. The store-man to act only based on automatically generated document based on the current state of inventory. Any authoritative personnel to supervise the inventory without reaching the store physically. Any critical deficiency on any item to be notified to the QM.

The Automation of Demand and Collection Procedure was the next requirement from the users. The requirements were to digitalized the ration demand and collection procedure where there will be two-layer authentication by allowing JQM or Non Commissioned Officer Responsible for Fresh Ration (Fresh NCO) to give input and the QM to verify the input. Less possible input from JQM is to relieve his burden of task and notification about the demand emplacement. The procedure should be followed similarly at Static Supply Depot (SSD) through Officer Commanding SSD (OC SSD) and Fresh/ Dry Ration Supervisor. Any authoritative personnel can supervise the demand and collection procedure with tracking about progress. Once items are ready for collection a notification will generate.

Fresh Calculation had been another requirement. The requirements were to calculate the fresh demand automatically based on parade-state considering food diversity. Forward the fresh demand list to SSD automatically. Only parade-state input from Fresh NCO and notification about the demand and collection update will be added.

Reports and Returns related requirement were also received. The requirements were to prepare a database to save related documents immediately after demanding every day. Prepare and preserve data for audit inspection. Generation summary of related documents automatically generated at the end of month. Any authoritative personnel can inspect the report and return at shortest possible time.

One interesting requirement was Ready Reckoner. As there are so many items in the ration list and the quantity differs for each item so a ready reckoner will be of great benefit for the staff as well as the command channel for smooth ration management. The requirements were to design a ready reckoner of all ration related documents. Search option for quickest output. In addition, there had been few common requirements which were well-developed frontend and user friendly Interface for server. It is quick to open application and least possible interference with other application. Through requirement analysis we found out some functional and non-functional requirements. Table 1 shows the functional and non-functional requirements of the proposed system.

***Table 1:* Functional and Non-Functional Requirements**

Type of Requirement	User Requirement
Functional	a. Digitalize Inventory Management System b. Digitalize Demand and Collection Procedure c. Automate Fresh Calculation d. Generate Related Documents Automatically e. Design Ready Reckoner
Non-Functional	a. Server and Database Management b. Data Preparation and Preservation for Inspection

4. SYSTEM DESIGN

System design was the outcome of the requirement analysis in which we followed the UML (Unified Modeling Language) technique. In UML, graphical notations are used to represent the design of a software project.

4.1 System Architecture

We have followed the layered architecture in which we have used five layers (Calculation and Demand, Approval of QM, Database, Approval of OC SSD and Distribution) as shown in Figure 1.

4.2 System Model

Context Diagrams shown in Figure 2 shows the interactions between the system (Automated Inventory Management System) and other actors or entities (QM, JQM, Database, Dry Ration Supervisor, OC SSD, Fresh Ration Supervisor, Server and Fresh NCO) with which the system is designed to interface with each other.

5. RESULT ANALYSIS

As the project is a web-based application software hence the selection of software platform was necessary for implementation of the project. Once the implementation was done we could take our software for evaluation or testing.

5.1 Software Platform

In this project we have used web-based platform for making the application. Here we have used HTML, CSS, Bootstrap for designing the front-end and for storing the data in Database we have used Django, which played a vital role while developing the website. The project structure necessitated the use of localhost till evaluation afterwards real-time network was used.

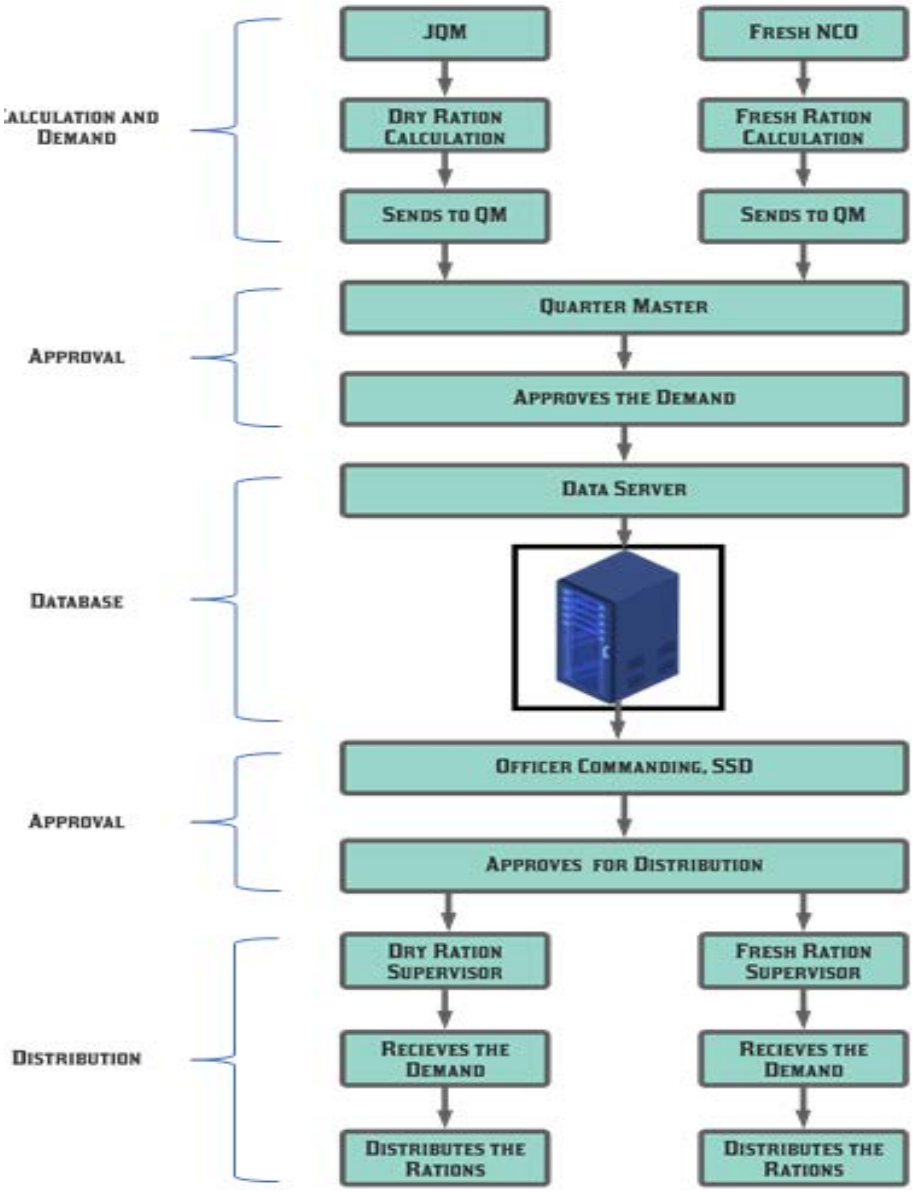

***Figure 1:* Layered System Architecture of the Proposed System**

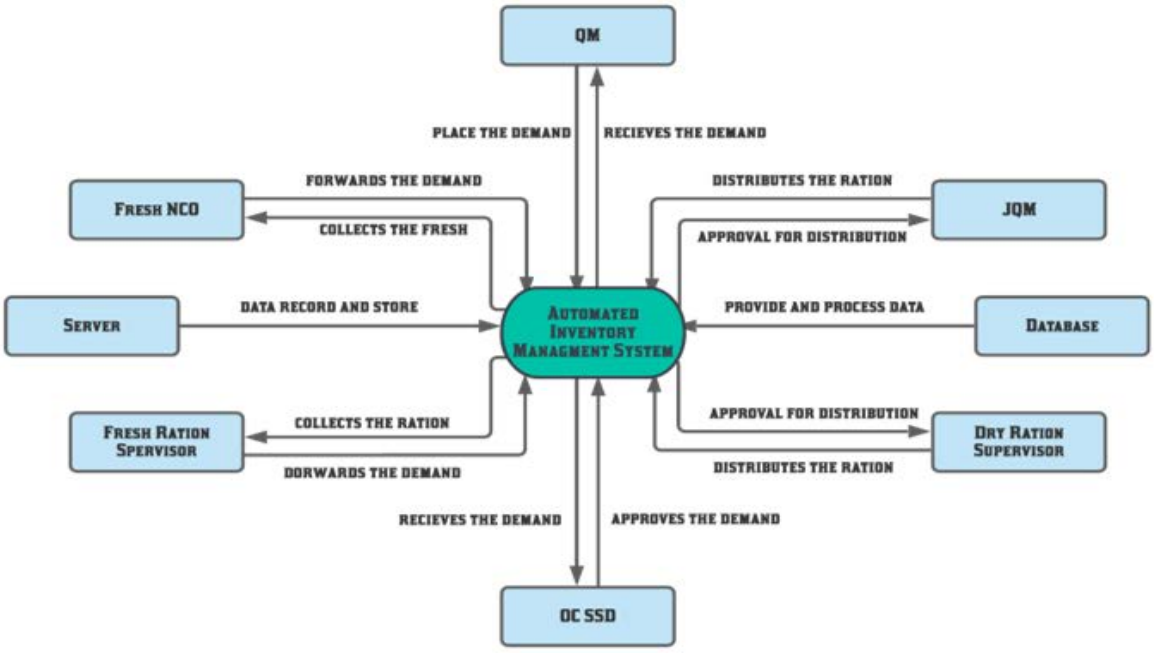

Figure 2: ***Context Diagram of the Proposed System***

5.2 Software Implementation

Logging-in requires unique Username and password. The two-layer authenticity was ensured through use of OTP sent at phone. After that the user will land up on his profile. Figure 3 shows the Screenshot of the System Front-End.

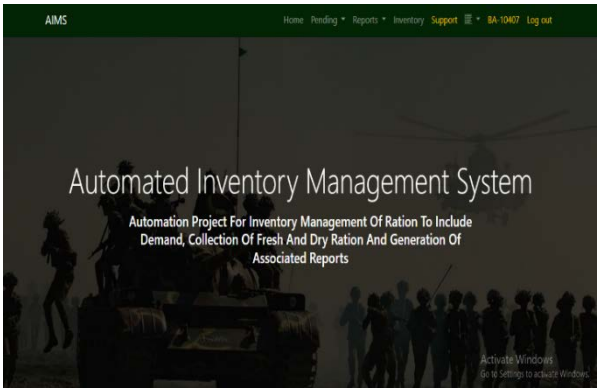

Figure 3: ***Screenshot of the System Front-End***

The functions of each user are different. So, they will have different navigation bars on the top right corner to perform their respective job. Each user will have a personal data page which consists all the personal information of that particular person who is responsible for the appointment.

Ready Reckoner and Menu- As there are so many items in the ration list and the quantity differs for each item so a ready reckoner will be of great help for the staff as well as the command channel for smooth ration management and correct forecasting. In the Ready Reckoner page, each user can check the scale of dry ration, fresh ration and also the menu on the whole month.

Ration Demand and Collection Procedure- The Fresh NCO/JQM will put demand. After the demand has been forwarded to the QM the fresh NCO/ JQM will get notification and the QM will receive SMS. QM will then send the demand to the OC SSD. The procedure is similar in nature for OC SSD down to his supervisors. OC SSD will forward it to the Fresh/ Dry ration supervisor. They will log-in to their profile and a unique token for each collection will be generated automatically which will be sent to the phone via SMS to Fresh NCO/ JQM for collection. After collection Fresh NCO/JQM will confirm it, then it will be added in the database.

Report Generation- In the reports page, QM, JQM and Fresh NCO will be able to check all the demands. They can also check the detail information of each demand which are stored in the database and they will be able to search a specific demand with the date or token number. They will have the provision to save the report as pdf and can directly print it as well.

Daily Issue of Ration in the Unit- In the units, ration needs to be issued from the inventory on daily basis in different cook house or mess according to the parade-state. JQM will issue the ration and the QM will get notified by SMS and he will confirm the issue of the JQM. Finally, JQM will get the confirmation and issue the amount of ration to the respective mess.

Inventory Management System- The dry rations are collected for at least 7 days. Again, every day from the inventory, rations are distributed in mess as per the parade-state. For which an inventory is required to maintain the collection of ration and also the daily issue of the ration. This inventory page can only be accessed by the QM and JQM of the unit. Figure 4 shows the Screenshot of the QM and JQM's Dashboard on Inventory with Current Balance of Dry Ration Items.

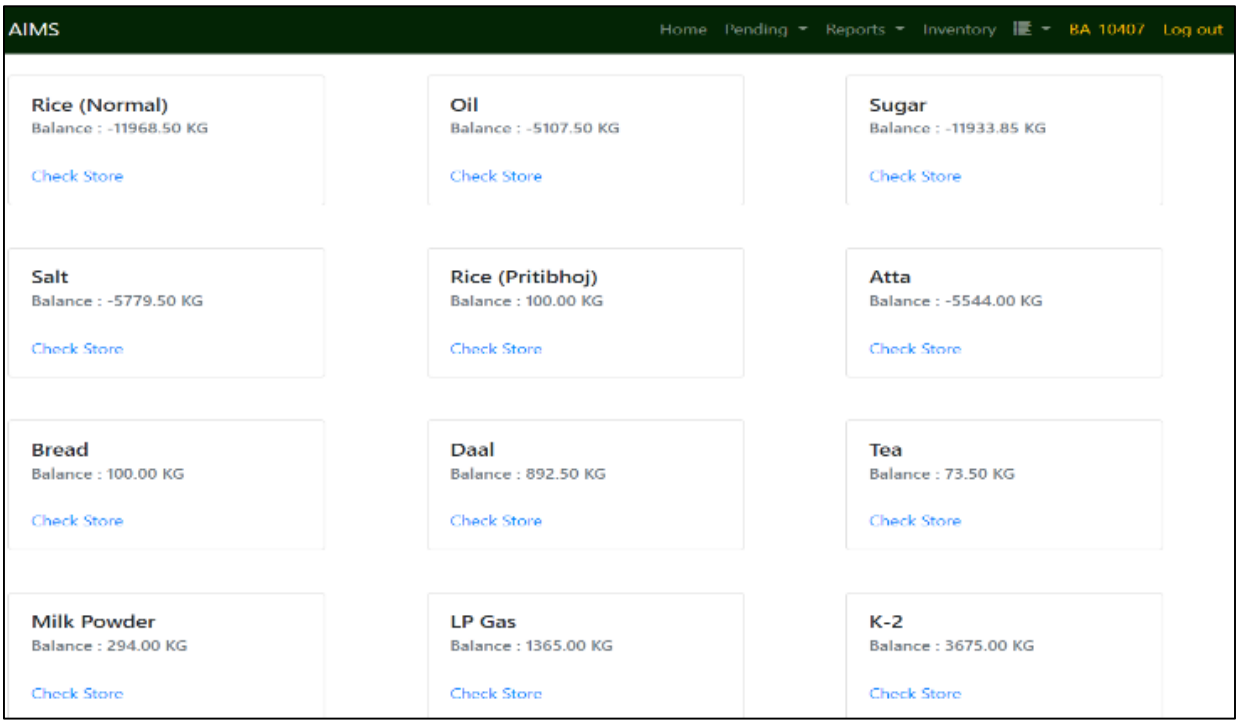

***Figure 4:* Screenshot of the Inventory**

Support- The QM being the only officer using this software from each unit may have some problems, issues, reminders, information to share with the OC SSD. Again, the OC SSD may have some notice to send to each unit within a short time. So, for solving this the Support navigation bar is available only for the QM of each unit and the OC SSD. The message will be directly sent to the email address of the respective person. So that, he can be notified within a short time and can act accordingly.

The Super Admin- The super admin is the main authority who will control the whole software. He can add or change the data of the users, add new users, add or change the fresh/ dry ration items, amend the scale of ration, select the menu for the whole month. He can monitor all the demands and collections taking place between different units and the SSD, individual unit's internal issue of dry ration from the inventory to different mess, the items and balance of the inventory of each unit, the quantity of ration items with time and date of demanding and receiving. This enhances the security of the whole system.

6. SYSTEM EVALUATION

We have considered evaluation from both expert and user. Expert evaluation was done using Cognitive Walkthrough and Heuristic Evaluation. User evaluation was done by Review-Based Evaluation. The outcome of the evaluation improved the system in many folds.

6.1 Cognitive Walkthrough

Cognitive walkthrough was originally proposed and later revised by Polson and colleagues (1992) as an attempt to introduce psychological theory into the informal and subjective walkthrough technique. A cognitive walkthrough is a structured approach to evaluating usability of a product. It involves the evaluator, who is not a user, asking four simple questions about the way a specific user journey is conducted. We had taken the assistance of ten evaluators and the summary is shown in Table 2.

***Table 2:* Summary of Cognitive Walkthrough**

Task	Evaluator	Q1	Q2	Q3	Q4
Demanding the Ration by Fresh NCO and JQM	E1	Yes	Yes	Yes	Yes
	E2	Yes	Yes	Yes	Yes
Log in and the Workflow of Demanding and Collecting the Ration	E3	No	Yes	Yes	Yes
	E4	Yes	Yes	Yes	No
Issuing Dry Ration on Daily Basis	E5	Yes	Yes	Yes	Yes
	E6	Yes	No	Yes	Yes
Inventory Management System	E7	Yes	Yes	Yes	Yes
	E8	Yes	Yes	Yes	Yes
Notification and Report Generation System.	E9	Yes	Yes	No	Yes
	E10	Yes	Yes	Yes	Yes

6.2 Heuristic Evaluation

Heuristic evaluation, developed by Nielsen and Molich (1990) is a method for structuring the critique of a system using a set of relatively simple and general heuristics. The

general idea behind heuristic evaluation is that several evaluators independently critique a system to come up with potential usability problems. It is important that there be several of these evaluators and that the evaluations be done independently. Nielsen's experience indicates that between three and five evaluators is sufficient. We had taken the assistance of five evaluators and the summary is shown in Table 3.

6.3 Review-Based Evaluation

The evaluation process was followed by thematic analysis developed by Joffe (*2012*) of the overall system. Total 12 end-users were involved directly in testing the overall designed system. The overall idea was to check the real-life implication of the project.

The outcome and the findings from this evaluation were very significant. Firstly, Requirement of Training- The users felt the necessity of training to get accustomed to the system and learn about different feature. Secondly, Language Barrier- The language barrier has been a great concern to the participants as the system does not support the participants' native language. Next, Mobile Version- The user urged for a mobile version of the system for flexibility of use.

7. CONCLUSIONS

Though the system had lots of positive things, it had few limitations as well. The user interface could have been better with pictorial depiction of the items, the system does not support Bangla, it does not have any AI implementation, it does not have any mobile version.

The Literature Studies unfolded the existing system which described the present system in practice. From the Research Methodology we found that V-Model is best suited for our proposed system hence was followed throughout the project. The Requirement Analysis/ Component Selection contains a concise and coherent summary of the system models. The Result Analysis is the final outcome of the system The System Evaluation is the end product of the paper.

In the near future we will try to add more features as per user requirements, implement AI-based inventory with mobile version and option for Bengali version for easy and smart inventory management.

ACKNOWLEDGEMENTS

Authors would like to express their gratitude to the Ministry of Defence, Bangladesh; Ministry of Education, Bangladesh; Bangladesh Army and Department of CSE, Military Institute of Science and Technology (MIST), Dhaka, Bangladesh. Authors also would like to acknowledge Colonel Siddharth Malik, SM, Indian Army, for his kind guidance at the very early stage of the research. The author's heartiest gratitude, profound indebtedness and deep respect go to their supervisor, and co-supervisor for their constant supervision, affectionate guidance and great encouragement and motivation.

***Table 3**: Summary of Heuristic Evaluation*

Ser	Location	Problem	Evidence	Severity					Recommendation
				E1	E2	E3	E4	E5	
1.	SMS on phone	When the message of any particular action arrives, it shows exact time including second and milliseconds even.	Match between system and the real world.	1	1	1	1	1	Seconds and milliseconds can be deducted.
2.	SMS on Phone	Message can be sent in Bangla for NCO and JCO.	Flexibility and efficiency of use	1	2	1	1	1	Messages can be sent to the NCO and JCO's in Bangla
3.	OTP on phone	Due to poor network it takes long time to get the OTP. There is no provision for OTP in email.	Flexibility and efficiency of use	2	1	1	2	1	OTP should be sent in both phone and email.
4.	Log-in Page	Can be more eye soothing and can have a better design with important information.	Aesthetic and minimalist design	1	1	1	1	1	Design should be improved.
5.	Report Page	No option for making the reports in pdf form and print	Help and documentation	2	2	1	2	2	Options for Converting into pdf and printing to be kept.
6.	QM's Profile	QM cannot change the NCO or JCO if they are on leave.	User control and freedom	2	1	2	1	2	Options for changing the NCO or JCO by the QM can be kept.
7.	QM's Profile	QM cannot check the inventory	User control and freedom	2	3	2	2	3	QM must be able to check the inventory from his profile.
8.	JQM's Profile	The dates for issuing are not shown.	Flexibility and efficiency of use	2	2	2	1	2	The dates can be shown in his profile.
9.	Pending Page	No notification sign in the pending section.	Visibility of system status	2	2	2	2	2	It must be properly visible.
10.	Each Profile	No provision to communicate with each other through the software.	User control and freedom	1	1	1	2	1	They can communicate or send important information by email directly from the software.

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AUTHOR BIOGRAPHY

Erteka-Ur-Rahman has passed SSC from I.E.T. Government High School, Narayanaganj in 2006 with GPA 5 out of 5 and passed HSC from Government Tolaram College, Narayanaganj in 2008 with GPA 4.7 out of 5. He has completed Bachelor of Arts (Pass) in Economics from Bangladesh University of Professionals (BUP), Mirpur, Dhaka in 2012. He enrolled BSc. in CSE, in the Military Institute of Science and Technology (MIST), one of the prestigious organizations of Bangladesh, in 2018. He successfully completed his graduation in 2022. He would like to pursue his higher studies in abroad and gain the world class knowledge and experiences to contribute in the development of his Motherland.

Rizwanul Hoque has passed SSC from Bangladesh Navy School and College, Chattogram in 2014 with GPA-5 out of 5 and passed HSC from Government Hazi Muhammad Mohsin College, Chattogram in 2016 with GPA-5 out of 5. He enrolled BSc. in CSE, in the Military Institute of Science and Technology (MIST), one of the prestigious organizations of Bangladesh, in 2017. He successfully completed his graduation in 2022. He would like to pursue his higher studies in abroad and gain the world class knowledge and experiences to contribute in the development of his Motherland.

Sharifa Rania Mahmud received BSc degree in Computer Science and Engineering (CSE) from Military Institute of Science and Technology (MIST) and Master Degree in CSE from Bangladesh University of Engineering and Technology. Her research works mainly focus on bioinformatics, database, and networking. She is currently served as an Assistant Professor at MIST. She has 11 publications in difference reputed conferences and journals and also currently supervising several projects and thesis related to her research interest.

Zinia Sultana received BSc degree in Computer Science and Engineering (CSE) from Military Institute of Science and Technology (MIST). Her research works mainly focused on image processing, machine learning, and deep learning. She is currently served as a lecturer at MIST. She has 04 publications in difference reputed conferences and journals and also currently supervising several projects and thesis related to her research interest.

CSE TECHNICAL PAPER
The MIST Journal of Computer Science and Engineering

Towards Developing an Imaging Application to Aid Physicians Analyzing MRI Images of Brain Tumor: A Machine Learning Approach Through Comparative Analysis

Jannatul Ferdous[1], Md Shakib Shahriar Khan[2], Tarannum Zaki[3], and Muhaimin Bin Munir[4]

Department of CSE, Military Institute of Science and Technology (MIST), Dhaka, Bangladesh

emails: *[1]simki56@gmail.com; [2]shahriarnibir615@gmail.com, [3]tarannumzaki@yahoo.com, and [4]muhaimin@cse.mist.ac.bd*

INFO

History:

Started: 04th April 2021
Proposal defence: 07th June 2021
Final defence: 27th March 2022
Submitted: 03rd April 2022
Published: 30th June 2022

Keywords:

Magnetic Resonance Imaging
Machine Learning
Deep Learning
Visual Geometry Group
Residual Neural Network

ABSTRACT

Brain tumour MRI is a prominent field of study where radiologists manually assess several magnetic resonance imaging (MRI) images produced regularly to detect affected tumour regions, which is laborious and time-consuming, and their accuracy is not up to the mark. MRI has been used to identify, segment, and classify brain tumour in various investigations however, only a few applications have been developed to manage the whole process of report generation and they lack the involvement of physicians who can assure the reliability of the system. We have proposed a method in which a patient can upload a brain tumour image into the system, and the system will assist the authorized doctor in producing a more accurate result in a short period of time. The proposed system provides possible classification for brain tumour and an interface that incorporates Digital Image Processing for improved visibility. We have trained four models using SVM, Naive Bayes, Transfer Learning on VGG-16 and ResNet-50; the highest accuracy was found on 92.02\% on ResNet-50 which was deployed in the application for classification procedure.

ব্রেইন টিউমার (Brain Tumor) এর এমআরআই (MRI) একটি উল্লেখযোগ্য গবেষণা ক্ষেত্র যেখানে টিউমার (Tumor) আক্রান্ত জায়গা শনাক্ত করার জন্য রেডিওলজিস্টরা (Radiologist) নিয়মিত বেশকিছু এমআরআই এর ছবি ম্যানুয়ালি পর্যবেক্ষণ করে থাকেন,যা শ্রমসাধ্য এবং সময় সাপেক্ষ, এবং এর সঠিকতা প্রত্যাশিত মানের নয়।এম আর আই মস্তিষ্কের টিউমার (Tumor) সনাক্ত করতে,সেগমেন্ট (Segment) করতে এবং শ্রেণীবদ্ধ করতে বিভিন্ন অনুসন্ধানে ব্যবহৃত হয়েছে কিন্তু রিপোর্ট (Report) তৈরির পুরো প্রক্রিয়াটি পরিচালনা করার জন্য শুধুমাত্র কয়েকটি অ্যাপ্লিকেশন তৈরি করা হয়েছে এবং তাদের মধ্যে চিকিত্সকরা জড়িত নেই যারা সিস্টেমের (System) নির্ভরযোগ্যতা নিশ্চিত করতে পারে। আমরা একটি পদ্ধতির প্রস্তাব করেছি যাতে একজন রোগী সিস্টেমে মস্তিষ্কের টিউমারের ছবি আপলোড (Upload) করতে পারে এবং সিস্টেমটি স্বল্প সময়ের মধ্যে আরও সঠিক ফলাফল তৈরি করতে অনুমোদিত ডাক্তারকে সহায়তা করবে। প্রস্তাবিত সিস্টেমটি মস্তিষ্কের টিউমারগুলির জন্য সম্ভাব্য শ্রেণীবিভাগ এবং একটি ইন্টারফেস প্রদান করে যা উন্নত দৃশ্যমানতার জন্য ডিজিটাল (Digital) চিত্র প্রক্রিয়াকরণকে অন্তর্ভুক্ত করে। আমরা এসভিএম (SVM), নেইভ বায়েস (Naive Bayes), ভিজিজি-১৬ (VGG-16) এবং রেস নেট-৫০(ResNet-50) এ ট্রান্সফার লার্নিং ব্যবহার করে চারটি মডেলকে প্রশিক্ষণ দিয়েছি; রেস নেট-৫০ (ResNet-50) এ ৯২.০২%-এ সর্বোচ্চ নির্ভুলতা পাওয়া গেছে যা শ্রেণিবিন্যাস পদ্ধতির জন্য আবেদনে স্থাপন করা হয়েছিল।

1. INTRODUCTION

The brain is a vital organ in the human body that regulates the operation of all other organs and aids in decision-making. Amongst the certain variety of brain diseases brain tumor are the most prevalent and fatal disease. Every year, around 350,000 new cases of brain tumor are identified worldwide, and the 5-year survival rate for patients diagnosed with a brain tumor is only 36%. The World Health Organization (WHO) introduced the most widely used grading scheme of brain tumor. It classifies brain tumor from grades I to IV with increasing aggressiveness. The detection of a brain tumor in its early stages is essential for the implementation of correct treatments Since persons diagnosed with brain tumor have a high mortality rate, early diagnosis of brain tumor is essential for the proper treatment.

The proper identification of a brain tumor and its stages is essential for preventing further deterioration and improving treatment and treating the disease Diagnosis of a brain tumor is done by a neurologic exam (by a neurologist or neurosurgeon), CT (Computer tomography scan), PET (Positron Emission Tomography) magnetic resonance imaging (MRI), and other tests like an angiogram, spinal tap, and biopsy. The approach of medical treatment for brain tumor is determined by the type, grade, and size of the tumor. MRI is often regarded as the most effective medical imaging tool, particularly for studying soft tissues and the nervous system. MRI is a scanning technique that uses a magnetic field and computer-generated radio waves to produce detailed images of organs and tissues in the body that cannot be found in X-rays, CT scans, and ultrasound. MRI scans do not employ X-rays or ionizing radiation, which sets them apart from CT and PET scans. Many researchers have proposed several strategies for successful tumor detection, including fast identification and segmentation of brain tumor.

Many approaches have been recommended for the classification of brain tumor in MR images, most notably fuzzy clustering means (FCM), support vector machine (SVM), artificial neural network (ANN), knowledge-based techniques, an expectation-maximization (EM) algorithm technique, which are some of the widely used techniques used for region-based segmentation and thus to extract the important information from medical imaging modalities. Manually evaluating the numerous magnetic resonance imaging (MRI) images produced regularly is a difficult task as well as a very time-consuming procedure and inaccurate in its interpretation (prone to human error). To increase the performance of the medical picture segmentation process while reducing its complexity, researchers are now moving towards automatic segmentation of MRI using Machine Learning and Deep Learning approaches.

1.1 Motivation/Problem Statement

Traditionally, radiologists or clinical experts manually evaluate the numerous magnetic resonance imaging (MRI) images produced on a regular basis to find out infected tumor areas, which is tedious, time-consuming and their accuracy is solely dependent on their experience. Brain tumor MRI is an emerging field of study. There are several studies on brain tumor detection, segmentation, and classification using MRI. Applications have been developed for the easier identification of brain tumors. However, the present application lacks the inclusion of a doctor who can confirm the system's reliability. Thereby we have proposed a system in which the patient can upload the image of a brain tumor into the system, and the system will assist the authorized doctor in providing a more accurate result within a brief span of time.

1.2 Objectives

Our research objectives are as follows:

- To develop an imaging application that will assist physicians in accurately assessing and detecting MRI brain images within a brief span of time.
- To suggest probable classification for brain tumor.
- To create an interface for physician with the incorporation of Digital Image Processing for better visibility.
- To help the patient in managing and receiving their reports on time.

1.3 Research Methods

The project is aimed to develop a system that will be helpful for doctors to assess and detect the MRI brain images properly. At the same time, it will be helpful for the patient to get their reports in time and manage it. The system can suggest some classification with a probability of occurrence. For developing this system, a background study on MRI imaging, machine learning, and deep learning for classification was made. Requirement analysis on the system was made through literature reviews and surveys on doctors and probable users. We started the development phase with model training on the MRI brain image data set. After that, a suitable image processing application has been created for easy assessment of the image by doctors. At last, the trained model with the best result and all image processing utilities were integrated into a web application that can be accessed by patients, doctors, and lab supervisors. Throughout the development process unit testing on different units was conducted. After integration, integration testing was conducted. Result analysis and comparative study were made on the developed system. The process is shown in Figure 1.

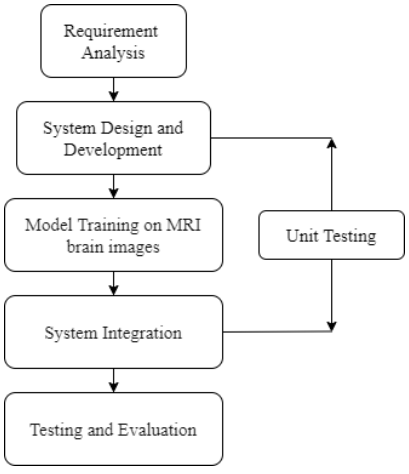

***Figure 1:* Methodological Overview**

The voters are the main customers of the system. The three functions related to voters are registration, logging in, and casting a vote. During registration, voters can create an account using their name, National ID (NID), and password which is stored on the blockchain, later to be approved by the admin. When voters log into their account, they will be able to see their private information such as private key, upon providing correct credentials during the login session. When the voters cast their vote, they need to import their Meta-mask ID using their private key, and then they will be able to select the candidate they wish to vote for. Upon submitting the vote, the transaction on the Meta-mask is confirmed. The process is shown as a flowchart in Figure 2.

1.5 Manuscript organization

To provide an effective solution to the problem mentioned above, the paper is organized as follows. In the following section, a brief discussion on the related work is given to highlight the contribution in this field as well as to show the challenging issues faced in this arena addressed by the research community. After that a detailed about methodological overview is discussed. The Design and development is briefly presented. Then result analysis and evaluation are discussed and at last limitations and future advancement of this research work are discussed followed by brief concluding remarks in the final section.

2. LITERATURE STUDIES

Sravanti et al. *[1]* proposed an image segmentation process and a variety of image filtering techniques to obtain image characteristics. The enhancement and filtering are significant because they increase picture quality and detection by sharpening edges, improving, reducing noise, and removing the undesired background. Roshan Helondeet et al. *[2]* recommends segmenting a brain MRI image using the K-means clustering method, followed by morphological filtering, to avoid the formation of mis-clustered areas following segmentation of the brain MRI image for tumor site identification. Saurabh Kumar et al. *[3]* proposed two methods SOM Clustering and SVM Classification for segmenting a tumor from an MRI image and determining the type of tumour. Because of its strong generalization performance, the Support Vector Machine (SVM) technique is regarded as a viable contender, especially when the size of the feature space is quite large.

Brain tumour classification has been performed using a number of machine learning algorithms throughout the years. Machine Learning and Deep Learning algorithms are used in numerous research publications to detect brain tumour. When these algorithms are applied on the MRI images the prediction of brain tumour is done very fast and a higher accuracy helps in providing the treatment to the patients. The objective of machine learning is to develop mathematical models that can be taught to provide meaningful outputs when given data to work with. The convolutional neural network (CNN, also known as ConvNet) is a type of Artificial Neural Network (ANN) that is most typically used to evaluate visual images. P Gokila Brindha et al. *[4]* introduced a self-defined Artificial Neural Network (ANN) and Convolution Neural Network (CNN) for identifying the existence of brain tumours and evaluating their performance. The proposed ANN model generates 65.21 % testing accuracy, whereas the CNN model implements the testing data with 89 % accuracy.

Ertosun and Rubin et al. *[5]* used to discriminate between low and high-grade Gliomas, as well as their grades. They were accurate 71% of the time and 96% of the time, respectively. Using axial brain tumor pictures, Paul et al. *[6]* trained and built two unique classification algorithms (a fully connected CNN). The CNN design was 91.43 % accurate, with two convolutional layers followed by two fully linked layers. Tahia Tazin and Sraboni Sarker et al. *[7]* proposed a convolutional neural network (CNN) to detect brain tumors from MRI. The efficacy of this method is demonstrated by quantitative results on the Brain Tumor dataset, which obtains an F1-score of 92% and classification accuracy of 92% on the test set.

Mohamed Arbane et al. *[8]* developed a deep learning strategy based on transfer learning for classifying brain tumors from MRI images using a convolutional neural network (CNN). The implemented system investigates many CNN architectures, including ResNet, Xception, and MobilNet-V2. This has earned the greatest results in terms of accuracy and F1-score, with 98.24 % and 98.42 % respectively. Talo and Baloglu et al. *[8]* used the pre-trained CNNResNet34 for transfer learning, whereas Swati and Zhao used CNN ResNet34 for transfer learning and fine-tuning (VGG19). Priyanssh and Akshata transfer learning-based prediction models for brain tumor detection using Resnet-50.

3. REQUIREMENT ANALYSIS

3.1 Requirement Collections

To find out the necessity and required modules for our application we did a requirement analysis for the proposed system. For this, we followed a few steps. Firstly, we tried to find out some of the previous works. We found many works on MRI brain tumour prediction but did not find any convenient application. For this reason, we did a survey on 25 people including doctors and common users. The survey was conducted with 10 questions which include 1 open-ended and 9 multiple choice questions.

3.2 Requirement Analysis

From our survey, we could come to a conclusion that,

- Both the lab supervisor and the patient can upload MRI images and assign doctors.
- The doctor will check and put remarks on the image.
- A machine learning-aided classification will be put forward which may help doctors to understand the tumor type.
- Interface for checking images with some image processing functionalities will be there.

4. SYSTEM DESIGN / EXPERIMENTAL SETUP / IMPLEMENTATIONS

4.1. *System Architecture*

The system architecture was designed based on the key feature of the system. These features include:

1) Three user roles: Patients, Doctors, and Lab Supervisors.
2) The image can be uploaded both by patients and lab supervisors with initial symptoms and doctor assigned. When uploaded by the lab supervisor the image will be visible on the patient's dashboard.
3) Suggested predictions will be given from the machine learning model which will be visible to the doctor.
4) The system will contain an image processing interface where doctors can perform different functionalities for better visibility.
5) Doctor will give his remarks on the finding which will be sent to the concerned patient.

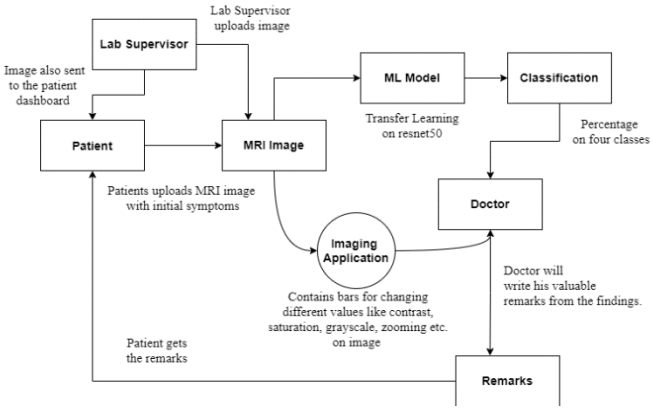

Figure 2: ***Flow Diagram***

4.2. *System Development*

Based on the system architecture we started developing our system. At first, we designed the mockups on our system. From the mockup, the frontend is developed which is then connected to the backend for all processing and logical tasks.

4.2.1. *Mockup Design*

At first, a prototype of the system is made. We designed the UI prototype and workflow of the system. For designing this mockup, we used a tool called Adobe Experience Design. Rather than emphasizing the design, we emphasized more in the user experience, simplicity of use, and efficiency.

4.2.2. *Frontend Development*

The user interface was developed using HTML, CSS, Bootstrap, and Javascript. As we are having 3 types of users, three different interfaces have been created with different functionalities. An admin interface has been created where all data can be accessed by the admin. Other than the role-based pages we also have a home, log-in, and sign-up pages. A patient can upload an MRI report with initial symptoms and the doctor assigned with it. This upload can also be completed by the lab user as well. This report will be checked and reviewed by the assigned doctor. The doctor can see the probable classification suggested by the system. At the same time, he will be taken to an image processing interface where he can manipulate the image for better visibility.

Table 1: ***Role-Based Functionalities***

User Roll	Signup	Upload Image	Image assessment	Remarks visibility
Doctor	From Admin	No	Yes	No
Lab Supervisor	From Admin	Yes	No	Yes if uploaded by him.
Patient	Using Signup page	Yes	No	Yes

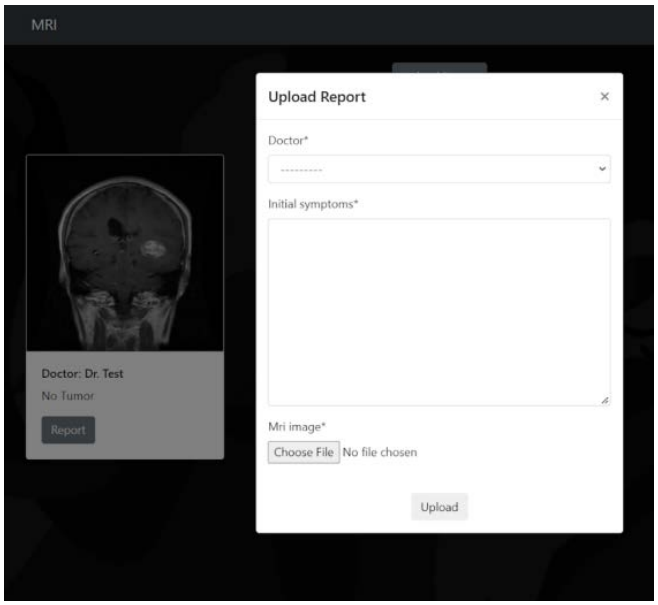

Figure 3: ***Patient uploading a report***

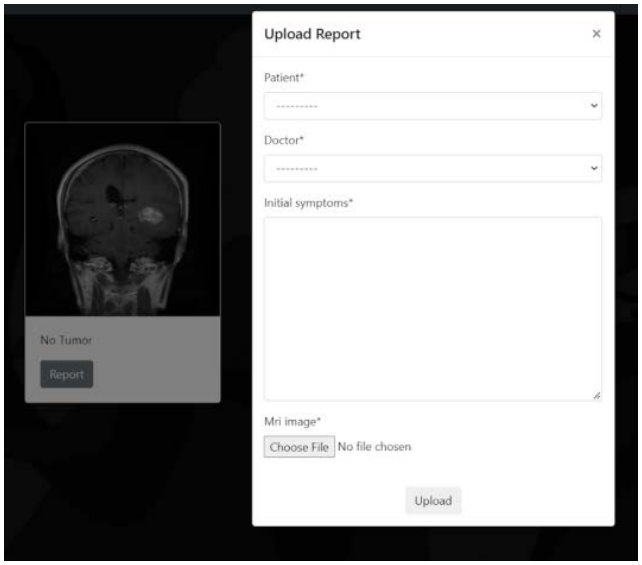

Figure 4: ***A lab supervisor uploading a report with initial symptoms, patient and doctor assigned with it***

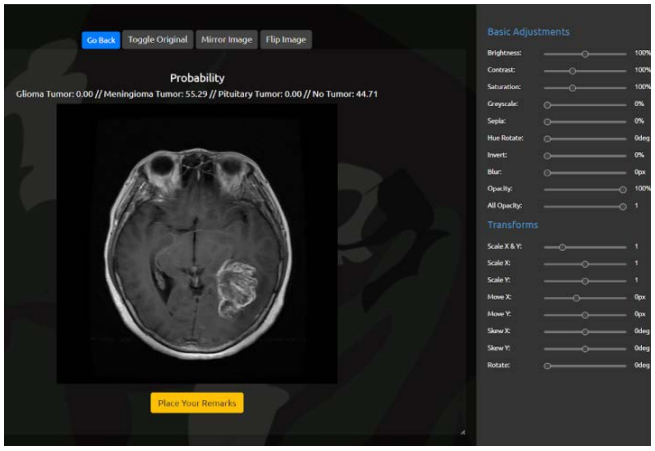

Figure 5: ***Image processing interface for better visibility by the doctor.***

4.2.3 Backend Development

Our system has a few data processing tasks. It includes taking report as input from the user and saving it in the database, MRI image classification, visibility of reports in different dashboards, etc. In our backend, we worked on managing data in the database. The records being created by the patient or lab supervisor are processed and stored in the database. We integrated the Machine Learning model to provide a probable classification of the provided MRI brain image. These logical functions are being carried out by a python framework called Django. We used Django because it is well compatible with the machine learning model which is trained using python programing language.

4.3 Machine Learning on MRI Dataset

4.3.1 Dataset: The dataset for creating Machine Learning models has been taken from kaggle[1]. This dataset contains around 3000 raw images, these images are of different size and shapes. All these are divided into 4 classes which are Glioma, Meningioma, Pituitary and no tumor. Each class has been divided into training and validation dataset for the training purpose.

4.3.2 Preprocessing: This dataset has been preprocessed for better model training. Preprocessing has been done differently on the basis of the algorithm used. For two of the Machine learning algorithms SVM and Naive Bayes, images have been resized as 150x150. Then these images have been flatten as an one dimensional array. For both cases 20% data has been taken for the test set. For model training on deep learning, transfer learning has been done on VGG16 and Resnet50 models. In both cases respective preprocessing functions have been done.

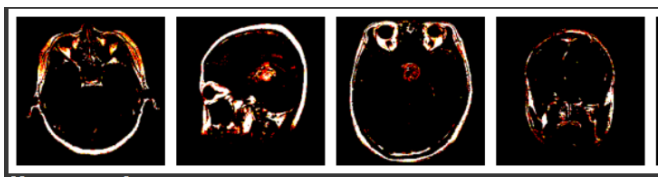

Figure 6: ***Image after applying VGG16 Preprocessor***

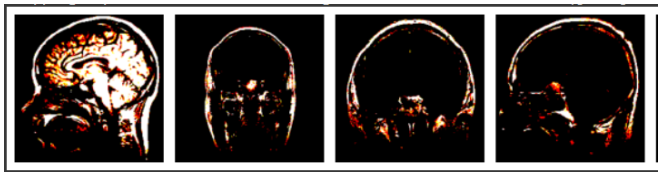

Figure 7: ***Image after applying Resnet50 Preprocessor***

4.3.3. Algorithms

We started the training process with a Machine Learning approach. We implemented two machine learning algorithms e.g. SVM and Naive Bayes. But the result was not satisfactory, so we went for deep learning. We used two of the imageNet models for transfer learning our dataset and got a model as our expected accuracy.

4.3.3.1 Machine Learning

There are a number of Machine Learning models which have been used previously for Brain tumor classification. Analyzing previous works, we saw SVM and Naive Bayes have produced good results which may fulfill our requirements. SVM is better than other algorithms for its better accuracy and better computational complexity [12]. Naive Bayes is a probabilistic algorithm.

SVM: For the preprocessing, we reshape the images to 224x224 pixels. Then flatten the images into a one-dimensional array for the training purpose. We used the SVC module [2] from the scikit-learn library for training purposes. We took a linear SVM kernel for training the model. In the end, we calculated a few metrics like accuracy, precision, recall, and F1 score.

Naive Bayes: We used the same preprocessing as that of SVM. We reshaped the images to 224x224 pixels. Then flatten the image to a one-dimensional array. We used the GaussianNB class from the scikit-learn library [3] for this training purpose. We got less accuracy than that of SVM in this case.

4.3.3.2 Deep Learning

Though our main aim is to develop an application but we wanted to get an accuracy of more than 90%. As we could not achieve that using SVM and Naive Bayes, we went for deep learning. Because of its superior results in this field on the previous works. Specifically, we tried transfer learning for getting a fine-tuned model. We did transfer learning on VGG16 and ResNet50 models which gave better results on previous works.

Transfer Learning on VGG16 Model: We took the VGG16 model and converted it into a Keras sequential model by removing the output layer from it. We added a new output layer of 4 nodes with the 'Softmax' activation function as our final output will be within 4 classes. We took around 2500 images for training and 780 images for validation in the training process. In the training process, we took a batch size of 32 images up to 100 epochs. It achieved good accuracy within a short period of time. Accuracy, recall, precision, and F1 score were calculated on the validation data set.

Transfer Learning on ResNet-50 Model: We took the ResNet-50 model and added a 'Flatten' layer and two 'Dense' layers for our training purpose. We took around 2500 images for training and 780 images for validation in the training process. In the training process, we took a batch size of 32 images up to 100 epochs. It achieved good accuracy within a short period of time. Accuracy, recall, precision, and F1 score were calculated on the validation dataset.

5. RESULT ANALYSIS

Our project has two parts, firstly we trained a machine learning model on the MRI image dataset, secondly we developed an application for managing MRI reports. Our result analysis part is divided into parts as comparative analysis on the learning algorithms and system evaluation on the developed application.

5.1 Comparative Analysis on Learning Algorithms

We expected to achieve an accuracy of 90%. We started the learning process by using the SVM and the Naive Bayes Algorithm. We calculated different matrices during the training process. We achieved an accuracy of 80% on SVM and 60% accuracy on Naive Bayes which is very less in comparison to our expected accuracy. For this reason, we went for Deep Learning. In the process of our literature review, we found previous works based on transfer learning on Medical images. Different models gave great results, among those we took VGG16 and ResNet-50 for the transfer learning process. This time we achieved a very good result with a validation accuracy of 88% for VGG16 and 92% for ResNet-50 which meets our expected accuracy rate. A comparative analysis is shown below:

5.2 System Evaluation

A thorough evaluation study was conducted to measure the functionality of our system from usability perspective. We carried out two different types of approaches for this. We conducted cognitive walk through on our system. User evaluation was conducted on number of users.

5.2.1 Cognitive Walk through

For this evaluation technique we choose few tasks of our system. Then we divided those task into few sub-tasks and evaluated those sub-tasks on the basis of four questions.

Q1: Is the effect of current action same as user's goal?
Q2: Is the control for the action visible?
Q3: Will the user know what to do at this stage?
Q4: Does the user know they did the right thing?

Task 1: Report uploading by Patient

Table 2: ***Cognitive walkthrough on Task 1***

Task	Q1	Q2	Q3	Q4
Patient presses the upload button	Yes	Yes	Yes	Yes
Patient input initial symptoms and upload MRI image	Yes	Yes	Yes	Yes
The patient presses the submit button	Yes	Yes	Yes	No, it's confusing

Task 2: Evaluation by Doctors

Table 3: ***Cognitive walkthrough on Task 1***

Task	Q1	Q2	Q3	Q4
Doctor select an image	Yes	Yes	Yes	Yes
Doctor check it with different image processing functionality	Yes	Yes	Yes	Yes
Doctor places his remarks	Yes	Yes	Yes	Yes

5.2.2 User Evaluation

We conducted user evaluation on 7 users including 2 doctors. In this evaluation process, we took a total of 6 tasks, among these 6 tasks 4 were conducted by 2 doctors and 2 tasks were carried out by 5 patient users. We could not find any lab supervisor to test our system. The summary of the user evaluation is given in Table 5.

Table 4: ***Result compiled***

Algorithm	Accuracy	Precision	Recall	F1 Score
SVM	80.5%	73.95%	86.58%	79.77%
Naive Bayes	60.06%	53.57%	91.46%	67.56%
Transfer Learning on VGG16	88.72%	88.93%	89.39%	88.49%
Transfer Learning on ResNet-50	92.02%	92.10%	92.28%	91.93%

Table 5: ***User Evaluation***

User Group	Tasks	No of Attempts (Avg)	Time to Complete task(Avg)	No of time asking for help(Avg)	Remarks
Doctor (n=2)	T1: Start eval-report	1	<1 sec	0	
	T2: Make changes on image.	2	1 sec	0	
	T3: Perform zooming and moving of image	4	45 sec	2	It is not well understood
	T4: Add Remarks	1	25 sec	0	
Patient (n=5)	T5: Upload a Report	1.2	84 sec	0	
	T6: Check Details	1	8 sec	0	

5. CONCLUSIONS

The fundamental goal of this research was to create a system that would aid physicians in assessing and detecting MRI brain tumors with more accuracy and robustness, as well as assisting patients in receiving and managing their reports on time. In this system, both the lab supervisor and the patient can upload MRI images and assign physicians, and the later doctor will examine and provide remarks on the image. A machine learning-aided classification is developed, which could help the physicians in understanding the tumor types, and an interface for examining images with certain image processing functions are included to assist doctors. Background research on MRI imaging, machine learning, and deep learning for classification was conducted in order to construct this system. The system's requirements were determined through literature research and surveys of physicians and potential users. At first, we have taken available dataset of brain tumor images and model training was done on that dataset. We initiated the procedure with a Machine Learning approach. The image was preprocessed using two Machine Learning techniques, SVM and Naive Bayes and found 80.5 % accuracy for SVM and 60.6 % accuracy for Naive Bayes. However, the outcome was unsatisfactory, so we moved to deep learning. For the model training on deep learning, transfer learning has been done on VGG16 and Resnet50 models, with 88.72% accuracy on transfer learning of the VGG16 model and 92.02% on transfer learning on resnet50 model.

The developed system has minimal limitations and challenges. In this system physician can be chosen by the patients, however there is no means to evaluate the grade of the physicians based on their qualifications. The system cannot take multiple images at the same time, but can only take one image at a time.

In future we should implement the technique of selecting physicians based on their expertise into our system so that the patient can choose according to their priority. Multiple brain MRI image uploading systems should be integrated to enhance the system. We will try to increase the system accuracy integrating more advance method.

ACKNOWLEDGEMENTS

Authors would like to express their gratitude to the Ministry of Defense, Bangladesh; Ministry of Education, Bangladesh; and Department of CSE, Military Institute of Science and Technology (MIST), Dhaka, Bangladesh. Authors also would like to acknowledge heartiest gratitude, profound indebtedness and deep respect to our supervisors, Tarannum Zaki, Lecturer, Department of Computer Science and Engineering, Military Institute of Science and Technology and Muhaimin Bin Munir, Lecturer, Department of Computer Science and Engineering, Military Institute of Science and Technology for their constant supervision, affectionate guidance and great encouragement and motivation.

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AUTHOR BIOGRAPHY

Major Jannatul Ferdous has passed SSC from Jamalpur Govt Girls' High School in 2006 with CGPA 5.0 out of 5.0 and passed HSC from Jamalpur Ashekh Mahmud College in 2008 with CGPA 4.2 out of 5.0. She enrolled BSc. in CSE, in the Military Institute of Science and Technology (MIST), one of the prestigious organizations of Bangladesh, in 2018. She successfully completed his graduation in 2022 with CGPA 3.0 out of 4.0.

Captain Md. Shakib Shahriar Khan has passed SSC from Mirzapur Cadet College in 2014 with CGPA 5 out of 5 and passed HSC from Mirzapur Cadet College in 2016 with CGPA 5.0 out of 5.0. He enrolled BSc. in CSE, in the Military Institute of Science and Technology (MIST), one of the prestigious organizations of Bangladesh, in 2018. He successfully completed his graduation in 2022 with CGPA 3.8 out of 4.0.

Tarannum Zaki has passed her BSc and MSc from Military Institute of Science and Tecnology (MIST), Dhaka, Bangladesh. She was associated with the department of Computer Science and Engineering, MIST as a Lecturer. Currently she is pursuing her higher study in USA.

Muhaimin Bin Munir has passed B.Sc. in Computer Science and Engineering (CSE) from Military Institute of Science and Technology (MIST), Dhaka, Bangladesh in 2020. He is currently working as a Lecturer in the department of Computer Science and Engineering, MIST, Dhaka, Bangladesh.

CSE TECHNICAL PAPER
The MIST Journal of Computer Science and Engineering

Development of an Intelligent Chatbot for MIST Website

Muhtasim Alim Apu[1], Usabbir Ahmed Shakil[2], and M. Akhtaruzzaman[3]

Department of CSE, Military Institute of Science and Technology (MIST), Dhaka, Bangladesh

emails: [1]*apurbasikdar08@gmail.com;* [2]*usubbir@gmail.com, and* [3]*akhter900@cse.mist.ac.bd*

INFO

History:

Started: 13th April 2021
Proposal defence: 10th Jun 2021
Final defence: 27th Mar 2022
Submitted: 30th Mar 2022
Published: 30th June 2022

Keywords:

Chatbot
Intelligent chatbot
MIST website
Natural Language Processing
Artificial Intelligence

ABSTRACT

Chatbot is a computer software that uses Artificial Intelligence (AI), such as Natural Language Processing (NLP), to imitate human interactions in their natural form, including text or spoken language. NLP aids computers in communicating with humans in their native language and scales other language-related activities. NLP allows computers to read text, hear voice, analyze, gauge sentiment, and identify the significant bits. The MIST website is a large portal offering a variety of services. It is challenging to extract required information from the website in most circumstances, especially for a first-time visitor. This project intends to construct an intelligent chatbot for this website to discover a solution to this problem focusing on the CSE department's entrance procedures and academic programs.

চ্যাটবট হল একটি কম্পিউটার সফ্টওয়্যার যা কৃত্রিম বুদ্ধিমত্তা (AI) ব্যবহার করে, যেমন প্রাকৃতিক ভাষা প্রক্রিয়াকরণ (NLP), পাঠ্য বা কথ্য ভাষা সহ মানুষের সাথে তাদের স্বাভাবিক আকারে যোগাযোগ করতে সহায়তা করে। NLP কম্পিউটারকে মানুষের সাথে তাদের স্থানীয় ভাষায় যোগাযোগ করতে সাহায্য করে এবং অন্যান্য ভাষা-সম্পর্কিত ক্রিয়াকলাপ স্কেল করে। NLP কম্পিউটারগুলিকে পাঠ্য পড়তে, ভয়েস শুনতে, বিশ্লেষণ করতে, অনুভূতি পরিমাপ করতে এবং উল্লেখযোগ্য বিটগুলি সনাক্ত করতে সহায়তা করে। MIST ওয়েবসাইট হল একটি বড় পোর্টাল যা বিভিন্ন ধরনের পরিষেবা প্রদান করে। বেশিরভাগ পরিস্থিতিতে, বিশেষ করে প্রথমবারের দর্শকদের জন্য ওয়েবসাইট থেকে প্রয়োজনীয় তথ্য বের করা চ্যালেঞ্জিং। এই প্রকল্পটি এই ওয়েবসাইটের জন্য একটি বুদ্ধিমান চ্যাটবট তৈরি করতে চায় যাতে CSE বিভাগের ভর্তি পদ্ধতি এবং একাডেমিক প্রোগ্রামগুলির উপর দৃষ্টি রেখে এই সমস্যার একটি সমাধান খুঁজে পাওয়া যায়।

1. INTRODUCTION

Chatbot is an artificial human alike conversation system used for better communication. The conventional chatbot system directly communicates with the visitor in textual conversation format. Other than this, we may find many websites and restaurant sites where an auto generated chatbot greets us and provides required information. This chatbot system is being used in every single social site.

1.1 Motivation

Present world is advancing so fast that we also have to keep pace with the digitalization just to survive in this era. Artificial intelligence chatbot system is being used in this modern world as a substitute of manual time-consuming effort of human. MIST website is also in need of such chatbot system for easy communication with the visitors. With this motivation, we have prepared a functional intelligent chatbot system for MIST website.

Microservices are an architectural paradigm with a high degree of cohesion. It emphasizes on modular, lightweight services (Roca, 2020). This chatbot is developed for students and parents to meet their queries like enquiry process, course details, eligibility criteria description etc. This chatbot is developed based on the chatterbot algorithm that is a python library. It makes the chatbot easy to generate output tailored to the users' input. That means the user does not always need to go to the college for a query. And the college does not need to engage any personnel for meeting the queries. The chatbot can perform the job for the college office. The framework

answers the queries of the user as if it was replied to by any individual (Shingte, 2020).

This chatbot was developed compared with the prevailing quick-service and full-service restaurants. While the quick-service system and full-service system had the best output in terms of satisfaction and behavioral outcomes, the chatbot ordering system had the highest number of orders. But the chatbot system is more suitable for quick service restaurants for the simplicity of the menu (Leung, 2020). Software to machine-learn conversational patterns from a transcribed dialogue corpus has been used to generate the chatbot. The chatbot integrates the language model and the computational algorithm to emulate informal conversation between the user and computer using natural language (Shawar, 2005).

Webhook have a major role in methods of reasoning. Despite the appealing features of the Diagflow, Diagflow has revealed an API which can allow it to send sales. The sales will be mapped into an arrangement and a fitting response will be sent to the API visitor, comparably as if the requesting message was made into Diagflow's conciliation (Punith S, 2020). Deep neural network can be specifically trained by backpropagating derivatives of a cost function that measures the discrepancy between the target outputs produced for each training case (Hinton, 2012).

Any system that can be simply trained for any purpose, is rarely be found. Mostly chatbots are used commercially, but there is less existing system being used for education purpose. We have taken this gap as our main objective. We have designed this chatbot system for our educational institute as a smart, intelligent guide for the users.

1.2 Problem Statements

MIST is a huge Academic Organization. A large number of visitors are seen in MIST website for various purposes on daily basis. But there is a major issue faced by the users. That is, users don't find their desired information on MIST website easily. They need some assistance or live guidelines. So, once the user visits the MIST website, he/she can directly ask to the guide/assistant what actually he is looking for. That's why MIST website needs an Intelligent chatbot system as a guide or assistant to support the visitors' queries.

1.3 Objectives

We developed our chatbot system for the visitors of MIST website. Our main objective for developing the intelligent chatbot system are,

- To design and develop an active chat system application
- To design and implement a knowledge-based (KB) dataset system for the chat engine
- To implement an inference engine for logical analysis and reasoning

1.4 Research Methods

The approach is the development and implementation of intelligent chatbot system. Research Methodology steps are presented in Figure 1.

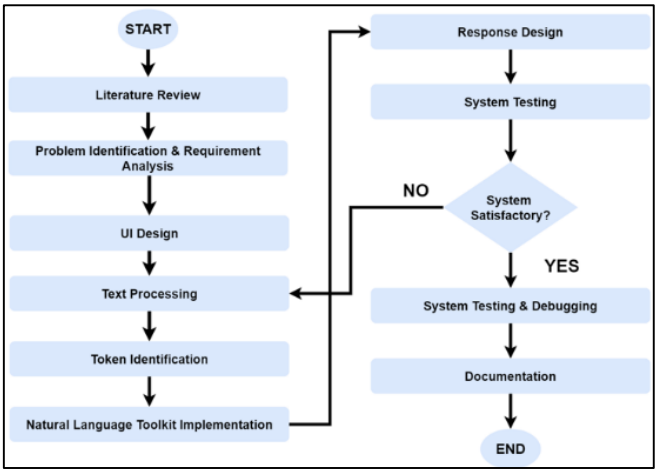

Figure 1: Research Methodology

1.5 Manuscript organization

The manuscript is organized as,

- Section one: Overview, Objectives, Intelligent Chatbot System for MIST website, Scopes of the study
- Section two: This section presents the system analysis and relevant steps
- Section three: System design and implementation are presented
- Section four: Result Analysis
- Chapter five: Conclusion of the presented work

2. SYSTEM ANALYSIS

Before we started our project, we have to analyze the requirement for our chatbot system. We have followed the following steps to develop the core system.

- Tokenization
- Stemming
- Creating Bag of Words
- Preparing Input Layer
- Feed Forward Neural Network
- Selection of Activation Function
- Weights and Bias Adjustment
- Final Result

3. SYSTEM DESIGN

System Architecture contains the big picture of the overall scene of the system. All the components of the system are shown in the system architecture. All the relations of the connected components of the system are shown in the system architecture, Figure 2. In our chatbot system we developed a dataset and we used 80% data as training data and 20% data for testing. Once the model is trained, our dataset got some knowledge from the training which will help it for decision making from the patterns of the tag in the dataset. At the same time, we developed our front-end using HTML, javascript, CSS. Once the visitor will ask any question, it will search the question from the dataset. A suitable answer will be generated from the NLG (Natural Language Generator) and appear in the Front-End User Interface. The Architecture of our system is demonstrated in Figure 2.

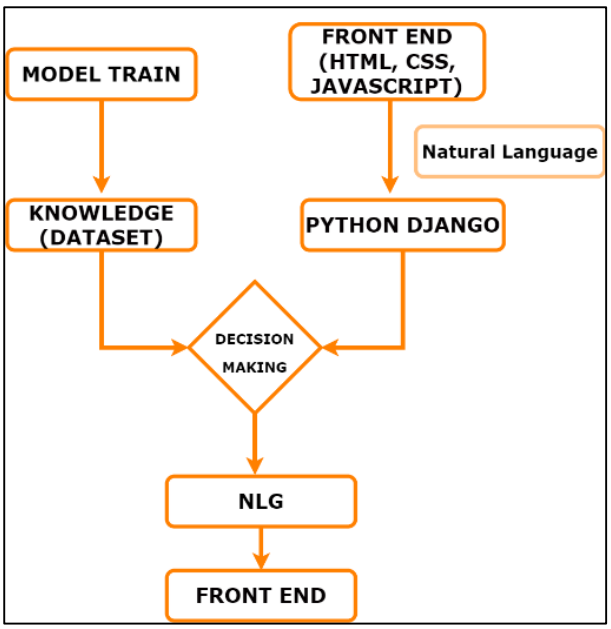

***Figure 2:* System Architecture**

4. RESULT ANALYSIS

We have implemented Feed Forward Neural Network, three hidden layers, two Activation Functions (Linear and ReLU), Cross Entropy Loss Function, and Adam Optimizer for optimization of training. With this we have achieved 97% accuracy for this system.

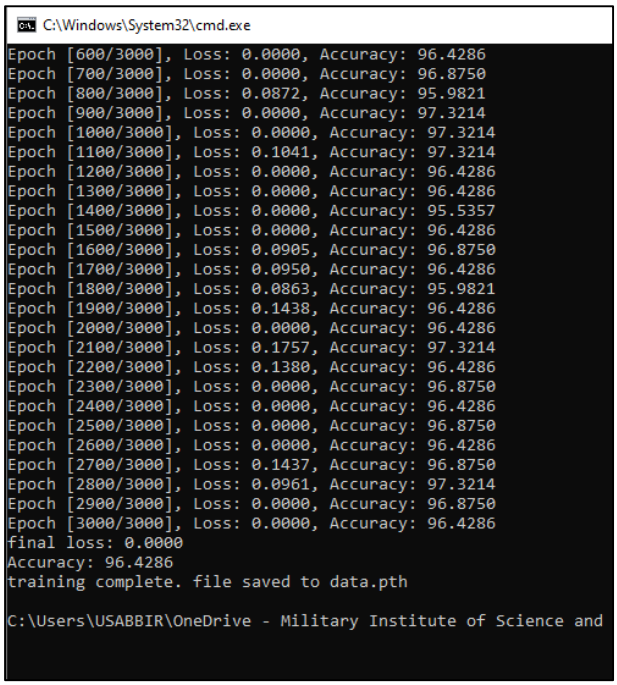

***Figure 3:* Accuracy**

We have designed our front-end using HTML, CSS, JavaScript, Ajax and we have used PyTorch and Django. Some screenshots of the user interface of our chatbot system are shown in Figure 4.

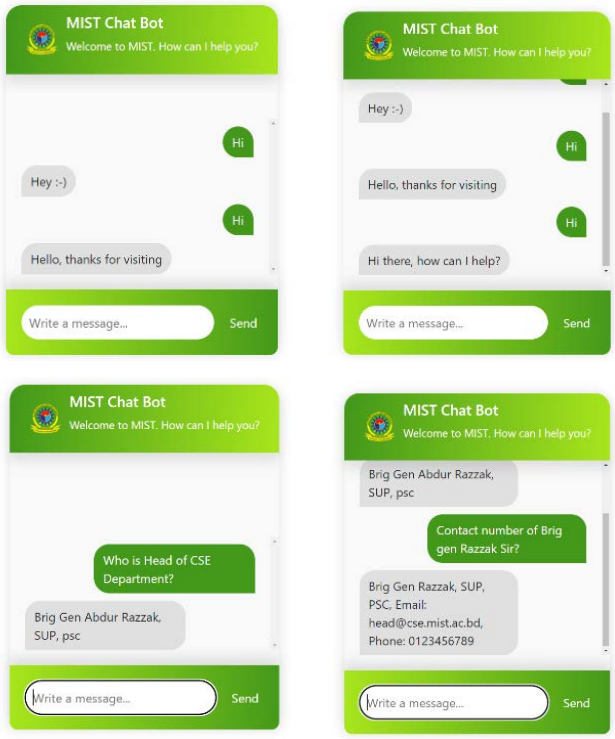

***Figure 4:* Chatbot screenshots**

5. CONCLUSIONS

Basing on the arising situation of the present world, Chatbot has become a very demanding choice for all kind of organizations. Starting from the small entrepreneurs up to large organizations and companies everyone is using chatbot for their customers and consumers support. The reason behind this huge demand is being more practically professional to their individual organizations. MIST is also a huge organization which is interacting with numerous students every day. So, there should be some professional way to interact with the students and visitors. Main purpose of this chatbot is to help the visitor with the required information. Normally it is not feasible to employ someone sitting in front of the screen all the time and waiting for the visitors. There should have some ways to minimize this problem. From the need of solving this evolving problem, this chatbot system is introduced. This chatbot system will help a bulk number of visitors by providing some kind of information regarding CSE department and MIST. They will be able to get a lot of support from this chatbot. Visitors can ask any kind of questions to the chatbot. As this is an intelligent chatbot system, it will learn every day from the previous course of knowledge and apply those to the future integration. A relation in between AI based chatbot and Golden Ratio (GR) could be established through uses and implementing of the concept for AI chatbot, as GR proved a lot of improvements in computing and science (*Akhtaruzzaman & Shafie, 2011*).

ACKNOWLEDGEMENTS

We are thankful to Almighty ALLAH for his blessing for successful completion of our thesis. Our heartiest gratitude, deep respect to our supervisor for his constant supervision, affectionate guidance, great encouragement, and motivation.

We are also thankful to the Department of Computer Science and Engineering of Military Institute of Science and Technology (MIST) for providing their all-out support during the thesis work.

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AUTHOR BIOGRAPHY

BA-10260 Capt Muhtasim Alim Apu has passed SSC from Barishal Cadet College in 2013 with GPA 5.00 out of 5.00 and passed HSC from Barishal Cadet College in 2015 with GPA 5.00 out of 5.00. He enrolled BSc. in CSE, in the Military Institute of Science and Technology (MIST), one of the prestigious organizations of Bangladesh, in 2018. He successfully completed his graduation in 2022. During his graduation, Capt Apu participated in various competitions, most importantly NCPC-2019, ICPC-2020. He would like to pursue his higher study in abroad and gain the world class knowledge and experiences to contribute in the development of his Motherland.

BA-10446 Capt Usabbir Ahmed Shakil has passed SSC from Annada Govt. High School in 2013 with CGPA 5.00 out of 5.00 and passed HSC from Brahmanbaria Govt. College in 2015 with GPA 5.00 out of 5.00. He enrolled BSc. in CSE, in the Military Institute of Science and Technology (MIST), one of the prestigious organizations of Bangladesh, in 2018. He successfully completed his graduation in 2022. During his graduation, Capt Usabbir participated in various competitions, most importantly NCPC-2019, ICPC-2020, ICEEICT-2021, ICT Innovation Fest 2021 through which he brought name and fame to the institution. He would like to pursue her higher studies in abroad and gain the world class knowledge and experiences to contribute in the development of his country

Dr. M. Akhtaruzzaman is an Assistant Professor in the Dept. of Computer Science and Engineering, Military Institute of Science and Technology, Bangladesh. He is also associated with DREAM Robotics Ltd., Dhaka, Bangladesh as a Consultant and Research scientist. He was awarded the PhD and MSc. from IIUM, Malaysia, and the BSc. from IIUC, Bangladesh. He has published 50+ research articles and awarded several Gold Medals as the recognition of his research works. His field of interest includes robotics, mechatronics systems, control engineering, AI, fuzzy systems, and quantum computing.

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CSE TECHNICAL PAPER
The MIST Journal of Computer Science and Engineering

Automated Image Processing Approach to Detect Ectopic Pregnancy Using Ultrasound Images

Pratyusha Kundu[1], Anika Zaman[2], Sabrina Afreen Haque[3], T. M. Shahriar Sazzad[4],* and *Shahriar Rahman Khan Nehal[5]

Department of CSE, Military institute of Science and Technology (MIST), Dhaka, Bangladesh.

emails: [1]*pkdroide@gmail.com;* [2]*anikazaman5470@gmail.com;* [3]*sabrinahaque77254@gmail.com;* [4]*shahriar@cse.mist.ac.bd; and* [5]*shahriarkhan@cse.mist.ac.bd*

INFO

History:

Started: 04th Month 2021
Proposal defence: 06th Month 2021
Final defence: 03rd Month 2022
Submitted: 04th Month 2022
Published: 30th June 2022

Keywords:

Medical image analysis
Ectopic pregnancy
Abnormal pregnancy
Image processing
Ultrasound image

ABSTRACT

Ectopic Pregnancy (EP) is an abnormal pregnancy where the embryo takes place outside the uterus and it can cause life-threatening situation if it is not diagnosed and treated as early as possible. There are different types of EP where tubal EP is one of the serious ones. Ultrasound, MRI are available to detect EP at the very early stage but the procedures used by these diagnosis methods are not fully automated. Additionally, due to complex cell structure, interpretation is still difficult and time-consuming for the radiologists using these methods. Incorporating an automated computerized-based approach can make this process easy. This study delineates an automated approach for tubal EP detection using Ultrasound images where conventional image processing has been used. This approach tends to provide an accuracy rate of 96.27% Additionally, the use of convolution neural network (CNN) with the conventional approach can assist to increase the accuracy to 96.55%, which possesses an acceptable accuracy rate in the radiography laboratory.

একটোপিক প্রেগন্যান্সি (EP) হল একটি অস্বাভাবিক গর্ভাবস্থা যেখানে ভ্রূণ জরায়ুর বাইরে সংঘটিত হয় এবং যত তাড়াতাড়ি সম্ভব এটি নির্ণয় এবং চিকিৎসা না করা হলে এটি জীবন-হুমকির কারণ হতে পারে। বিভিন্ন ধরণের ইপি রয়েছে যেখানে টিউবাল ইপি গুরুতর এক। আল্ট্রাসাউন্ড, এমআরআই খুব প্রাথমিক পর্যায়ে EP সনাক্ত করার জন্য উপলব্ধ কিন্তু এই রোগ নির্ণয়ের পদ্ধতিগুলি দ্বারা ব্যবহৃত পদ্ধতিগুলি সম্পূর্ণরূপে স্বয়ংক্রিয় নয়। উপরন্তু, জটিল কোষ গঠনের কারণে, এই পদ্ধতিগুলি ব্যবহার করে রেডিওলজিস্টদের জন্য ব্যাখ্যা করা এখনও কঠিন এবং সময়সাপেক্ষ। একটি স্বয়ংক্রিয় কম্পিউটারাইজড-ভিত্তিক পদ্ধতির অন্তর্ভুক্ত করা এই প্রক্রিয়াটিকে সহজ করে তুলতে পারে। এই অধ্যয়নটি আল্ট্রাসাউন্ড চিত্রগুলি ব্যবহার করে টিউবাল ইপি সনাক্তকরণের জন্য একটি স্বয়ংক্রিয় পদ্ধতির বর্ণনা করে যেখানে প্রচলিত চিত্র প্রক্রিয়াকরণ ব্যবহার করা হয়েছে। এই পদ্ধতিটি 96.27% এর নির্ভুলতার হার প্রদান করে অতিরিক্তভাবে, প্রচলিত পদ্ধতির সাথে কনভোলিউশন নিউরাল নেটওয়ার্ক (CNN) ব্যবহার নির্ভুলতাকে 96.55% এ বৃদ্ধি করতে সহায়তা করতে পারে, যা রেডিওগ্রাফি পরীক্ষাগারে একটি গ্রহণযোগ্য নির্ভুলতার হার ধারণ করে।

1. INTRODUCTION

Pregnancy can be of two types: normal pregnancy and ectopic pregnancy (EP). In normal pregnancy, the fertilized egg develops inside the uterine cavity. On the contrary, in EP is a rare type of pregnancy where the fertilized egg gets implanted at a site other than the usual uterine cavity *(Swami et al., 2015)*. This type of pregnancy can cause serious conditions (i.e., internal bleeding, infections) in a female body which can be lethal for both the fetus and the pregnant mother. There are various types of EP including ruptured, tubal, ovarian or

abdominal etc. The majority (98.7 percent) of the EPs occur in fallopian tubes which are known as tubal ectopic pregnancies *(Khaydarovich et al., 2021)*. Recently, there are a number of diagnosis options available to detect EP including blood test, Ultrasonography, MRI test. In blood test detection procedure, when the level of Beta hCG is higher than the usual level, it is decided that primarily the patient has EP *(Farren et al., 2020)*. But this procedure is unable to locate the exact place of occurrence. In ultrasound scanning method, color Doppler is used and it helps to increase the accuracy rate of detection moderately *(Wen et al., 2021)*. However, the radiologists must be highly skilled to examine the images correctly. MRI has the highest accuracy rate *(Ramanathan et al., 2018)*. But this test is very expensive and it is not always possible to install the MRI equipment in all the diagnostic centers in developing countries like the South Asian region and African countries. To summarize, for detecting EP, the existing available diagnosis processes are time consuming, not fully automated and do not provide higher accuracy in detecting the EP. So, this research study focused on the automated medical image processing approaches to detect EP automatically using Ultrasound images so that these approaches can minimize human errors and help the experts to diagnose EP within a short period of time.

1.1 Motivation

One of the main motivations for our research is using image processing to detect a rare type of pregnancy i.e., EP. This study also has worked on detecting tubal EP because the majority of EP happens are tubal EP. This study also has been carried out to assist the radiologists to detect this rare type of abnormality within a short period of time.

1.2 Problem Statements

It is really necessary to detect ectopic pregnancy correctly at the early stage to protect a female from an unexpected death. Therefore, it is essential to incorporate a computerized automated image processing approach which will assist the radiologists to investigate the ectopic pregnancy at the very early stage.

1.3 Objectives

Following are the objectives of this research:

- To analyze existing available image processing approaches for the detection of tubal ectopic pregnancy
- To propose a suitable image processing technique for the detection of tubal ectopic pregnancy using ultrasound images (mainly detection of misplaced embryo).

1.4 Research Methods

The research approach used in this study consisted of a number of phases shown in Figure 1.

1.5 Manuscript organization

This research study is organized in a number of sections. First, the research problem is identified through literature review. The existing detection processes are figured out including their limitations and issues which is delineated in the section "Literature Studies". This step is followed by the collection of necessary data from a radiography lab. Then the data has been analyzed and based on the analysis two types of automated approaches have been proposed. It is described in "Proposed Method" elaborately. Then the experimental results and the comparison among them are mentioned "Results Analysis" section. Finally, "Conclusion" comprises of conclusion and future work.

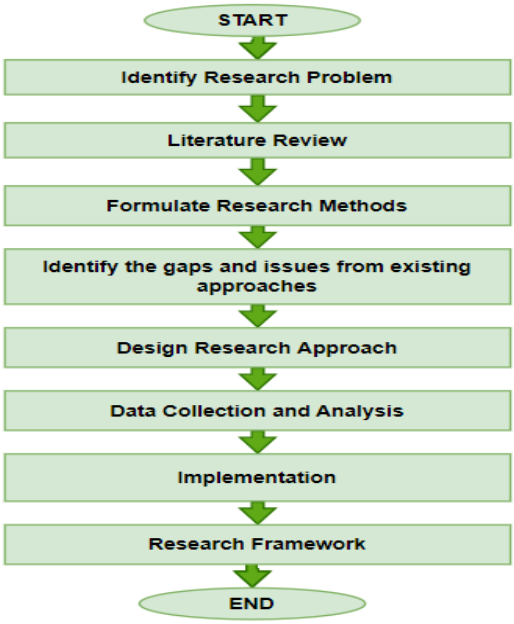

Figure 1: Flow diagram of the activities in preparing the research

2. LITERATURE STUDIES

The following researches have been done to detect ectopic pregnancy:

Table 1: Related works in tabular form part 1

References	Approach	Findings	Limitations
(Surampudi & Gundabattula 2016) (Swami *et al.*, 2015)	Blood Test	• Measures the level of Beta hCG (Human Chorionic Gonadotropi) • If the level of Beta hCG is higher than 1500 mIU/ml then EP is detected	• Manual methods are used to detect • Cannot detect exactly where the ectopic pregnancy has occurred
(Sindhuja & Vijayarg havan, 2019)		• Measures the Serum Creatinine Phosphokinase (CPK) levels along with beta HCG • The cut-off value of CPK for EP detection is 51 IU/lit	• Manual methods are used • If there is a significant overlap in CPK values then the serum is unreliable

***Table 2:* Related works in tabular form part 2**

Ref	Approach	Findings	Limitations
(Ramanathan et al., 2018) (Zheng et al., 2021) (Yoshigi et al., 2006)	MRI	• Can detect Ep with its ○ multiplanar imaging capabilities ○ larger FOV (field-of-view) ○ Ability to identify tissue characteristics and blood products • Accuracy rate to detect EP is 96%	• Not fully automated • Highly expensive • Not possible to install high technology equipment required for this test in every diagnostic center
(Khaydarovich et al., 2021) (Kirk et al., 2007) (Wen et al., 2021)	Ultrasonography	• Abdominal ultrasound, Color Doppler and TVS (Trans-vaginal Ultrasound) is used to detect EP • Very effective to detect ectopic pregnancy at an early stage • Cost-effective	• Semi-automated • Requires highly skilled radiologists to analysis the ultrasound images • Time consuming

So, none of the approaches mentioned in table 1 and table 2 are fully automated. Therefore, a computerized automated image processing approach is necessary to assist the radiologists to investigate the ectopic pregnancy at the very early stage.

3. PROPOSED METHOD

To detect tubal ectopic pregnancy, first test ultrasound images have been collected from a radiologist. Two methods have been proposed in our research in order to detecting the ectopic pregnancy. In proposed method 1, first we have done enhancement, filtering and segmentation consecutively. Then we have gained knowledge about the features used by radiologists to detect tubal ectopic pregnancy manually which is donut shaped region visible on the image and its characteristics like radius, circularity etc. We have used this knowledge to identify the Region of Interest (ROI) which is the donut shaped pattern. Figure 2 shows a number of identified EP regions for a number of test images using this study approach. In proposed method 2, we have incorporated machine learning on the segmented images found from proposed method 1. We have done convolution neural network (CNN) classification on those images where we have built a 10 layered model.

5. RESULT ANALYSIS

In total 322 images have been tested in our approach. In 322 regions, 310 regions have been detected correctly using the proposed method 1. So, proposed method 1 has gained the accuracy of 96.27%. On the other hand, in proposed method 2, the 10 layered model in CNN classification has gained the accuracy of 96.55%. The table # shows the comparative analysis among the proposed approaches by this study and proposed approach by *(Lima et al, 2021)*.

***Table 3:* Comparative results among this study proposed approach and exiting available works**

Proposed	Used approach	Accuracy (approx.)
Lima et al., 2021	Manual	86%
Proposed method 1	Conventional image processing	96.27%
Proposed method 2	Machine learning approach	96.55%

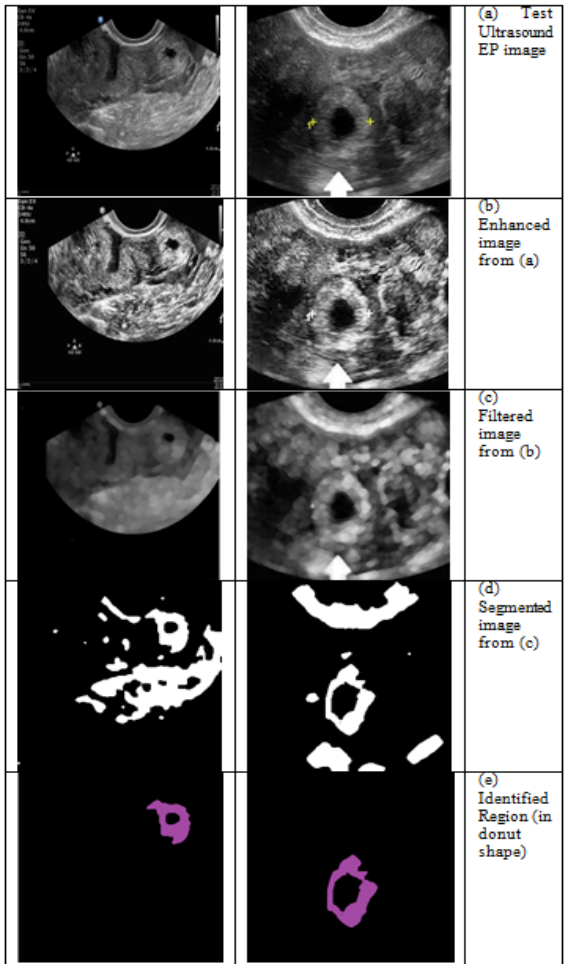

***Figure 2:* Identified region (donut-shaped in purple color)**

6. CONCLUSIONS

Manual detection of EP is very time consuming and the success rate normally depends on the person's skill. In this study, an automated approach has been proposed which is less complicated and takes less time with high precision. Radiography laboratory experts already accepted the test results and the accuracy rate.

In future, this study will investigate further to analyze EP of other regions (Cervical, Interstitial, Ovarian, and Abdominal).

ACKNOWLEDGEMENTS

We would like to delightedly acknowledge radiologist Dr. Rumi for providing the test datasets and necessary feature information for this study. We would like to express our heartiest gratitude towards Military Institute of Science and Technology for its relentless technical support.

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AUTHOR BIOGRAPHY

Pratyusha Kundu has passed SSC from Holy Cross Girls' High School in 2015 with GPA 5.00 out of 5.00 and passed HSC from Holy Cross College in 2017 with GPA 5.00 out of 5.00. She successfully completed her graduation from Military Institute of Science and Technology (MIST) in 2022.

While studying in college, she participated in various competitions for example, Math and Science Olympiads. During her graduation, **Pratyusha** volunteered in the orientation program of freshers in 2019 in MIST. She also participated in Robotics design and development through which she brought name and fame to the institution. **Pratyusha** would like to pursue her higher studies in abroad and gain the world class knowledge and experiences to contribute in the development of her Motherland.

Anika Zaman has passed SSC from Holy Cross Girls' High School in 2015 with GPA 5.00 out of 5.00 and passed HSC from Holy Cross College in 2017 with GPA 5.00 out of 5.00. She successfully completed her graduation from Military Institute of Science and Technology (MIST) in 2022.

During her study in the college, **Anika** participated in various competitions such as Science Olympiads, Debate competitions. She also participated in club activities. During her graduation, **Anika** participated in ICPC-2019 and NCPC-2020 through which she brought name and fame to the institution. **Anika** would like to pursue her higher studies and gain the world class knowledge and experiences to contribute in the development of her Motherland.

Sabrina Afreen Haque has passed SSC from Ideal School and College in 2015 with CGPA 5 out of 5 and passed HSC from Ideal School and College in 2017 with CGPA 5 out of 5. She successfully completed her graduation from Military Institute of Science and Technology (MIST) in 2022.

During her graduation, **Sabrina** participated in various competitions, most importantly Robotics design and development, Math Olympiad, through which he brought name and fame to the institution. **Sabrina** would like to pursue her higher study in abroad and gain the world class knowledge and experiences to contribute to the development of her Motherland.

Dr. T. M. Shahriar Sazzad completed his BSc Engg. in CoE from AIUB in 2003. He was awarded his MSc IT from Uni of ABERTAY Dundee, Scotland, UK in 2006. He was awarded his PhD from Eidth Cowan University, WA, Australia in 2017. He is associated with Military Institute of Science and Technology (MIST), Dhaka, Bangladesh as an Assistant Professor. Currently he is in Higher Study Leave in the University of Florida, USA as a Postdoctoral research fellow. His research interest includes Image processing, Tissues Image Analysis, gamma encoding, and Cryptography.

Shahriar Rahman Khan Shahriar Rahman Khan completed his Higher Secondary Certificate exam from Notre Dame College in 2016. He then persuaded his BSc degree in Computer Science and Engineering from the Military Institute of Science and Technology in 2020. His research works mainly focus on Image Processing, Machine Learning, Deep Learning, and Natural Language Processing. He is currently working as a lecturer at the Military Institute of Science and Technology (MIST), Dhaka, Bangladesh. He has published 3 conference papers in IEEE access and Springer in the year 2020-2021 and is currently supervising several projects and papers related to his research interest.

CSE TECHNICAL PAPER
The MIST Journal of Computer Science and Engineering

Context Based Emotion Recognition from Bengali Text

Lopa Ahmed[1], Isbat Khan Polok[2], and Adnanul Islam[3]

Department of CSE, Military Institute of Science and Technology (MIST), Dhaka, Bangladesh

emails: [1]*lopaahmed296@gmail.com;* [2]*isbatkhanpolok@gmail.com; and* [3]*adnanul@cse.mist.ac.bd*

INFO

History:

Started: 01st Month 2021
Proposal defence: 30th June 2021
Final defence: 27th March 2022
Submitted: 30th March 2022
Published: 30th June 2022

Keywords:

Emotion Recognition
NLP
Emotion
Romanized Bangla
Dataset
BERT
Context

ABSTRACT

Every individual's everyday life has become a routine of expressing their ideas, opinions, emotions, and experiences through social networking sites and platforms on the internet in this era of rapid technological innovation. These points of view can be utilized to develop strategies for increasing efficiency in a range of fields, including business, politics, research, and analysis. Natural language processing (NLP) uses emotion detection to automatically monitor, evaluate, and categorize people's ideas and opinions in order to get a sense of how they feel. To date, a substantial amount of study has been done on the Emotion Recognition of the English language, with notable results. Unfortunately, there has been a scarcity of research on the Bangla language in the subject of Emotion Recognition. Despite the fact that social networks have increased the popularity of romanized Bangla among Bangla speakers, there is even less research on romanized Bangla text. As a result, the focus of this study was on emotion recognition for both raw and romanized Bangla texts. A corpus of romanized Bangla texts was created from a raw Bangla feeling corpus in this study. Datasets of military, medical, religious and general context are collected and tested with the Bidirectional Encoder Representations from Transformers. Finally, the outputs are studied and evaluated.

প্রতিটি ব্যক্তির দৈনন্দিন জীবন দ্রুত প্রযুক্তিগত উদ্ভাবনের এই যুগে ইন্টারনেটে সামাজিক নেটওয়ার্কিং সাইট এবং প্ল্যাটফর্মের মাধ্যমে তাদের ধারণা, মতামত, আবেগ এবং অভিজ্ঞতা প্রকাশ করা একটি রুটিন হয়ে দাঁড়িয়েছে। এই দৃষ্টিভঙ্গিগুলি ব্যবসা, রাজনীতি, গবেষণা এবং বিশ্লেষণ সহ বিভিন্ন ক্ষেত্রে দক্ষতা বৃদ্ধির জন্য কৌশল বিকাশের জন্য ব্যবহার করা যেতে পারে। ন্যাচারাল ল্যাঙ্গুয়েজ প্রসেসিং (NLP) আবেগ শনাক্তকরণ ব্যবহার করে স্বয়ংক্রিয়ভাবে নিরীক্ষণ, মূল্যায়ন এবং শ্রেণীবদ্ধ করার জন্য লোকেদের ধারনা এবং মতামতগুলিকে কীভাবে অনুভব করে তা বোঝার জন্য। আজ অবধি, উল্লেখযোগ্য ফলাফল সহ ইংরেজি ভাষার আবেগ স্বীকৃতির উপর যথেষ্ট পরিমাণ অধ্যয়ন করা হয়েছে। দুর্ভাগ্যবশত, ইমোশন রিকগনিশন বিষয়ে বাংলা ভাষায় গবেষণার অভাব দেখা দিয়েছে। সামাজিক নেটওয়ার্কগুলি বাংলা ভাষাভাষীদের মধ্যে রোমানাইজড বাংলার জনপ্রিয়তা বাড়ালেও, রোমানাইজড বাংলা টেক্সট নিয়ে গবেষণাও কম হয়েছে। ফলস্বরূপ, এই অধ্যয়নের ফোকাস ছিল কাঁচা এবং রোমানাইজড উভয় বাংলা পাঠ্যের জন্য আবেগ স্বীকৃতির উপর। এই গবেষণায় একটি কাঁচা বাংলা অনুভূতি থেকে রোমানাইজড বাংলা পাঠ্যের একটি সংগ্রহ তৈরি করা হয়েছিল। সামরিক, চিকিৎসা, ধর্মীয় এবং সাধারণ প্রেক্ষাপটের ডেটাসেটগুলি ট্রান্সফরমার থেকে দ্বিমুখী এনকোডার প্রতিনিধিত্বের সাথে সংগ্রহ এবং পরীক্ষা করা হয়। অবশেষে, আউটপুট অধ্যয়ন করা হয় এবং মূল্যায়ন করা হয়।

1. INTRODUCTION

Emotions are mental states triggered by neurophysiological changes and are linked to ideas, feelings, behavioural responses, and a level of pleasure or dissatisfaction. There is

no scientific agreement on a definition at this time. Mood, temperament, personality, disposition, and inventiveness are all connected with emotions. Emotion research has exploded in the last two decades, with contributions from a wide range of disciplines, including psychology, medicine, history, sociology of emotions, and computer technology. Numerous hypotheses attempting to explain the origin, function, and other elements of emotions have sparked greater research into the subject. The development of materials that excite and evoke emotion is one of the current topics of research in the idea of emotion. Emotions are complicated in nature.

Emotion Recognition is the practice of distinguishing distinct human behaviors and emotions. The precision with which people can figure human emotions varies greatly. Technology-assisted emotion recognition is a relatively new field of study. Work in this field is still in its onset. In the field of psychology, human emotion is a topic of great interest. It aids in the comprehension of human nature and behaviors. Furthermore, emotional moods can have an unspoken impact on human communication, concentration, and the ability to memorize information. To identify emotions in a human, various approaches are utilized, including facial expressions, body movements, blood pressure, heartbeat, and textual information. Emotion recognition is a hot topic among computational linguists these days.

1.1 Motivation

Bengali is used for all official work in our country, and it is also widely used on social media. As a result, emotion recognition from Bengali text is extremely important. The motivations considered are:

a. Emotion recognition from Bengali text will assist us in understanding the emotional perspectives of social media users.
b. In many places, we use romanized Bengali. Emotion recognition from romanized Bengali, on the other hand, has not yet been attempted. The goal of this project is to recognize emotion in romanized Bengali.
c. In addition to recognizing emotion from (context-independent) individual sentences, it may be more meaningful to do so based on a specific context in order to obtain more specific results. As a result, our project focuses on emotion recognition in context.

1.2 Problem Statements

Bengali being a widely used language still lags behind in the sphere of NLP. Emotion recognition from Bengali text is important as all of us use Bengali in social media posts, facebook, twitter and other areas. Understanding emotion from textual data is various sector has equal importance as that from visible facial expression. Context based recognition system allows to understand the emotion even in a better way.

Earlier studies on emotion detection relied quite a lot on methodologies from traditional machine learning, while recent advances in deep learning like, recurrent neural networks and transfer learning have taken relatively unnoticed. However, their application promises further advancements. Indeed, deep learning techniques have become noticeable in a variety of decision support activities involving sequential data [13] and, in particular, linguistic materials [14], where deep learning was able to improve performance when developing decisions from unstructured text. Deep learning has the inherent advantage of successfully modeling highly non-linear relationships.

We have chosen context based dataset for modelling our emotion recognition system. Military contextual dataset is one of the most significant among those. Bangladesh has an army which is 46th out of 142 countries considered for the annual GFP report of 2022 and 3rd most powerful in south asia. Official language used in Bangladesh army is Bengali and it is used to circulate orders, letters, policies, rules and regulations and also responses. About two lakhs of personnel present in the army use Bengali for official reports, returns and responses. Those data are accumulated together.

For context based emotion recognition we have taken into consideration four contextual datasets. We have used BERT model to classify and process datasets which is the most recent model for vectorising, processing and training. BERT is planned to pre-train deep bidirectional representations from unlabeled text by conditioning on both left and right context in all layers which is different from some other language representation models like ELMo *[15]*, Therefore , the pre-trained BERT model can be fine-tuned only with one additional output layer to generate the state of the art models for a wide range of tasks, such as question answering and language inference, without requiring significant task-specific architectural changes.

1.3 Objectives

With their ability to learn multi-level automatic feature representations, deep learning algorithms have been increasingly popular in recent years. Due to its sequential processing, that incorporates the underlying sequential semantics of language, the BERT model has emerged as one of the most popular deep learning models for NLP-related tasks.

We're working on a project called Natural Language Processing in which we're trying to recognize emotion in Bengali writing. Bengali is presented in two different ways on different platforms. One is written in ordinary Bengali, while the other is written in romanized Bengali which will be discussed in details in this paper. Both are commonly used. The research objectives followed by us are as follows:

(1) To construct an emotion dataset based on military environment.
(2) To put different NLP and deep learning techniques for emotion recognition into practice and study them.
(3) Recognize emotion in Bengali and Bengali romanized text.
(4) To compare the performance of multiple state-of-the-art approaches to context-based emotion recognition (e.g. military, medical, general etc.).

1.4 Research Methods

The methodology we have followed for the research starts from studying the previous papers and journals. We continued studying papers throughout the whole process of our work.

Then we collected and created Bengali corpus. Some of the datasets were already annotated as we have collected from different sources[1][2][3]. However, some amongst them were annotated manually for better results. After the creation of dataset, word embedding and model training has been done. The next processes of methodology is shown below:

1.4.1. Data Preprocessing

1.4.1.1. Numerals, Emoticons, And Hashtags Removal

Sentences may contain emoticons, numerals, a URL, a reference of a user, or the hashtag symbol. They aren't useful for emotion recognition; instead, they increase to the text noise and degrade model performance. As a result, we removed them from our dataset.

1.4.1.2. Bangla Punctuation Removal

The removal of punctuation is a common practice in data acquisition and data mining. Although the presence of punctuation marks generally indicates the presence of an emotion, deleting them may result in a reduction in categorization accuracy [16]. However, because the goal of this study is to extract emotion from unbiased text, all Bangla punctuation marks are deleted during pre-processing from the dataset.

1.4.1.3. Duplicates and Null Rows Removal

Dataset duplication can corrupt the training data with the test data, leading to a faulty model. Furthermore, by misinterpreting features, null values can have an impact on the model's performance. As a result, they have been removed from the dataset.

1.4.2. Tokenization

Tokenization is the process of breaking down a phrase, sentence, paragraph, or even an entire text document into smaller components like individual words or phrases. Tokens are the names given to each of these smaller units. Words, numerals, or punctuation marks could be used as tokens. By finding word boundaries, tokenization creates smaller units. The end of one word and the start of the next are referred to as word boundaries. These tokens serve as a starting point for stemming and lemmatization. An example for tokenization can be given as follows:

"This is a cat."

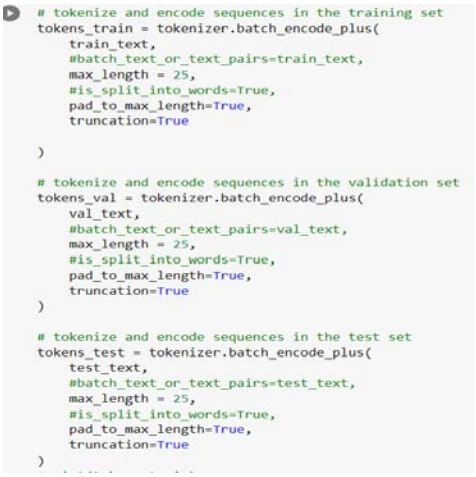
After tokenizing the above string, we get ['This', 'is', 'a', cat'].

For our methodology, tokenizing has been done with transformer library's4 AutoTokenizer package. From this library, we imported 'AutoTokenizer' and 'AutoModel'. Then using the 'from_pretrained()' function of the 'AutoModel' package, we have imported an instance of the pretrained 'sagorsarker/bangla-bert-base' model and tokenizer of the same pretrained model was taken from the 'AutoTokenizer' package. There are many pre trained BERT models having different names with slight difference in their architecture e.g, number of parameters, language of training dataset and its size. Since we are working with Bangla language, we have taken the model named 'sagorsarker/bangla-bert-base' and tokenized our dataset with its tokenizer.

1.4.3. Word Embedding

Word embedding is done after the dataset has been pre-processed. Individual words are represented as real-valued vectors in a defined vector space in word embedding. Because each word is mapped to a single vector, the vector values are acquired in a way similar to that of a neural network, and similar words retain similar representation, the technique is frequently used with deep learning. This allows for, among other things, identifying a word's context in a document, semantic and syntactic similarity, and relationships with other words. At first, the dataset is split up into train, test and validation sets. Then tokenization and word embedding of each of these sets were done individually using the 'batch_encode_plus()' function and it is the tokenizer of the imported BERT model. This tokenizer alone performs both the tasks of tokenization and word embedding and then returns a dictionary of 'token_ids','attention_mask' and 'token_type_ids'. These 'token_ids' are the unique ids for each word with a vector assigned with each id. The length of assigned vectors of all of these ids are same. Word embedding of BERT model uses the technique of wordpiece embedding for tokenization and then positional and segment embedding for tokens. Only after word embedding, the datasets become ready to be fed to the model for processing and for training and testing.

If there is no value or matching available in the pre-trained model, then a new unique value is assigned to that word. For the convenience of the model, a fixed length for word embedding is chosen and for doing that the tokenizer adds padding to the sentences where it is necessary to obtain the fixed length embedding. Attention mask gives a list of truth and false values. It represents the original and padded tokens with these truth values. The raw code for implementing word embedding is given below:



```
# tokenize and encode sequences in the training set
tokens_train = tokenizer.batch_encode_plus(
    train_text,
    #batch_text_or_text_pairs=train_text,
    max_length = 25,
    #is_split_into_words=True,
    pad_to_max_length=True,
    truncation=True

)

# tokenize and encode sequences in the validation set
tokens_val = tokenizer.batch_encode_plus(
    val_text,
    #batch_text_or_text_pairs=val_text,
    max_length = 25,
    #is_split_into_words=True,
    pad_to_max_length=True,
    truncation=True
)

# tokenize and encode sequences in the test set
tokens_test = tokenizer.batch_encode_plus(
    test_text,
    #batch_text_or_text_pairs=test_text,
    max_length = 25,
    #is_split_into_words=True,
    pad_to_max_length=True,
    truncation=True
)
```

*Figure 1: **Word embedding***

[1] https://data.mendeley.com/datasets/24xd7w7dhp/1
[2] https://dumps.wikimedia.org/bnwiki/latest/
[3] https://github.com/ben-aaron188/covid19worry/tree/master/data_phase_1
[4] https://www.analyticsvidhya.com/blog/2021/09/a-deep-dive-into-transformers-library/

Datasets are given as input and vectors with its id representations are obtained as output after word embedding. Since all data in datasets are not of equal length and a fixed length is chosen for word embedding, therefore, attention mask is used to understand the original and added tokens in each line. The outputs of the word embedding are attached herewith for better understanding:

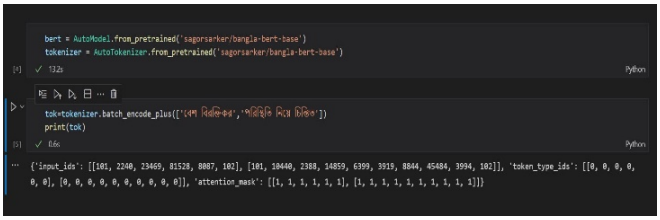


***Figure 2:* Dictionary with Token id and attention masks**

This is one output of word embedding of raw Bengali text where attention masks and input ids are shown.

1.4.4. BERT Model Setup

1.4.4.1. General BERT Model

BERT and other Transformer encoder architectures have proven to be quite effective in a range of NLP tasks (natural language processing). They create natural language vector-space representations that can be used in deep learning models. The Transformer encoder architecture is used by the BERT family of models to process each token of input text in the context of all tokens before and after it, hence the name: Bidirectional Encoder Representations from Transformers. Typically, BERT models are trained on a huge corpus of text before being fine-tuned for specific tasks. The working procedure of BERT model is shown below:

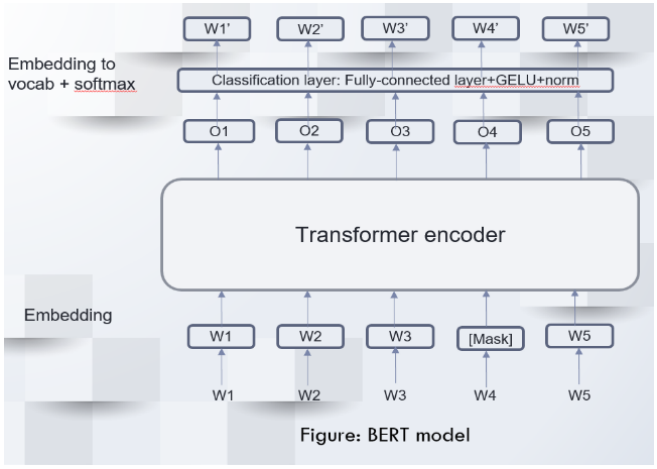


***Figure 3:* BERT model (general)**

At first the input sentence is taken and it is tokenized into words. The words are then masked and sent to the transformer. Masked language and picture modeling are comparable to auto-encoding modeling, which is focused on building results from disorganized or distorted data. Masking, as the name implies, is used in conjunction with these modeling processes, in which we mask words from a sequence of inputs, and the designed model must predict the masked words in order to finish the sentence. When we need to forecast the context of words, these models are applied. The model must use deep learning and multiple representations of words because words can have various meanings in various places.

1.4.4.2. BERT Setup for Our Process

We set the model and fine tune it according to our work. At first, we froze all the parameters. We have defined hidden layers in the model and the softmax activation function was set for the output layer.

```
        self.bert = bert

        # dropout layer
        self.dropout = nn.Dropout(0.1)

        # relu activation function
        self.relu =  nn.ReLU()

        # dense layer 1
        self.fc1 = nn.Linear(768,512)

        # dense layer 2 (Output layer)
        self.fc2 = nn.Linear(512,3)

        #softmax activation function
        self.softmax = nn.LogSoftmax(dim=1)
```

***Figure 4:* Our model**

The rectified linear activation function, or ReLU for short, is a piecewise linear function that gives output of the input directly if the input is positive. Else, it gives output as zero. Because a model that utilizes it, is quicker to train and generally produces better results, it is the default activation function for many types of neural networks and BERT is one of them. A dropout layer has also been added to avoid overfitting. Then, we have added a fully connected layer following the output layer of the network. The number of nodes in the output layer differs based on the number of categories to be classified. There are two dense layers we have set and lastly softmax layer. In neural network models that predict a multinomial probability distribution, the softmax function is utilized as an activation function in the output layer. Softmax is utilized as the activation function for multi-class classification issues involving more than two class labels. We have used softmax as the activation function, categorical cross-entropy as the loss function. We have six classification labels such as happy, sad, anger, disgust, surprise and fear. The output of the softmax layer for our model are classified into six labels.

1.4.5. Train Model

It is vital to grasp the context of a text in natural language processing, which necessitates a continuous understanding of multiple previous lines of words. The most critical task is to train BERT model. We used two unsupervised tasks to pre-train BERT: MLM and NSP. We merely mask a percentage of the input tokens randomly to train a deep bidirectional representation, and then predict those masked tokens. This is regarded as 'masked LM' operation (MLM). In this example, as in a typical LM, the final hidden vectors corresponding to the mask tokens are sent into an output softmax over the vocabulary. We mask 15% of all WordPiece tokens in each

sequence at random in all of our tests.

We only forecast the masked words rather than recreating the complete input, unlike denoising auto-encoders. Although this allows us to generate a bidirectional pre-trained model, the [MASK] token does not emerge during fine-tuning, resulting in a mismatch between pre-training and fine-tuning. We pre-train for a binarized next sentence prediction challenge that can be easily produced from any monolingual corpus in order to train a model that understands sentence relationships. In particular, while selecting sentences A and B, for each pre-training example, 50% of the time B is the actual next sentence after A (labeled as IsNext), and 50% of the time it is a random text from the corpus (labeled as NotNext). This is the concept of NSP.

Fine-tuning is simple since the Transformer's self-attention mechanism allows BERT to mimic a wide range of downstream tasks, whether they involve single texts or pairs of texts, simply changing out the relevant inputs and outputs. A frequent approach for applications requiring text pairings is to encode text pairs independently before applying bidirectional cross attention. Instead, BERT combines these two stages using the self-attention mechanism, because encoding a concatenated text pair with self-attention efficiently incorporates bidirectional cross attention between two phrases.

```
sent_id, mask, labels = batch

# clear previously calculated gradients
model.zero_grad()

# get model predictions for the current batch
preds = model(sent_id, mask)

# compute the loss between actual and predicted values
loss = cross_entropy(preds, labels)
```

```
# compute the training loss of the epoch
avg_loss = total_loss / len(train_dataloader)

# predictions are in the form of (no. of batches, size of batch, no. of classes).
# reshape the predictions in form of (number of samples, no. of classes)
total_preds  = np.concatenate(total_preds, axis=0)

#returns the loss and predictions
return avg_loss, total_preds
```

***Figure 5:* Model training**

The flowchart of the methodology with six emotion levels is:

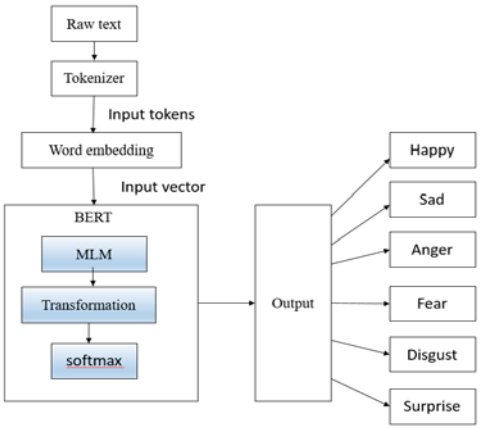


***Figure 6:* Methodology for six emotion levels**

The methodology we have followed for Romanized Bengali dataset is as follows where we have used same methodology as raw Bengali datasets. However, we transformed raw Bengali into Romanized Bengali through transliteration. That means by writing individual code for transforming each word of raw Bengali into Romanized Bengali. We considered each letter with Bengali punctuation marks for transliteration process. The following flowchart shows the methodology of Romanized Bengali texts.

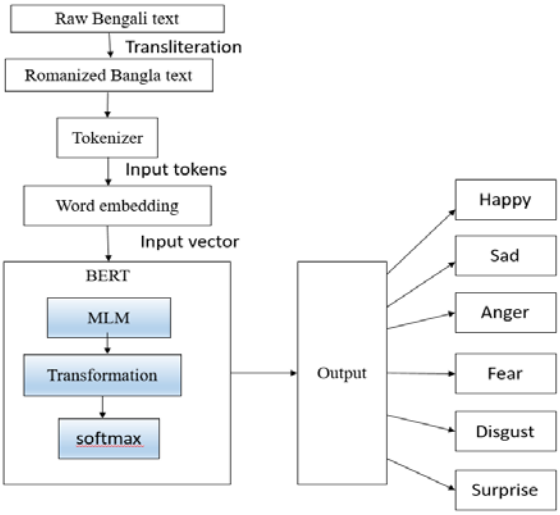


***Figure 7:* Methodology for Romanized Bengali texts**

1.4.6. Post Processing

Several post-processing tasks are conducted throughout the analysis of the results to investigate the factors affecting the models' performance. We have performed testing of our model with three emotion levels for better result which is shown with a comparative study in the evaluation chapter. The methodology we have followed for three emotion levels is:

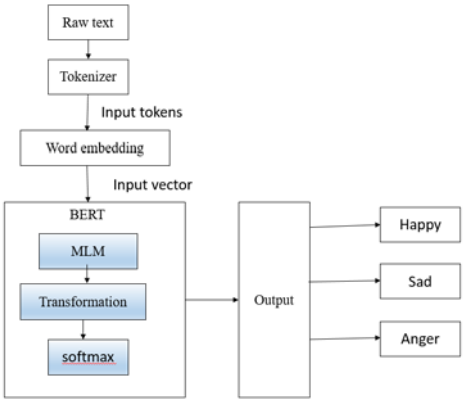


***Figure 8:* Methodology for three emotion levels**

2. LITERATURE STUDIES

Emotion recognition is an emerging area of research. Numerous analysts have worked on emotion recognition from micro-blogging destinations and from short stories or other sort of literature. This section presents the literature review of some of the related works. Not much of the works are done for emotion detection in Bengali.

Aditya Pal et al. *[8]* used machine learning and deep learning methods for emotion classification from Bengali text. They worked a lot with spelling variation and morphological variations of Bengali literature mainly short stories. This dataset named 'Anubhuti' is the first dataset for emotion recognition from Bengali literature. They had captured the context of famous Bengali short stories. But they used manual error detection and manual annotation. They annotated their dataset by three experts of Bengali language and collected the results individually from them which is a hectic and not so foolproof method. This paper detected only four emotions those are, joy, anger, sadness and suspense. Therefore, other emotions categories were not taken into consideration which is a major drawback of this paper. Their annotation is also confusing like fear is amalgamated with suspense. In another paper, Sara Azmin et al. *[2]* detected emotion by supervised machine learning algorithm. Multinomial Naïve Bayes (NB) classifier. The final dataset is able to detect only three emotions like happy, sad and angry which is a drawback as other emotions. Accuracy of this method is about 78.6 percent. This paper focused on emotion detection from opinions in social media, various blogs and public platform. The proposed method pre-processes the corpus to simplify the classification process. It classifies the data into three emotion class such as happy, sad and angry using Multinomial Naive Bayes classifier. They have converted original six labelled datasets into three labels that's why they faced problems in labelling.

Again, H.A. Ruposh et al. *[9]* proposed the technique of identifying six basic emotions like happy, sad, anger, fear, surprise and disgust respectively using 1200 emotive words to train the SVM classifier to identify emotions. This system claims 73 percent accuracy which is greater than Naive based approach that is having 60 percent of accuracy. It used machine learning algorithm and SVM classifier mainly on twitter data. Furthermore, Armin Seyeditabari et al. *[10]* used emotion lexicon like ISEAR and Word-Net-Affect to detect emotion. They consulted both supervised and unsupervised approaches, however, mostly unsupervised approach. They dealt with implicit expression of emotion, use of metaphors, cross cultural and intra cultural variations. In this paper, they did not create a multi-class classification methodology based on the nature of the data and task. However, they showed new ways to increase the emotional qualities of embeddings and vector models those could be beneficial in unsupervised methods, or be used as features in neural networks. This paper shows the usefulness of emotion detection in political, marketing sector to understand customer reaction on products and services.

In another paper, Maryam Hasan et al. *[6]* proposed a soft classification approach to measure the probability to assign a message to each emotion class. Their approach includes two main tasks such as an offline training task and an online classification task. The first task creates models to classify emotion in text messages. For the second task, they developed a two-stage framework called 'Emotex-Stream' to classify live stream text messages for real time emotion tracking. Lastly, they proposed an online method to measure public emotion. Their work deals with the challenges of detecting emotion in social networking platforms are casual style of microblog data, semantic ambiguity of text messages, fuzzy boundaries for emotion classes, inconsistent annotators and many more. They classified as many as 28 emotions with four broad heads like: Happy-active, Happy-inactive, Unhappyactive and unhappy inactive. They could detect emotion with 90 percent accuracy.

Moreover, Francisca Adoma Acheampong et al. *[1]* proposed different concepts related to Emotion Detection, the approach and technique to detect emotion from text and datasets which contains data that are used to express emotions. This paper is a beginner's guide in the field of Emotion detection. It also let us know the presently available data sources for text based emotion recognition. They have used BERT model and bi-LSTM classifier for emotion classes. The research investigates the effectiveness of using transformer encoders to detect emotions on the ISEAR dataset (i.e., anger, disgust, sadness, fear, joy, shame, and guilt). However, they have worked on only ISEAR dataset not the other type of data. This paper also highlights the recent state of research on the field of emotion detection. Fabio Calefato et al. *[4]* proposed about developing a toolkit called 'EmoTxt' which actually detects emotion from text. This toolkit works with CSV file only on their gold standard dataset. No other format of file can be used in this model. Another drawback is the toolkit is completely developed on java. The EmoTxt classification models in a supervised machine learning setting using Support Vector Machines (SVM). This toolkit has less generality. This paper discusses such a system which is implemented and prevailing. Another important contribution of the paper is that the system discussed here can help us to modify our dataset and train it accordingly for custom emotion classification model.

Again, Bernhard Kratzwalda et al. *[7]* proposed a system of finding emotional state from text basing on deep learning for affective computer as behaviour on the surrounding environment depends on the emotional state of an individual. The basic concepts discussed in this paper are Deep Learning, Emotion Recognition, Natural Language Processing, Transfer Learning. They talked about different layers of deep learning for emotion detection and among these processes the output layer of the overall process detects the emotion. Then Jiawen Deng et al. *[5]* discussed about the research and advancement, approaches for emotion recognition with the help of deep neural networks. This paper also discusses about different stages of deep neural learning and the challenges of emotion detection from text on the basis of shortage of large scale datasets, fuzzy emotional boundaries, incomplete emotional information in texts and emotion recognition from a dialogue. Again, Erdenebileg Batbaataret al. *[3]* showed the drawback of previous techniques that the word embedding vectors that were used to be adopted in Emotion Detection that could represent rich semantic/syntactic information but could not capture the emotional relation between words. To overcome such drawbacks, this paper comes up with the idea of a neural network architecture called Semantic-Emotion Neural Network (SENN), which is compatible with the semantic/syntactic and emotional information which is implemented by pre-trained word representations. They proposed two sub-networks of SENN model. The first sub-network called Bidirectional Long Short Term Memory which

takes the contextual information and focus on semantic relationship and the second sub-network is the convolutional neural network (CNN) which can basically bring out the emotional features and can map emotional relationship between words of the text. They identified six basic emotions.

3. SYSTEM DESIGN AND IMPLEMENTATIONS

3.1. Experimental Setup

For our work, we have chosen python version-3.7.11. We have used gpu for processing data. The installed versions of gpu toolkit were cuda_10.0.130_411.31 and cudnn-10.0-windows10-x64-v7.6.5.32. We have used the 'PyTorch' machine learning framework for our task. The installed 'PyTorch' version was 1.1.0.

3.2. Experimental Result Before Post Processing

In this section, we present performance measures i.e. accuracy, F1 score, confusion matrix from our trained BERT model to analyze the impact of word embedding on multilabel emotion recognition for both Bangla raw and romanized texts. Firstly, the evaluation measures are compared for all four contexts with our process of word embedding for each classification method. We have calculated both macro and weighted average F1 scores. However, because of some imbalance in the dataset, the macro average does not operate well with it. Therefore, the evaluation tables include the weighted average F1 score. Table 3 shows the comparison amongst four different contextual datasets Where it is seen the highest accuracy is of general dataset and then of military dataset. Accuracy of religious and medical datasets are relatively low. These are public datasets and contained lots of null values and garbage values that deteriorated the quality of the datasets.

***Table 1:* Comparison of accuracy and F1 score of different contextual datasets**

Dataset	Size	Accuracy	F1 Score (%)						Average F1 score
	Train		Happy	Sad	Anger	Disgust	Fear	Surprise	
General Data	4995	34	36	35	21	43	38	26	35
Military Dataset	5000	36	44	38	00	24	46	00	36
Medical Dataset	5000	31	40	37	38	22	25	36	33
Religious Dataset	5000	29	39	21	15	42	27	32	31

The performance of the model largely depends on the quality of the datasets. The dataset was mostly public and many sentences were translated into Bengali from English through google translator.

4. RESULT ANALYSIS

Output of the model after development is shown in this section. In Figure 9, the vector output of the word embedding is shown.

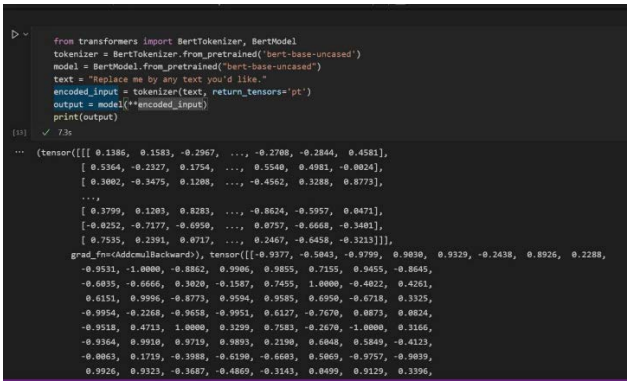


***Figure 9:* Vector output**

Figure 10 shows the output for the six emotion levels.

***Figure 10:* Output levels**

The single sentence output is shown in Figure 11. Single sentence output means the model takes output as single sentence and predict the emotion level expressed in this sentence.

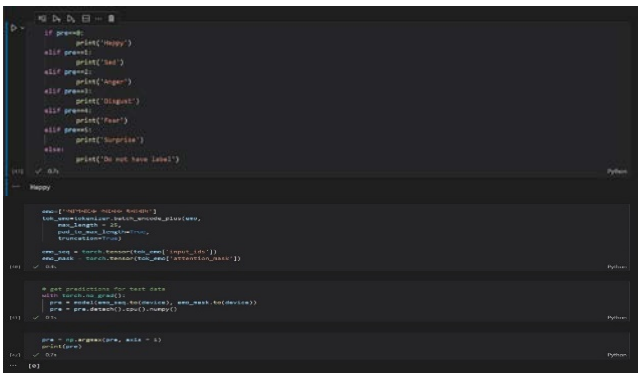


***Figure 11:* Output of single sentence prediction**

4.1. Output of The Contextual Datasets with Six Levels

The output of contextual dataset with six emotion levels are shown where precision, accuracy, recall, f1-score and also macros are shown. Weighted average of F1-score is also shown in the output. When the actual class is 'No' but the predicted class is 'True' then it is called 'False positive'. And, when the actual class is 'True' but the machine prediction is 'False' then it is 'False negative'. The simplest obvious

performance metric is accuracy, which is just the ratio of properly predicted observations to all observations. One would believe that if our model is accurate, it is the best. An accuracy is indeed a useful statistic, but only when the datasets are symmetric and the values of false positives and false negatives are almost equal. As a result, other parameters are also considered while evaluating the performance of the model. Our model received a score of 0.34 for general dataset, indicating that it is around 34% accurate. The universal formula for calculating accuracy is:

$$Accuracy = TP + TN \div TP + FP + FN + TN \quad (1)$$

The ratio of accurately predicted positive readings to total expected positive readings is known as precision. The ratio of accurately predicted positive readings to all readings in the actual class is known as recall. The weighted average of Precision and Recall is the F1 Score.

$$Precision = TP \div TP + FP \quad (2)$$

$$Recall = TP \div TP + FN \quad (3)$$

$$F1score = 2 \times (Recall \times Precision) \div (Recall + Precision) \quad (4)$$

As a result, this score considers both false positives and false negatives. Although it is not as obvious as accuracy, F1score is generally more useful than accuracy, especially if the class distribution is unequal. When false positives and false negatives have equivalent costs, accuracy works well. It's important to look at both Precision and Recall if the cost of false positives and false negatives is considerably different. We have different precision, recall and F1 score for each of the four datasets. Here shown the output of general and military datasets where in first case the weighted average F1 score is 0.35 means 35 in a scale of 100.

	precision	recall	f1-score	support
0	0.38	0.34	0.36	137
1	0.39	0.32	0.35	142
2	0.21	0.22	0.21	93
3	0.51	0.37	0.43	185
4	0.31	0.49	0.38	105
5	0.23	0.30	0.26	88
accuracy			0.34	750
macro avg	0.34	0.34	0.33	750
weighted avg	0.36	0.34	0.35	750

Figure 12: ***Output for general dataset***

```
preds = np.argmax(preds, axis = 1)
print(classification_report(test_y, preds))
```

[31] ✓ 0.1s

	precision	recall	f1-score	support
0	0.42	0.45	0.44	113
1	0.45	0.33	0.38	123
2	0.00	0.00	0.00	11
3	0.18	0.33	0.24	42
4	0.60	0.38	0.46	8
5	0.00	0.00	0.00	6
accuracy			0.36	303
macro avg	0.28	0.25	0.25	303
weighted avg	0.38	0.36	0.36	303

Figure 13: ***Output of Military dataset***

4.2. Output of The Contextual Datasets with Three Levels

The output of contextual dataset with three emotion levels are shown where precision, accuracy, recall, f1-score and also macros are shown in the figures below. Weighted average of F1-score is also shown in the output.

```
preds = np.argmax(preds, axis = 1)
print(classification_report(test_y, preds))
```

[52] ✓ 0.4s

	precision	recall	f1-score	support
0	0.51	0.45	0.48	225
1	0.49	0.66	0.56	247
2	0.66	0.51	0.58	278
accuracy			0.54	750
macro avg	0.55	0.54	0.54	750
weighted avg	0.56	0.54	0.54	750

Figure 14: ***Output of general dataset***

```
preds = np.argmax(preds, axis = 1)
print(classification_report(test_y, preds))
```

[31] ✓ 0.7s

	precision	recall	f1-score	support
0	0.42	0.39	0.41	119
1	0.43	0.24	0.31	132
2	0.26	0.58	0.36	52
accuracy			0.36	303
macro avg	0.37	0.40	0.36	303
weighted avg	0.40	0.36	0.36	303

Figure 15: ***Output of military dataset***

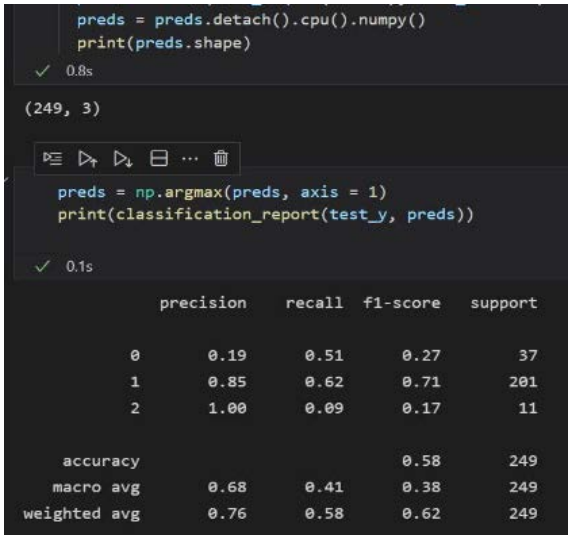


Figure 16: ***Output of medical dataset***

4.3. Output of Romanized Dataset

Figure 17 shows the output of Romanized Bangla that shows how raw Bengali text is transformed into Romanized one as the way we write in our social media blogs or comments. However, all the words are not properly transliterated. Some words are showing different result than we write in our daily life.

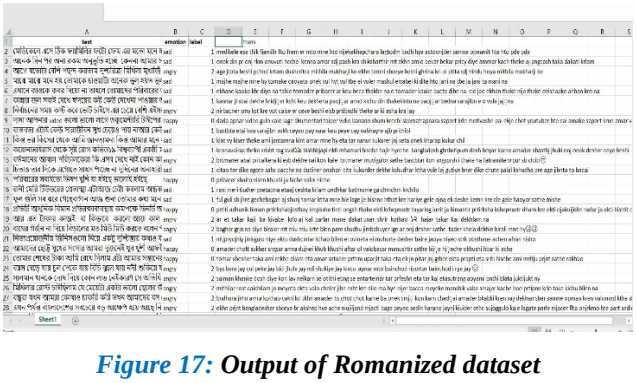


Figure 17: ***Output of Romanized dataset***

4.4. Discussion

Here in our model, the performance is measured with accuracy, precision, recall and F1-score. The output with six emotion levels gave quite poor performance the average accuracy is 31 percent. The highest accuracy with six emotion classes belongs to military dataset as this dataset was annotated manually. However, the other datasets were collected from open online sources where those were annotated beforehand. Therefore, those datasets contain imbalanced number of false positive and false negative. If there is an imbalance in the number of false positive and false negative, there will be lower value of accuracy and F1-score which is the case happened in our datasets. Mostly, their annotations were not alright the way it should be and for a machine, the annotations were much confusing.

In case of military dataset, as there were some complicacies (discussed in the later chapter) in data collection and also the sentences were with less emotion expressing than normal conversations of other context based datasets, the overall result could not even cross 50 percent. However, when the levels were reduced, that means from six levels we converted into three emotion levels, the datasets have shown a better performance which is more than 50 percent in case of all the performance measures.

Moreover, the collection of Bengali dataset on emotion recognition was tiresome as there are not many open emotion rich datasets in Bengali. That's why, the datasets are constructed by translating from English to Bengali in google translator. Ultimately, the translation process deteriorated the overall quality of the dataset as the google translator is able to translate line by line. It cannot fully detect the conceptual meaning of Bengali language. Figure 6.9 shows the comparison of general, military, medical and religious datasets of three levels and six levels of datasets. The performance of three levels is higher than that of six levels.

5. CONCLUSIONS

Our research is aimed at the enrichment of the sector of emotion recognition from Bengali language in the sphere of NLP. This study compares different emotion levels on a dataset of different circumstances to show benchmark results for context-based emotion recognition of

raw Bangla and romanized Bangla texts using a multilabel classification approach. We began our research by reviewing previous publications and journals. Throughout the course of our job, we continued to study publications. After that, we compile and construct a Bengali corpus. As we gathered data from many sources, some of the datasets were already annotated. However, some of them were manually annotated for better results. Word embedding and model training were completed once the dataset was created.

We have used Bangla BERT-base that contained pre-trained model of Sagor Sarker. In a variety of NLP tasks, BERT and other Transformer encoder architectures have proven to be highly effective (natural language processing). They provide vector-space representations of natural language that can be employed in deep learning models. The BERT family of models uses the Transformer encoder architecture to process each token of input text in the context of all tokens before and after it. We have followed the process of tokenization, word embedding and then model training.

The main problem in this study was to find a big and consistent dataset of Bangla raw and romanized texts in various contexts with sufficient emotion level annotations. As a result, we created a unique romanized Bangla emotion recognition corpus by assembling a raw Bangla corpus from numerous sources and mechanically converting the Bangla texts into romanized Bangla. We implemented the system using BERT, primarily Bangla BERT, and demonstrated a comparison of dataset performance in various contexts, with a specific contribution in collecting Military context-based dataset.

ACKNOWLEDGEMENTS

We are thankful to Almighty Allah for his blessings for the successful completion of our thesis. Our heartiest gratitude, profound indebtedness and deep respect go to our supervisor,

Name of your Supervisor, Designation, Academic Address with Department & Institution, for his constant supervision, affectionate guidance and great encouragement and motivation. His keen interest on the topic and valuable advices throughout the study was of great help in completing thesis. We are especially grateful to the Department of Computer Science and Engineering (CSE) of Military Institute of Science and Technology (MIST) for providing their all-out support during the thesis work. Finally, we would like to thank our families and our course mates for their appreciable assistance, patience and suggestions during the course of our thesis

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AUTHOR BIOGRAPHY

Lopa Ahmed has passed SSC from Joypurhat Girls' Cadet College in 2014 with CGPA 5.0 out of 5.0 and passed HSC from Joypurhat Girls' Cadet College in 2016 with CGPA 5.0 out of 5.0. She enrolled BSc. in CSE, in the Military Institute of Science and Technology (MIST), one of the prestigious organizations of Bangladesh, in 2017. She successfully completed his graduation in 2022.

Isbat Khan Polok has passed SSC from Rangpur Cadet College in 2014 with CGPA 5.0 out of 5.0 and passed HSC from Rangpur Cadet College in 2016 with CGPA 5.0 out of 5.0. He enrolled BSc. in CSE, in Military Institute of Science and Technology (MIST), one of the prestigious organizations of Bangladesh, in the year of 2017. He successfully completed his graduation in 2022.

Md. Adnanul Islam completed his BSc in 2016 and MSc in 2019 from Bangladesh University of Engineering and Technology (BUET). He is currently pursuing his PhD in Monash University, Australia. Prior to this, he was serving as an Assistant Professor in the department of Computer Science and Engineering at Military Institute of Science and Technology (MIST), Dhaka, Bangladesh.

CSE TECHNICAL PAPER
The MIST Journal of Computer Science and Engineering

LiveBox: A Real-Time Social Distance Surveillance System Aided by Deep Learning

Labiba Islam[1], Sherajam Munira Pritha[2], Sharifa Rania Mahmud[3], and Iyolita Islam[4]

Department of CSE, Military Institute of Science and Technology (MIST), Dhaka, Bangladesh

emails: [1]*labiba.islam.24697@gmail.com;* [2]*pritha7610302@gmail.com;* [3]*rania@cse.mist.ac.bd; and* [4]*iyolita2011@gmail.com*

INFO

History:

Started: 01st March 2021
Proposal defence: 30th June 2021
Final defence: 27th March 2022
Submitted: 30th March 2022
Published: 30th June 2022

Keywords:

COVID-19
Social Distancing
Distance Estimation
CNN
YOLO
Object detection

ABSTRACT

History shows that pandemics and epidemics have swept the globe in profound ways. The novel coronavirus took the lives of almost 5.99 million people worldwide till now. As long as new varieties rage and individuals in most countries remain unvaccinated, the answers to how many more to die and how the world will recover remain uncertain. As the name implies, social distancing entails people physically separating themselves from one another in order to reduce intimate contact and hence the transmission of an infectious disease like COVID-19. Researchers are developing strategies to make the social distance more acceptable to individuals, expecting that recognizing it will make their lives simpler. Object detection has gained increased interest as a result of social distancing. The most efficient strategy to reduce the transmission of infection is to keep individuals separated from one another. For estimating social distance from top-down real-time videos, the suggested technique uses the most recent Convolutional Neural Network (CNN) models, You Only Look Once (YOLO), and Euclidean distance. Compared to previous CNN algorithms, this technique presents the simplest method of estimating social distance. Because the suggested technique is simple to grasp and produces results that are faster and more accurate than previously utilized object detection algorithms. The tracking accuracy is checked using data sets acquired from various locations and circumstances. With this suggested technique, tracking precision is attained, highlighting its efficiency and excellent performance in object detection.

ইতিহাস দেখায় যে মহামারীগুলি সর্বদা গভীর উপায়ে বিশ্বকে প্রবাহিত করেছে। নভেল করোনাভাইরাস এখন পর্যন্ত বিশ্বব্যাপী প্রায় ৫.৯৯ মিলিয়ন মানুষের জীবন নিয়েছে। যতক্ষণ না নতুন জাতের ক্রোধ এবং বেশিরভাগ দেশে ব্যক্তিরা টিকাহীন থাকবে, ততক্ষণ আরও কতজন মারা যাবে এবং কীভাবে বিশ্ব পুনরুদ্ধার করবে তার উত্তর অনিশ্চিত রয়ে গেছে। নাম থেকে বোঝা যায়, সামাজিক দূরত্ব মানুষকে শারীরিকভাবে একে অপরের থেকে আলাদা করতে বাধ্য করে যাতে ঘনিষ্ঠ যোগাযোগ কম হয় এবং তাই কোভিড -19 এর মতো একটি সংক্রামক রোগের সংক্রমণ। গবেষকরা ব্যক্তিদের কাছে সামাজিক দূরত্বকে আরও গ্রহণযোগ্য করার কৌশল তৈরি করছেন, আশা করছেন যে এটিকে স্বীকৃতি দেওয়া তাদের জীবনকে আরও সহজ করে তুলবে। সামাজিক দূরত্বের ফলে বস্তু সনাক্তকরণে আগ্রহ বেড়েছে। সংক্রমণের সংক্রমণ কমানোর সবচেয়ে কার্যকরী কৌশল হল ব্যক্তিদের একে অপরের থেকে আলাদা রাখা। টপ-ডাউন রিয়েল-টাইম ভিডিওগুলি থেকে সামাজিক দূরত্ব অনুমান করার জন্য, প্রস্তাবিত কৌশলটি সাম্প্রতিকতম কনভোলিউশনাল নিউরাল নেটওয়ার্ক মডেলগুলি এবং ইউক্লিডীয় দূরত্ব ব্যবহার করে। পূর্ববর্তী কনভোলিউশনাল নিউরাল নেটওয়ার্ক অ্যালগরিদমগুলির তুলনায়, এই কৌশলটি সামাজিক দূরত্ব অনুমান করার সবচেয়ে

সহজ পদ্ধতি উপস্থাপন করে। কারণ প্রস্তাবিত কৌশলটি উপলব্ধি করা সহজ এবং ফলাফলগুলি তৈরি করে যা পূর্বে ব্যবহৃত বস্তু সনাক্তকরণ অ্যালগরিদমগুলির চেয়ে দ্রুত এবং আরও সঠিক। বিভিন্ন অবস্থান এবং পরিস্থিতি থেকে অর্জিত ডেটা সেট ব্যবহার করে ট্র্যাকিং নির্ভুলতা পরীক্ষা করা হয়। এই প্রস্তাবিত কৌশলটির সাহায্যে, ট্র্যাকিং নির্ভুলতা অর্জন করা হয়, এটির কার্যকারিতা এবং বস্তু সনাক্তকরণে চমৎকার কর্মক্ষমতা হাইলাইট করে।

1. INTRODUCTION

Social distancing is a method for lowering the percentage of people who become contaminated with viruses. Indeed, researchers have speculated that humans may face more lethal viruses in the long term, such as COVID-19. Consequently, Social Distancing will become a common strategy for reasonable people regularly, and it will be a valuable means of controlling the spread of this sort of infection. Researchers have associated with social distance monitoring in order to make social distancing more agreeable to individuals and to make monitoring it simpler for them, particularly for those with complex multi-factorial health complications. Initially, Social distance monitoring necessitates real-time detection and recognition. For real-time object detection, several deep CNN algorithms had already been deployed. However, the solution provided here is the most recent. This study uses the approach in conjunction with the Euclidean distance and newest 'YOLO' Deep Convolutional Neural Network algorithm. The COCO data set is used to pre-train the YOLO object detection algorithm. Some self-collected input videos from distinct contexts are used to assess the percentage of tracking accuracy.

YOLOV5 differs from previous versions in that it is a PyTorch implementation rather than a fork from the original Darknet. The YOLOV5 features a CSP backbone and a PA-NET neck, the same as the YOLO v4. Mosaic data augmentation and auto-learning bounding box anchors are two of the most significant enhancements. YOLOV5 is trained on the COCO dataset that can be used for model ensemble (combining multiple models in the prediction process), Test Time Augmentation (making random changes to the test images, such as flipping, rotating, and so on), and hyper parameter evolution (optimizing hyper parameters using a genetic algorithm for optimization).

Furthermore, if we consider the other object detection modules, YOLOV5 has a higher speed facility than others despite lower accuracy than R-CNN. As our system requires speed more than precision, we have chosen YOLOV5 over R-CNN and others.

1.1 Motivation

The motivations behind working on this project have two major reasons. At first, the current epidemic has spawned a slew of new study areas, not just in medicine but also in engineering. The subject of object detection is strongly connected to social distance estimation, which inspired this technique, which included research using a novel convolutional neural network algorithm (Beniwaland, 2022). Second, for all individuals working out or traveling, social distance has become the new normal. After the lockdown, institutions must maintain social distance, and future circumstances involving lethal diseases will necessitate social distance estimates. The goal is to find a better and more straightforward technique to achieve more speed and accuracy. This sparked an interest in social distance estimation studies.

1.2 Problem Statements

The biggest issue is social assemblies; when individuals come into direct interaction, viral transmission is more likely. Distancing oneself from others is one technique to decrease the transmission of infections. Hospitals, institutions, supermarkets, and organizations are committed to ensuring and controlling social distance. Social distance estimation is a hotly pursued topic of object detection research. In object detection, old CNN techniques are employed. Having the most up-to-date and efficient algorithm is always a must in research. According to the most of the researchers contagious diseases can be controlled by less contact among people. The number of people being affected reduces to 16 from 406 if the percentage of contact is reduced to 50% and if it is reduced to 75% the number reduces to less than three persons.

1.3 Objectives

We're working on a project involving Convolutional Neural Network in which we're trying to attain the following objectives:

(1) To detect violation of optimum social distance in real-time.

(2) To provide assistance in monitoring social distancing.

1.4 Research Methods

The proposed method is evaluated on real-time video. From the video, the desired frames are gained. YOLO object detector detects objects where the only person is detected from the desired frame on the proposed method. Then the formula of Euclidean distance helps determine the distance in pixels using each one's centroid information. The persons are marked with green centroids. Then the distance between the centroids is calculated using Euclidean distance. If a violation occurs, the persons violating proper distancing are marked with a' High Risk' red colour box. For maintaining proper distancing, the persons will be marked with a yellow box written 'Low Risk'. Thus, the social distance estimation from

the number of violating can be estimated. The total number of detected persons and correctly detected shows the estimation perfectly. The system architecture is shown in Figure 1.

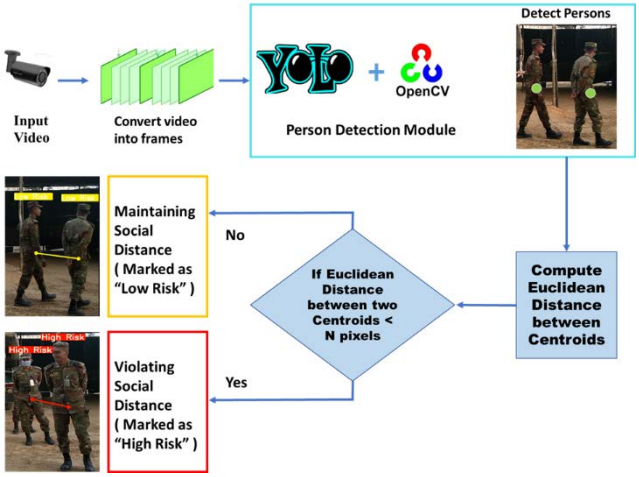


***Figure 1:* System Architecture of the proposed system.**

The methodology of the detection technique follows some sequential steps. The proposed methodology is dependent on python code. We have used Visual Studio as a platform to run all the tools and files, including the code.

1) Input Video: Real-time video or sample videos as mp4 format kept where python code is present to run the python interpreter.

2) Convert Video into Frames: The frame is used from the video file. Pre-process images taken by a video to detect the image's components and classify them using python. Most video formats that transform video into frames work with Python 3 and OpenCV, which accept mp4 files. A method was constructed to perform OpenCV with YOLO, which requires frame rate, person centroids, and person detection confidences. A frame will be showing results according to it. A blob is created for extracting the dimensions from the frame, which will pass through CNN and outputs prediction.

3) YOLO Convolutional Neural Network Model: After successfully converting video into frames, YOLO based CNN model was applied where pre-trained weights and class names used as YOLO is compatible with the real-time person detection module. The approach involves a single deep neural network called PyTorch, which splits the input into grid cells that directly predicts a centroid and its confidence scores. Here, YOLOV5 with PyTorch backbone is working on a pre-trained COCO dataset. COCO has recognition, instances over 1.5 million objects, 80 object categories, 91 stuff categories, and five captions per image. A fully CNN architecture generates a 1x1 kernel with three different sizes and three networks. A blob is constructed to perform object detection with YOLO and OpenCV. Person centroids and their confidence scores are initialized for inference which helps loop over the layer outputs. PyTorch extracts class id and probability of person are computed.

4) Detect Person: YOLOV5 trained on the COCO dataset is used for object detection in our proposed method. CNN architecture is structured with weights and class names compatible with deep neural networks for accurate time detection. A sigmoid function is used for object score and class confidence because we detect only a person. For the COCO dataset, this is true that this object fits into one class, not belong to other classes. OpenCV and YOLO combined worked as person detection from video and classified them in only one class. Drawing bounding boxes around persons and finding the centroids of the box is also a feature of YOLO.

5) Compute Euclidean Distance Between Centroids: Computation between centroids is needed after the person class is detected now. Euclidean distance estimation algorithm computes bounding boxes, thus representing the accurate detection of the person. For measuring the Euclidean distance at first, we need object tracking. A scenario is created for every frame for object tracking. Each scenario is shown as four steps in the Figures below.

Figure 2 is showing the first step. A centroid is the center of each detected person which are marked with purple coloured dots and two IDs (ID#1, ID#2) are given to those persons.

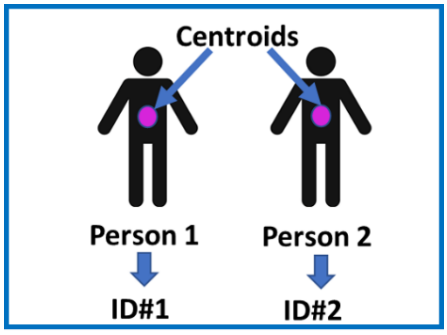


***Figure 2:* Step 1: Centroids and ID**

Figure 3 shows the next step where the purple one is shown as old centroid and the yellow one is showing new centroid and the single yellow one is showing as a new person detected. Lines are drawn from every old centroid to new centroid to know the movement.

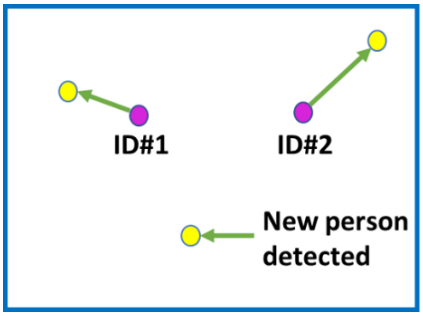


***Figure 3:* Step 2: Old new centroid and new detection**

Figure 4 is showing the step 3 where the new detected person is marked as ID name ID#3.

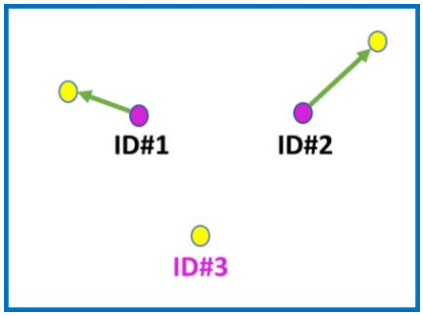


Figure 4: ***Step 3: New detected person is marked***

Figure 5 shows Step 4 in which finally three persons who are detected are being demonstrated with three ID names. If one of those ID cannot be found for consequent 40 frames, the ID will be erased.

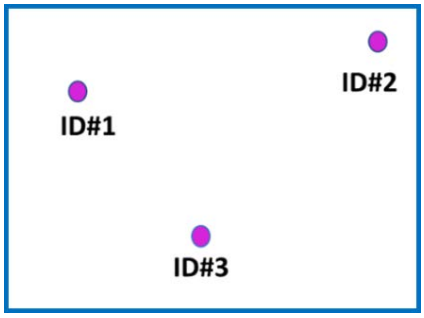


Figure 5: ***Step 4: Final Detection with IDs***

For the camera to person detection, the focal length is measured by the following formula:

$$F = (P \times D)/W \quad (1)$$

where, F= Focal Length, P = Pixel the object is covering in the photo, D = Distance from object(person) to camera's focal length, W = Width of the object(person). Then,

$$D' = (W \times F)/P \quad (2)$$

where, D'= Camera to person distance, F = Focal Length. After measuring camera to person distance, person to person distance is measured by Euclidean distance formula:

$$D = \sqrt{(Y_2 - Y_1)^2 + (X_2 - X_1)^2} \quad (3)$$

Figure 6 shows how X_1, X_2, Y_1, Y_2 is denoted from the image plane to persons. Then gained distance between two centroids for people results in the next step.

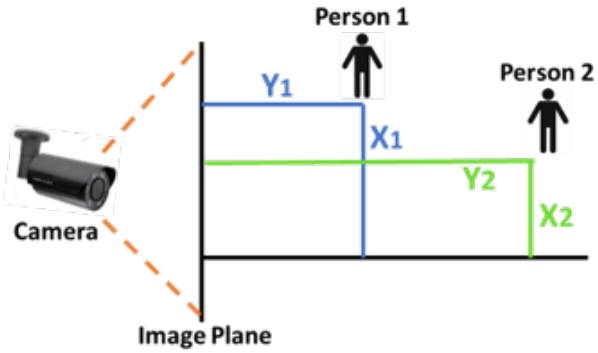


Figure 6: ***Person-to-person distance***

6) Distance Between two centroids: Here, the cut-off distance for social distancing is 50 pixels. That means N=50.

i) All the detected persons will be marked with green at first.
ii) If the Euclidean distance between two centroids < N pixels, the distance will be shown in red as 'High Risk'.
iii) If the Euclidean distance between two centroids ≥ N pixels, then the distance will be shown in yellow as 'Low Risk.'

Social distance detection parameter is applied to get the result. This whole process is recursive. A detection function takes arguments and extracts the dimension of the frame. Because the distance between objects will be measured concerning other objects present in that real-time video.

2. LITERATURE STUDIES

Artificial intelligence specialists concentrate their technical understanding to construct mathematical models for assessing this pandemic condition utilizing shared data from around the country. To contribute to the well-being of a living society, this article proposes using machine learning and deep learning models to understand its everyday exponential behavior and predict COVID-2019's future reach-ability across countries using real-time data from the Johns Hopkins dashboard *(N.S. Punn et al, 2020)*. Another research project is to develop a system that can identify an item and estimate its distance and direction from a person in real-time. The suggested system consists of an object detection model and a distance approximation method, which approximates the distance and direction of objects. MobileNet and Single Shot Detector, both deep neural networks pre-trained on the COCO dataset, are used to recognize and localize items. The detection model uses labeled bounding boxes to highlight the discovered items. The distance approximation technique then uses the coordinates of these bounding boxes to forecast an object's distance and orientation. The system is tested using multiple photos and a live video feed from a camera. However, photographs of a single item captured from various distances are used to measure the system's efficacy. According to the findings, the method predicts the distance with an average accuracy of 96 percent *(R. Beniwal et al, 2022)*. Previous research has looked into using signal changes to identify human movement. Noises, on the other hand, have an impact, such as multi-path effect and device difference, existing approaches cannot achieve high accuracy and low false alarm rate at the same time *(T. Xin et al, 2018)*. To gain a complete image understanding, it should not only concentrate on classifying different images but also try to precisely estimate the concepts and locations of objects contained in each image. This task is referred to as object detection. The progress in the machine and deep learning has already designed various algorithms. Some methods are R-CNN, Fast R-CNN, Faster R-CNN, viola jones *(G. Agarwal et al, 2021)*. A violation threshold is defined to determine if the distance value exceeds the minimal social distance barrier. Furthermore, a tracking algorithm is utilized to recognize persons in video sequences so that the person who violates/crosses the social distance threshold is

monitored *(I. Ahmed, 2021)*. YOLO has been improved to five versions and is now considered one of the best objects in detecting algorithms. The fifth generation of YOLO, dubbed YOLOv5, is the most recent version that the original creator of YOLO did not create. However, the YOLOv5 performs better than the YOLOv4 in terms of both accuracy and speed *(D. Thuan, 2021)*. Various face detection method has been proposed, and comparative studies have been done. Finally, a video dataset labeling method is proposed along with the labeled video dataset to compensate for the lack of dataset in the community. It is used for the evaluation of the system. The system's performance is measured in accuracy, F1 score, and prediction time, which must be minimal for practical use *(S. Srinivashan, 2021)*. All this research work has two things in common: real-time and directly or indirectly related to human tracking and social distancing.

3. REQUIREMENT ANALYSIS

Under the requirement analysis process, any system needs to undergo the requirement elicitation process. The success of any system lies with the user. An excellent system may go in vain if users do not feel the necessity of using it. Keeping this issue in mind, we have undergone a survey of 20 queries on more than 100 people *(Labiba et al, 2021)* regarding their knowledge on the importance of social distance monitoring and the necessity of a system that may help. Some results are shown in pie chart in the Figure 7 and 8.

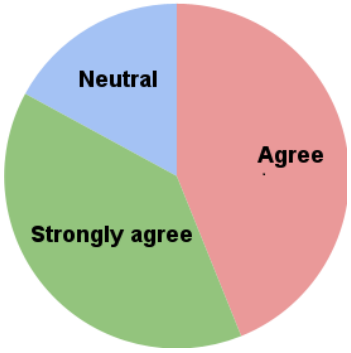


***Figure 7:* Response to 'Institutions organizations having crowd gatherings face difficulties to maintain social distancing'**

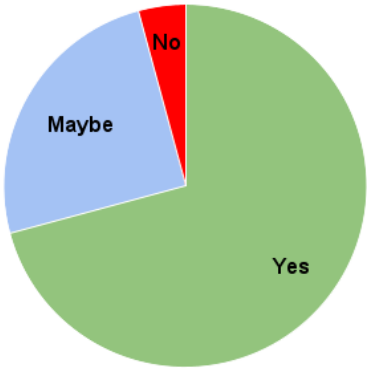


***Figure 8:* Response to 'Do you think having a desktop application system to automate the procedure will be beneficial?'**

The result of the other queries also had a positive indication, like the two queries presented above on the necessity of monitoring the social distancing, which triggered us to build an application. The application will be desktop-based so that institutions can implement it easily even without having the facility of internet.

4. SYSTEM DESIGN

The system's front end was developed with Django, which is a free and open-source web framework based on Python. Django is a set of Python libraries that allows rapid and quickly building of a high-quality Web application. It can be used on both the front end and the backend. We have used this framework for our system front end. The basic building block for creating pages of the system we have used is HTML. The template system in Django makes it simple to create dynamic HTML pages. Dashboard, sign-up page, login page for the user has created in HTML, aided by Django template. The snapshots of Figure 9, 10 and 11 of the front end demonstrates how the user can use the access the system and how the layout of sequence of pages in the system is done.

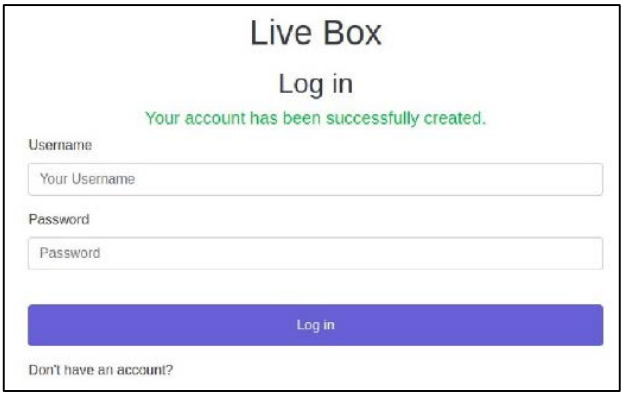


***Figure 9:* Sign Up page**

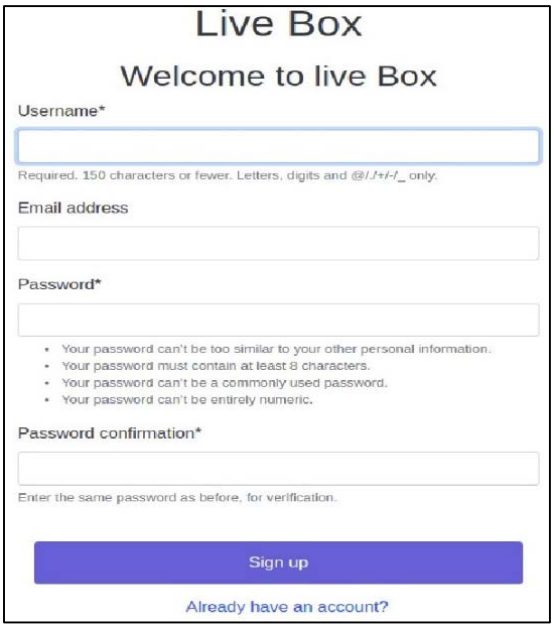


***Figure 10:* Successful Notification after signup**

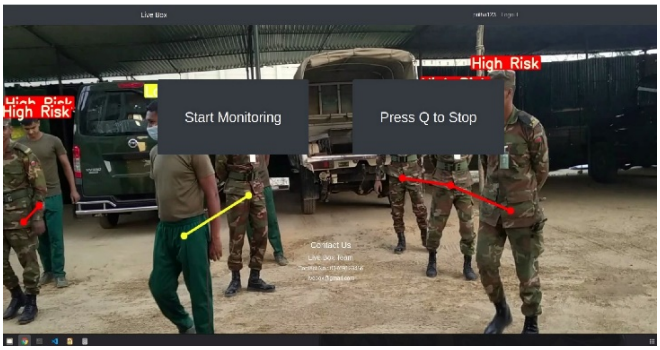


Figure 11: Home page

After logging in, user appears in the homepage where user can click the "Start Monitoring" button to let the monitoring start. When user wants to terminate monitoring, he can press 'Q' from keyboard to shut down the camera and then click the logout button to leave the system.

5. RESULT ANALYSIS

The detailed experiment review of the model was described in methodology chapter of proposed method. Six different types of situations and environments were taken as input data to get an acceptable tracking accuracy in percentage. Footage environments or situations are of following characteristics:

- Environment 1: Daylight
- Environment 2: Nightlight
- Environment 3: Fuzzy
- Environment 4: Crowded
- Environment 5: Top View
- Environment 6: Angular View

For each environment, we have taken three frames and calculated the tracking accuracy for each frame. We calculated Tracking Accuracy for the frame in percentage by multiplying the number of correctly detected with 100 and dividing it by the total person.

$$Frame\ Tracking\ Accuracy = \frac{No.of\ Correctly\ Detected \times 100}{No.of\ Total\ person} \quad (4)$$

Then, the tracking accuracy of that particular environment was calculated by adding the tracking accuracy from each environment frame and then dividing the sum by the total number of frames.

$$Tracking\ accuracy\ of\ env. = \frac{Sum\ of\ frames\ Tracking\ Accuracy}{Total\ Frame} \quad (5)$$

Table 1: Tracking Accuracy for Daylight Footage

Sr.	Frames	Accuracy Per frame	Accuracy of the environment
1.	Frame 1	88%	
2.	Frame 2	75%	82%
3.	Frame 3	83%	

$$Tracking\ Accuracy\ of\ whole\ environment\ in\ \% = \frac{The\ Sum\ of\ Tracking\ Accuracy\ for\ frames\ in\ percentage}{Total\ Frame}$$

$$= (88 + 88 + 83)/3 = 87\%\ (approximate) \quad (6)$$

Tracking Accuracy gained from Daylight Footage: 82%

Table 2: Tracking Accuracy for Nightlight Footage

Sr.	Frames	Accuracy Per frame	Accuracy of the environment
1.	Frame 1	100%	
2.	Frame 2	100%	100%
3.	Frame 3	100%	

$$Tracking\ Accuracy\ gained\ from\ Nightlight\ Footage = \frac{100+100+100}{3} = 100\%\ (approximate) \quad (7)$$

Table 3: Tracking Accuracy for Fuzzy Footage

Sr.	Frames	Accuracy Per frame	Accuracy of the environment
1.	Frame 1	100%	
2.	Frame 2	100%	100%
3.	Frame 3	100%	

$$Tracking\ Accuracy\ of\ whole\ environment\ in\ percentage = \frac{The\ Sum\ of\ Tracking\ Accuracy\ for\ frames\ in\ percentage}{Total\ Frame}$$

$$= \frac{100+100+100}{3} = 100\%\ (approximate) \quad (8)$$

Table 4: Tracking Accuracy for Crowded Footage

Sr.	Frames	Accuracy Per frame	Accuracy of the environment
1.	Frame 1	83%	
2.	Frame 2	88%	81%
3.	Frame 3	71%	

$$Tracking\ Accuracy\ of\ whole\ env.in\ percentage = \frac{The\ Sum\ of\ Tracking\ Accuracy\ for\ frames\ in\ percentage}{Total\ Frame}$$

$$= \frac{83+88+71}{3} = 81\%\ (approximate) \quad (9)$$

Table 5: Tracking Accuracy for Top View Footage

Sr.	Frames	Accuracy Per frame	Accuracy of the environment
1.	Frame 1	100%	
2.	Frame 2	83%	94%
3.	Frame 3	100%	

$$Tracking\ Accuracy\ of\ whole\ env.in\ percentage = \frac{The\ Sum\ of\ Tracking\ Accuracyfor\ frames\ in\ percentage}{Total\ Frame}$$

$$= \frac{100+83+100}{3} = 94\%\ (approximate) \quad (10)$$

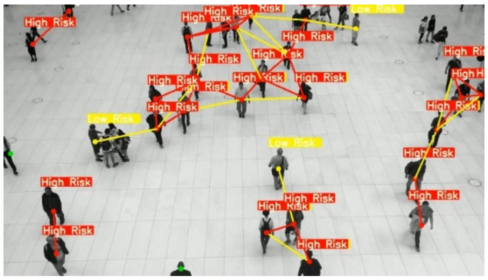
Table 6: Tracking Accuracy for Angular View Footage

Sr.	Frames	Accuracy Per frame	Accuracy of the environment
1.	Frame 1	95%	
2.	Frame 2	95%	97%
3.	Frame 3	100%	

$$Tracking\ Accuracy\ gained\ from\ Angular\ View\ Footage = \frac{95+95+100}{3} = 97\%\ (approximate) \quad (11)$$

Finally, some snapshots of the system detection style can be demonstrated by the Figure 12.

(a)



(b)

(c)

(d)

(e)

Figure 12: ***Environment from (a) Daylight (b) Angular View and (c) Fuzzy (d) Nightlight (e) Top View Footage***

The Overall result from the six different environment is compiled in Table 7.

Table 7: ***Overall evaluation result***

Sr.	Environment	Accuracy	Overall Accuracy
1.	Daylight	87%	
2.	Nightlight	100%	
3.	Fuzzy	100%	94%
4.	Crowded	81%	
5.	Top View	94%	
6.	Angular View	97%	

The overall accuracy is 94% which is quite satisfactory.

6. CONCLUSIONS

This research has been directed a thorough review where the new advancement of deep learning networks object recognition is noticeable; deep models have improved execution. However, there are as yet numerous challenges and difficulties. With YOLO in a scientific python development environment, we got 94\% of tracking accuracy, proving its tremendous performance as a Social Distance Detection system.

With its fatal spread, the COVID-19 flare-up is becoming a worldwide catastrophe. The illness is quickly spreading and poses a threat to humanity. When faced with a critical requirement, one should always play it safe, one of which is social separation. The most effective way to combat the overwhelming COVID-19 ailment is to isolate oneself from others. Individuals should retain a 3ft or 1m gap between them, according to the WHO, to practice healthy social distancing. This framework focuses on a solution for continually assessing social separation using YOLO object detection on video film and photographs. We use an estimate of the actual distance to pixel and setting and edge to identify social distance violations between persons. Given the growing number of affected persons, there is still no effective treatment or accessible cure for the condition. While scientists, clinical research organizations, and specialists are constantly working to provide appropriate treatments or antibodies for the harmful contamination, no such permanent immunization has been developed too far. Thereby, we firmly believe our system will come into great help where vaccination is not yet completed; people are not fully aware or in control, and in the case of organizations where there is mass gathering.

ACKNOWLEDGEMENTS

Authors are thankful to Almighty Allah for his blessings to complete our thesis. Our heartiest gratitude, profound indebtedness, and deep respect go to our supervisor, Asst. Prof Sharifa Rania Mahmud, for her constant supervision, affectionate guidance, and great encouragement and motivation. Her keen interest in the topic and valuable advice

throughout the study were of great help in completing a thesis. We are incredibly grateful to the Department of Computer Science and Engineering (CSE) of the Military Institute of Science and Technology (MIST) for providing. Finally, we would like to thank our families and our course-mates for their appreciable assistance, patience, and suggestions during our thesis.

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AUTHOR BIOGRAPHY

Sherajam Munira Pritha has passed SSC from A K High School & College in 2012 with GPA 5.00 out of 5.00 and passed HSC from Motijheel Ideal School & College in 2014 with GPA 5.00 out of 5.00. She enrolled BSc. in CSE, in the Military Institute of Science and Technology (MIST), one of the prestigious organizations of Bangladesh, in 2016. She successfully completed her graduation in 2022. Shrajam Munira Pritha would like to pursue her higher study in abroad and gain the world class knowledge and experiences to contribute in the development of her Motherland.

Labiba Islam has passed SSC from Gandaria High School in 2012 with GPA 5.00 out of 5.00 and passed HSC from Motijheel Model School & College in 2014 with GPA 5.00 out of 5.00. She enrolled B.Sc. in CSE, in the Military Institute of Science and Technology (MIST), one of the prestigious organizations of Bangladesh, in 2016. She successfully completed her graduation in 2022. Labiba Islam would like to pursue her higher study in abroad and gain the world class knowledge and experiences to contribute in the development of her Motherland.

Sharifa Rania Mahmud received BSc degree in Computer Science and Engineering (CSE) from Military Institute of Science and Technology (MIST) and Master Degree in CSE from Bangladesh University of Engineering and Technology. Her research works mainly focus on bioinformatics, database, and networking. She is currently served as an Assistant Professor at MIST. She has 11 publications in difference reputed conferences and journals and also currently supervising several projects and thesis related to her research interest.

Iyolita Islam received B.Sc. degree in computer science and engineering from Military Institute of Science and Technology (MIST), Dhaka, Bangladesh in 2017. She is currently pursuing M.Sc. in computer science and engineering from MIST. Since 2018, she is serving as a lecturer in computer science and engineering department, MIST. She is the author of 5 conference papers and 3 journals. Her research interest includes Human Computer Interaction, Blockchain Technology and Industry 4.0.
She was awarded best paper award in International Conference on Sustainable Technologies for Industry 4.0 (STI 2019). She is an associate member of The Institution of Engineers, Bangladesh (IEB).

CSE TECHNICAL PAPER
The MIST Journal of Computer Science and Engineering

Exploring Natural Life Conservation using Machine Learning and IoT based Sound Classification

B. M. Nishanul Alam Nishat[1], Mohian Islam[2], Saba Ahmed Momo[3], S M Anisur Rahman[4], and Md Mustaqim Abrar[5]

Department of CSE, Military Institute of Science and Technology (MIST), Dhaka, Bangladesh

emails: *[1]201814043@student.mist.ac.bd; [2]201814037@student.mist.ac.bd; [3]201814053@student.mist.ac.bd; [4]anis972@gmail.com; and [5]94abrar@gmail.com*

INFO

History:

Started: 15th April 2021
Proposal defence: 10th June 2021
Final defence: 27th March 2022
Submitted: 30th March 2022
Published: 30th June 2022

Keywords:

Nature Conservation
Natural life conservation
Machine Learning
Sound classification
IoT

ABSTRACT

Natural life conservation is crucial to sustaining the ecological balance. Sustainable and power-efficient solutions will change the current threat to nature. The solution requires to be robust and nature friendly. Different methods and procedures are taken regarding natural life conservation. But most of them are not real-time or require human involvement. The main two threats against natural life conservation are tree cutting and animal hunting in the forest. Forest authorities are relentlessly trying and investigating areas. Regular monitoring and watch tower-based solutions lack long-term effectiveness. Digital real-time solutions require hardware and software efficiency. Current approaches to detect animal hunting using gunshot and tree cutting and literature review have clearly defined the required features of a solution. The improvement of Machine Learning and edge computing has opened new opportunities. Detecting the wood cutting and animal hunting can be done by simply differentiating these anomalous sounds from the natural environment. Regarding this, a ML-based solution has been proposed. Here we have developed a custom dataset. This dataset is fed to train multiple models using different ML algorithms. These different trained models are combined to build an ensemble technique that can provide better immunity and result than a single ML model. The Convolutional Neural Network (CNN), random forest, PyTorch based Neural Network (NN), Support Vector Machine (SVM) with CNN and gradient boosting classifier has been used together with ensemble learning. This ensemble provided 97.3% accuracy in detecting gunshots and tree cutting in the natural environment. This model is deployed to a Raspberry Pi to develop the integrated solution, which can be installed in any natural environment to detect anomalous sounds in the forest.

পরিবেশগত ভারসাম্য বজায় রাখার জন্য প্রাকৃতিক জীবন সংরক্ষণ অত্যন্ত গুরুত্বপূর্ণ। টেকসই এবং শক্তি দক্ষ সমাধান প্রকৃতির বর্তমান হুমকি পরিবর্তন করবে। সমাধানটি শক্তিশালী এবং প্রকৃতি বান্ধব হওয়া প্রয়োজন। প্রাকৃতিক জীবন সংরক্ষণের জন্য বিভিন্ন পদ্ধতি ও পদ্ধতি গ্রহণ করা হয়। কিন্তু তাদের অধিকাংশই প্রকৃত সময় নয় বা মানুষের সম্পৃক্ততা প্রয়োজন। প্রাকৃতিক জীবন সংরক্ষণের বিরুদ্ধে প্রধান দুটি হুমকি হল গাছ কাটা এবং বনে পশু শিকার। বন কর্তৃপক্ষ নিরলস চেষ্টা করছে এবং এলাকা তদন্ত করছে। নিয়মিত পর্যবেক্ষণ এবং ওয়াচ টাওয়ার ভিত্তিক সমাধানের দীর্ঘমেয়াদী কার্যকারিতার অভাব রয়েছে। ডিজিটাল রিয়েল টাইম সমাধানগুলির জন্য হার্ডওয়্যার এবং সফ্টওয়্যার দক্ষতা প্রয়োজন। বন্দুকের গুলি এবং গাছ কাটা এবং সাহিত্য পর্যালোচনা ব্যবহার করে পশু শিকার শনাক্ত করার বর্তমান পদ্ধতিগুলি একটি সমাধানের প্রয়োজনীয় বৈশিষ্ট্যগুলিকে স্পষ্টভাবে সংজ্ঞায়িত করেছে। মেশিন লার্নিং এবং এজ কম্পিউটিং এর

উন্নতি নতুন সুযোগ খুলে দিয়েছে। কাঠ কাটা এবং পশু শিকার শনাক্ত করা প্রাকৃতিক পরিবেশ থেকে এই অস্বাভাবিক শব্দগুলিকে আলাদা করে করা যেতে পারে। এ বিষয়ে একটি এমএল ভিত্তিক সমাধান প্রস্তাব করা হয়েছে। এখানে আমরা একটি কাস্টম ডেটাসেট তৈরি করেছি। এই ডেটাসেটটি বিভিন্ন এমএল অ্যালগরিদম ব্যবহার করে একাধিক মডেলকে প্রশিক্ষণ দেওয়া হয়। এই বিভিন্ন প্রশিক্ষিত মডেলগুলিকে একত্রে একত্রিত করে একটি এনসেম্বল কৌশল তৈরি করা হয়েছে যা একক এমএল মডেলের চেয়ে স্বতন্ত্র প্রতিরোধ ক্ষমতা এবং ফলাফল প্রদান করতে পারে। কনভোলিউশনাল নিউরাল নেটওয়ার্ক (সিএনএন), রান্দম ফরেস্ট, পাইটর্চ ভিত্তিক নিউরাল নেটওয়ার্ক (এনএন), সিএনএন-এর সাথে সাপোর্ট ভেক্টর মেশিন (এসভিএম) এবং গ্রেডিয়েন্টবুস্টিং ক্লাসিফায়ারকে এনসেম্বল লার্নিংয়ে একসাথে ব্যবহার করা হয়েছে। এই দলটি প্রাকৃতিক পরিবেশে বন্দুকের গুলি এবং গাছ কাটা শনাক্ত করতে ৯৭.৩% নির্ভুলতা প্রদান করে। সমন্বিত সমাধান বিকাশের জন্য এই মডেলটি একটি রাস্পবেরি পাইতে স্থাপন করা হয়েছে। যেটি যেকোন প্রাকৃতিক পরিবেশে স্থাপন করা যেতে পারে বনের অস্বাভাবিক শব্দ শনাক্ত করতে।

1. INTRODUCTION

1.1 Motivation

Natural life conservation refers to the process of protecting and preserving the ecological balance between animals, plants and their habitats. In recent years, climate change has been elicited by human activities, e.g. animal hunting and illegal logging. This drastic change leads to endangering ecological balance and habitats of animals. Human activities are constantly threatening biodiversity. Many prevention procedures have been taken over time, but most of them require human resources and are expensive. Our research focuses on a system that uses sound classification and integrated hardware that can effectively reduce human resource necessity. It focuses on the real-time detection of illegal logging and animal hunting with the help of sound collection and real-time classification.

1.2 Problem Statements

Tree cutting activities are illegal, but due to the shortage of human and other resources, governments are not very successful in curbing this menace. One way to stop this is to detect the tree cutting process in an early stage so that timely measures can be taken to stop the same. The simplest method of early detection of tree cutting is to monitor the forest area either manually regularly or using some automatic techniques. As tree cutting generates a lot of noise, it can be detected by regularly monitoring the acoustic signals inside the forest. An acoustic signature can provide valuable information about the activities of any intruder inside the forest.

Sounds contain various information that humans use to understand the surroundings, and our behaviours and thoughts are heavily based on this auditory information, along with information gathered from different sensory registers. Even if visual information is not given, humans can easily recognize the scene from the surrounding sounds because our expectations are well trained from experience, facilitating a long-term, non-human, and low-energy consumption ubiquitous computing system for monitoring the nature reserve. Nevertheless, hand-crafted human features need numerous domain knowledge and inevitably make the designing process time-consuming and expensive.

1.3 Objectives

The objectives of the thesis are (a) to design an integrated system to conserve the natural life balance, (b) to build a sound classification model to differentiate the gunshot and tree cutting sound in the forest from natural sound, (c) to implement ensemble deep learning to maintain the consistency of the results for a reliable solution.

1.4 Research Methods

In order to achieve the above objectives, a literature review and an existing system analysis were done. By doing so, the required feature of the system was finalized. The system required building a sound classification model. To do so, custom datasets were obtained. Then multiple deep learning algorithms were used to train the datasets. The Convolutional Neural Network (CNN), Random Forest, Gradient Boosting Classifier, Support Vector Machine Enabled CNN and pytorch were used to model development. Then these models were incorporated into a weighted ensemble method to combine the results from different models. Finally, this ensemble model was deployed to the hardware of our framework.

1.5 Manuscript organization

The rest of the paper contains a brief description of the literature review. Then the requirement studies are described, and this chapter is followed by the development procedures of the proposed method. Then the result analysis shows the model accuracy.

2. LITERATURE STUDIES

Natural life conservation is in the peak of attention throughout the world. Different software, hardware and integrated approaches have been taken in order to sustain the ecological balance. The advent of Artificial intelligence and machine learning-based classification has brought a new scope for developing a system which will sustain and provide continuous positive results regarding the environmental crisis.

Forest life is being endangered due to rapid deforestation and animal hunting. Forest resources are declining, and even protected parts of the forest are becoming vulnerable. Regular monitoring and prevention are required to solve this imminent threat to our environment. Among different procedures pursued to eradicate deforestation, the satellite imaging process can be potentially used to identify the deforestation areas. Selective logging and clear-cuts of deforestation have been identified using satellite imaging processes. But this process takes a year around the process to identify the deforestation.

Due to the rapid improvement of machine learning models and algorithms, audio classification has adopted multiple methods. Deep learning methods for audio classification show improved results. The comparison between environmental sound classification and urban sound classification using deep learning algorithms shows that deep learning can obtain sustainable outcomes. Localization, recognition and detection of audio signals can be enhanced using deep learning algorithms. The frequency-based Convolutional Neural Networks (CNN) are mostly used for sound classification. But most of these approaches are adopted to image conversion and classification. A. Khamparia et al. (*2019)* have researched deep learning networks for classifying environmental sounds based on the generated spectrograms of the sounds. They used spectrogram images of environmental sounds to train Convolutional neural networks (CNN) and Tensor Deep Stacking Network (TDSN).

When detecting sound in real-time in the forest, collecting audio data in real-time is challenging. Different methods have been proposed for audio collection and transmission. Valéria Harvanová et al. (*2009)* This paper introduced a unique solution based on real-time analysis of sounds from surroundings using sound recognition on the paper. It mainly focuses on wireless sensor networks responsible for sound collection and actual exposure of logging. They also introduced the experiments of the ZigBee communication range in a forest environment. Lucian Petrica (*2009*) evaluated the feasibility of performing SSL (Sound Source Localization) on low-power, energy-constrained, microphone array equipped sensor nodes (SNs) with the Delay-and-Sum (DS) beamforming algorithm. It evaluated array configurations of 4, 8, and 16 microphones and a multitude of DS algorithm configurations.

Ensemble classification methods are often much more accurate than the individual classifiers that make them up. Ensemble methods are learning algorithms that construct a set of classifiers and then classify new data points by taking a (weighted) vote of their predictions. There are mainly 3 reasons to select ensembles; they are computational, statistical and representational benefits over a single machine learning model. Ensembles are used for different purposes. They have shown better results in audio classification. Medical audio datasets are also trained using this method for accuracy and faster detection. The classifier build-up is a part of the overall sound detection system. This classifier needs to be incorporated into a computational device. This device will be installed in the forest for anomaly detection. Various hardware solutions are proposed regarding this issue.

Prasetyo, in his paper (*2018),* has proposed a detection system for illegal wood cutting by detecting the sound and vibration created by chainsaws. The whole mechanism uses the Arduino Uno and GSM module. But the system can detect only chainsaw sound, and it has not used an ensemble method.

Mporas (*2020)* has proposed a framework to detect wood cutting sounds in the forest. Acoustic surveillance is mentioned to eradicate deforestation. But they have used a single method based detection mechanism which uses a support vector machine. AudioMoth is a low cost, small size, low power operation device that has a simple construction method. It increases the scalability of deployments in remote areas. But a single unit costs around 50 USD. Moreover, as it is a dedicated hardware, any change in the detection mechanism requires a change in the hardware.

Therefore, a low cost yet efficient device needs to be developed which will be able to detect animal hunting and tree cutting in a forest and inform the authority.

3. REQUIREMENT ANALYSIS

Development of a system requires understanding the necessity and features. Proper understanding of the system leads to successful project development.

3.1 Requirement Collections

To collect the requirements of our system, we have gone through several research papers. These research papers have a similar goal to our problem. They have followed different strategies to solve the problem. We have studied their methods and identified their shortcomings. Moreover, we have studied existing systems, which gave us insight into requirements.

3.2 Component Selections

We have chosen machine learning algorithms for software development as they are robust and intelligible. And for the hardware, we have selected raspberry Pi 3B+ for its high efficiency in low power.

4. SYSTEM DESIGN

The very first step of our development was dataset collection. We had collected a total of 1950 audio datasets of woodcutting, gunshot and natural sound. After that, we processed these audio data. We trimmed and merged them to 4-second individual audio.

After that, we converted this audio into spectrograms. We also used MFCC (Mel Frequency Cepstral Coefficient) to extract features from audio. Then we used a total of 5 ML algorithms to train our model. These algorithms were Convolutional Neural Network(CNN), Pytorch, Gradient Boosting Classifier, Random Forest, and Support Vector Machine enabled CNN. After that, we took the weighted ensemble model from each output of these algorithms.

Finally, we deployed this ensemble to a Raspberry Pi. which would be placed in a forest. This device collects audio and provides decisions about the audio using a model developed.

The development of the whole system is visualized in Figure 1.

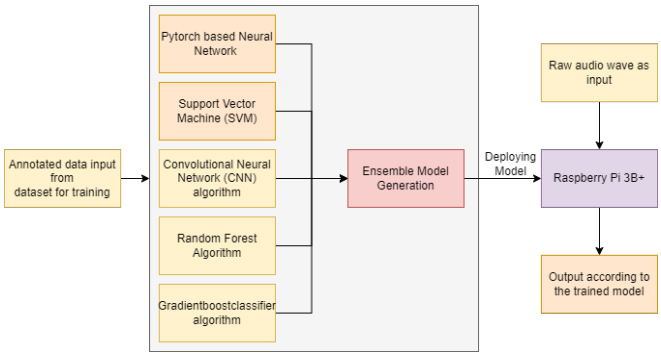

***Figure 1:* System Architecture**

5. RESULT ANALYSIS

Our system is tested against trained data and test data. We have done some statistical analysis which shows the accuracy of the system. Fig 2. shows the accuracy of different models in 3 scenarios, i.e. gunshot, woodcutting and natural sound.

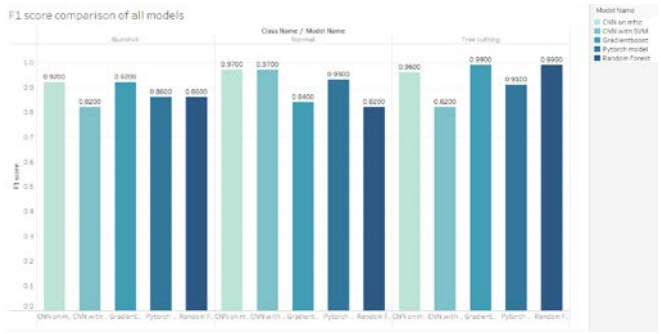

***Figure 2:* Comparison among different models.**

We have chosen the ensemble technique over any single algorithm-based model. The accuracy of the ensemble is 97% which is the highest among the algorithms used. This result is shown in Figure 3.

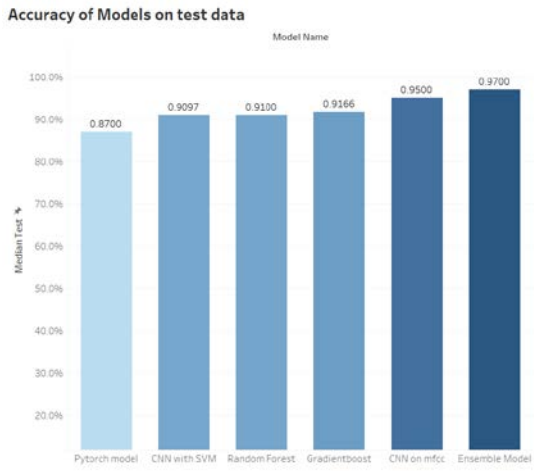

***Figure 3:* Comparison among different models on test data.**

6. CONCLUSIONS

In the proposed method of sound classification, we have achieved accuracy more than any existing research. We have developed custom datasets. Moreover, our approach follows both image processing and multi-level feature extraction. We have also used hardware to integrate the ensemble model. Our system works in real-time and provides necessary feedback. The future scope of our project is to build coverage for a whole forest where multiple devices will be connected and controlled centrally. Deforestation and animal hunting are problems that affect the habitats and our environment. Our system is determined to eradicate these problems using sound. Our integrated system is power efficient and accurate in most cases.

ACKNOWLEDGEMENTS

The authors would like to express their gratitude to the Ministry of Defense, Bangladesh; Ministry of Education, Bangladesh; and Department of CSE, Military Institute of Science and Technology (MIST), Dhaka, Bangladesh.

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AUTHOR BIOGRAPHY

B. M. Nishanul Alam Nishat has passed HSC from Notre Dame College in 2017 with GPA 5.00 out of 5.00. He enrolled BSc. in CSE, in the Military Institute of Science and Technology (MIST), one of the prestigious organizations of Bangladesh, in 2018. He successfully completed his graduation in 2022.

During his graduation, B. M. Nishanul Alam Nishat participated in various competitions, most importantly NCPC-2019 ICPC-2019, Bracathon and Innovation Fest 2021. B. M. Nishanul Alam Nishat would like to pursue his higher study abroad and gain world class knowledge and experiences to contribute in the development of his Motherland.

Mohian Islam has passed HSC from Residential Model College in 2017 with GPA 5.00 out of 5.00. He enrolled BSc. in CSE, in the Military Institute of Science and Technology (MIST), one of the prestigious organizations of Bangladesh, in 2018. He successfully completed his graduation in 2022.

During his graduation, Mohian Islam participated in various competitions, most importantly ICPC-2018, Bracathon. Mohian Islam would like to pursue his higher studies in abroad and gain the world class knowledge and experiences to contribute in the development of his Motherland.

Saba Ahmed Momo has passed HSC from Holy Cross College in 2017 with GPA 5.00 out of 5.00. She enrolled BSc. in CSE, in the Military Institute of Science and Technology (MIST), one of the prestigious organizations of Bangladesh, in 2018. She successfully completed her graduation in 2022.

During her graduation, Saba Ahmed Momo participated in various competitions, most importantly Mujib 100 Ideas and Innovation Fest 2021. Saba Ahmed Momo would like to pursue her higher study abroad and gain the world class knowledge and experiences to contribute in the development of her Mother Land.

S M Anisur Rahman is presently Director (Science & Technology) as well as Researcher in Bangladesh Institute of Maritime Research and Development (BIMRAD). He has completed his both BSc and MSc Degrees in Computer Science and Engineering (CSE) with 1st class. Besides the research on Computer Science and Engineering, he has keen interest on Maritime and Hydrography Research and Development. His various research works have been published in various reputed International and Conference with a very high impact factor. In his whole life he achieved different academic board scholarships with his excellent performance.

Md. Mustaqim Abrar received his B.Sc. degree in Computer Science and Engineering from Military Institute of Science and Technology (MIST), Dhaka, Bangladesh. He is currently working as a Lecturer in the Department of Computer Science and Engineering, MIST. His research interests include image processing, pattern recognition, computer vision, and machine learning.

CSE TECHNICAL PAPER
The MIST Journal of Computer Science and Engineering

Application of Graph Coloring in University Course Scheduling

Dhrubo Barua[1], Fabiha Mukarrama Binte Mannan[2], Sarafa Anika[3], Md. Mahbubur Rahman[4], and Swapnil Biswas[5]

Department of CSE, Military Institute of Science and Technology (MIST), Dhaka, Bangladesh

emails: [1]*iamdhrubobarua@gmail.com;* [2]*fabiha1999@gmail.com;* [3]*saraf.anika.mist@gmali.com;* [4]*mahbub@cse.mist.ac.bd; and* [5]*swapnil.cse16@gmail.com*

INFO

History:

Started: 15th April 2021
Proposal defence: 10th June 2021
Final defence: 27th March 2022
Submitted: 30th March 2022
Published: 30th June 2022

Keywords:

Algorithm
Graph coloring
Constraints
Scheduling

ABSTRACT

Course scheduling problem can be represented as a graph where the courses resemble the vertices and the common teachers in the courses are the edges. Graph coloring is a technique of assigning colors to certain elements of a graph subjected to certain constraints. Again Graph theory is the study of the structural effects of graphs which emerged from a branch of mathematics providing deep insight not only for scientific research but also in solving real-world problems. This work comprises graph coloring to propose efficient solutions to scheduling problems arising in universities. Here the objective of the graph coloring problem is to assign colors to graph vertices so that adjacent vertices connected by an edge get different colors. Graph coloring algorithms were used to assign courses with a color which represents a different time slot. We consider this in the University platform including the courses assigned to the respective teachers. This research intends to show a comparative analysis of five graph coloring algorithms used in the context of university course scheduling of Military Institute of Science and Technology, Bangladesh and to point out the algorithm which works better on the basis of the maximum number of courses assigned a color in the schedule.

কোর্স শিডিউলিং সমস্যা একটি গ্রাফ হিসাবে উপস্থাপন করা যেতে পারে যেখানে কোর্সগুলি শীর্ষবিন্দুর সাথে সাদৃশ্যপূর্ণ এবং কোর্সের সাধারণ শিক্ষকরা প্রান্ত। গ্রাফ কালারিং হল নির্দিষ্ট সীমাবদ্ধতা সাপেক্ষে একটি গ্রাফের নির্দিষ্ট উপাদানগুলিতে রঙ বরাদ্দ করার একটি কৌশল। আবার গ্রাফ তত্ত্ব হল গ্রাফের কাঠামোগত প্রভাবের অধ্যয়ন যা গণিতের একটি শাখা থেকে উদ্ভূত হয় যা কেবল বৈজ্ঞানিক গবেষণার জন্য নয়, বাস্তব-বিশ্বের সমস্যা সমাধানের জন্যও গভীর অন্তর্দৃষ্টি প্রদান করে। এই কাজটি বিশ্ববিদ্যালয়গুলিতে উদ্ভূত সময়সূচী সমস্যাগুলির দক্ষ সমাধান প্রস্তাব করার জন্য গ্রাফ রঙের অন্তর্ভুক্ত। এখানে গ্রাফ কালারিং সমস্যার উদ্দেশ্য হল গ্রাফ শীর্ষবিন্দুতে রং বরাদ্দ করা যাতে একটি প্রান্ত দ্বারা সন্নিহিত শীর্ষগুলি বিভিন্ন রঙ পায়। গ্রাফ কালারিং অ্যালগরিদমগুলি একটি রঙের সাথে কোর্স বরাদ্দ করতে ব্যবহৃত হয়েছিল যা একটি ভিন্ন সময়ের স্লটকে প্রতিনিধিত্ব করে। আমরা এটিকে বিশ্ববিদ্যালয়ের প্ল্যাটফর্মে বিবেচনা করি সংশ্লিষ্ট শিক্ষকদের জন্য নির্ধারিত কোর্স সহ। এই গবেষণাটি মিলিটারি ইনস্টিটিউট অফ সায়েন্স অ্যান্ড টেকনোলজি, বাংলাদেশ-এর ইউনিভার্সিটি কোর্স শিডিউলিংয়ের প্রেক্ষাপটে ব্যবহৃত পাঁচটি গ্রাফ কালারিং অ্যালগরিদমের তুলনামূলক বিশ্লেষণ দেখাবে এবং কোন অ্যালগরিদমটি নির্ধারিত সর্বাধিক সংখ্যক কোর্সের ভিত্তিতে আরও ভাল কাজ করে।

1. INTRODUCTION

University Class Scheduling is the process of assigning time slots to each of the offered courses in a particular semester or term. The time slots are assigned such that so that two or more courses with common teachers do not get assigned with the same time slot. In most universities, courses are scheduled manually by the staff responsible (*2011*) However, manual implementation of university course scheduling can lead to misuse of human effort resulting to a schedule with conflicts. So, to overcome this problem, automation of scheduling is a dire need for universities.

The course scheduling in Military Institute of Science and Technology involves meeting the constraints and it is time consuming for the teaching staff responsible in course scheduling.

1.1 Motivation

Most of the time its seen that after scheduling a course manually, if a change is needed in the routine, the consequent changes to be made are lengthy due to the fact that the schedule has to be conflict free.

1.2 Problem Statements

In this research, graph coloring algorithm was used for scheduling the offered courses. There were many other algorithms used for implementing the scheduling process and among them the graph coloring was the most popular. Since the courses offered represents the vertices and time slot represents the color, vertex coloring was used to assign the time slot to each of the courses.

1.3 Objectives

This research is intended to model the information of the courses offered in a particular term or semester at MIST as an undirected graph and five of graph coloring algorithms were applied to generate the course schedule.

1.4 Manuscript organization

Describe in short how the rest of the manuscript is organized.

2. LITERATURE STUDIES

Considering the scheduling problem, a reliable and standard timetable must meet several requirements and should also satisfy the desires of all parties involved as much as possible, with the view of maintaining its credit as being part of the instruments for ascertaining the success of any institution. This necessitates the need for devising an efficient automated means of getting rid of the hectic and heavy tasks involved in examination timetable and Invigilation scheduling which has been differently described by the articles we went through for the background study.

Genetic algorithms, according to Parera, Sukmana and Wardhani, at UIN Syarif Hidayatullah Jakarta's Faculty of Science and Technology, can aid with class scheduling. The Class Block Feature can assist you in quickly creating a class schedule; the ideal values for optimal crossover parameter, optimal mutation parameter, and maximum population are 0.4, 0.37, and 20 accordingly. It took about 4 minutes to compile 161 data and design a class schedule that was free of conflicts *(2016)* A comparison between the constructive backtracking problem and repair based backtracking problem was discussed with the example of n queens' problem. The standard backtracking algorithm and most constrained algorithm was ineffective and insufficient respectively for n greater or equal to 1000. The hill climbing using the min conflict heuristics performed well requiring only 50 repairs irrespective of problem size. On the other hand, the informed backtracking program proved unnecessary for large n as it never backtracked which proved to be better than hill climbing *(1992)*. A bi-objective branch-and-bound and a constraint algorithm are proposed for the unit-time job shop scheduling problem. This problem is modeled as a bi-objective mixed graph coloring using both the chromatic number and the sum of path-endpoints coloring where sum of the colors assigned to the endpoints of maximal paths to determine the optimal set of the non-dominated solutions.

A new lower bound is also constructed for the sum of path-endpoints coloring which is used alongside an existing lower bound from the literature on two bounding procedures which has been told by Kouider et al *(2021)*. Moreover, Genetic Algorithm (GA) is used to develop a standalone application for automatic generation of examination timetables that will liberate lecturers from the laborious and difficult tasks involved in coming up with examination timetable manually. It makes use of the techniques inspired by biology which includes selection, chromosomes, crossover, and mutation to solve a given problem. It is based on C R I T constraints that might be soft or hard. It also contains a connection with the user and the system like registration of faculty, department, subside department, venue, viewing courses and gradually export and can be sent in email. This interaction is like a tree told by Aminu et al *(2019)*. According to another study, for the studied cases, VC* (Vertex Coloring combined with 2

heuristics) achieved a significantly lower Probability of Dropped Students (PDS), which was within 3.22 percent, reducing the PDS of Vertex Coloring (VC) by about 65 percent. Although graph coloring does not eliminate all existing conflicts, it significantly reduces them and improves resource utilization *(2010)*. A simple graph-node coloring algorithm is used to generate some viable solutions that fully satisfy the hard constraints while only partially satisfying the consecutiveness constraint. Following that, the ABC algorithm is used to massage the viable solutions in order to improve the objective function *(2011)*. By viewing each event as a vertex and then adding edges between any vertex pairings that are subject to an event clash constraint, timetabling problems can be readily turned into an equivalent graph coloring problem.

Each open time slot in the timetable is then assigned to a color, and the aim is to find a coloring that is no more than the number of available time slots. The Hybrid Particle Swarm Optimization (HPSO) algorithm's fitness value (TPV) is clearly superior to the GA for small and medium-sized problems, as shown by another experimental study. In terms of enormous size in TPV, HPSO was somewhat poorer than GA. The HPSO, on the other hand, has lower SCV2 and SCV3 (soft constraint values) than the GA for all issue sizes *(2011)*. Timetabling problems can be easily converted into an

equivalent graph coloring problem by considering each event as a vertex, and then adding edges between any vertex pairs that are subject to an event clash constraint. Each time slot available in the timetable then corresponds to a colour, and the task is to find a colouring such that the number of colours is no larger than the number of available time slots by Lewis *(2015)*.

3. PROBLEM STATEMENT

The use case for this research is the class scheduling system at Military Institute of Science and Technology(MIST). There are 5 weekdays starting from sunday to thursday. The class time is from 8:00 am to 2:40 am and every slot has one hour of time. There are 6 slots per day having a break between 11:00 to 11:45 am. The students are categorized in four different levels as level 1 to level 4. The students of level 3 and level 4 have two different sections named section A and B. A student can be only one level and a section at a time.

There are unique course codes for each course which are of 3 digits. The first digit of the code indicates the level in which the course is offered. For example, if a course code is 123, the first digit is 1 so the course is offered to the students of level 1. The last digit can define whether a course is theoretical or sessional. If the last digit is an odd number, then it is theoretical and sessional otherwise. Each course can be conducted by one or multiple teachers. Every course has a specific contact hour which determines the number of slots required in a week for the course. Suppose, the contact hour of a course is 3. It means that it will take 3 slots per week. There are multiple constraints that need to be satisfied while designing the scheduling.

The slots of a course can be consecutive or discrete. It means that if a course takes 3 slots per week it can be done by assigning 3 different slots, or 2 consecutive and 1 discrete slots or 3 consecutive slots. If multiple courses have the same teacher, then they cannot be assigned in the same time slot even if the courses are of different levels or different sections. Also, two courses cannot be assigned in the same time slot if they are of the same level. If the course code defines a sessional course, then it has to be assigned consecutive 3 slots.

4. PROBLEM REPRESENTATION

4.1. Graph Representation

- Vertex: Each offered course for a term is considered as a vertex. The contact hours of each theory courses are the corresponding credit and that of the sessional courses is always 3 regardless the credit. Sum of the contact hours of all courses is the total number of vertices.
- Edge: In between two vertices, an edge will exist if these contain common teachers or if the level and the section of the courses match.
- Color: The colors represent the time slots. After application of any graph coloring algorithm, each vertex or course will be allotted a time slot.

4.2. Constraints

Constraint satisfaction is required while creating a schedule in this institution.

- If any two offered courses have any common teacher these courses cannot be placed in the same slot.
- If the level and section of any courses are similar these courses cannot be placed in the same slot.
- If the course is sessional, then it should cover 3 consecutive slots from the slot of 800 am or 1145 am.

5. METHODOLOGY

5.1. First-fit

- A color set is created for any connected graph which is initially blank.
- The starting vertex is chosen from the set of vertices' first vertex. The first color is applied to the selected vertex, and this color is added to the color set.
- For coloring, the next vertex in the set of vertices is chosen. Find the adjacent vertices of a selected vertex using the adjacency matrix.
- The selected vertex is given a color from the color array that is not the same as the color of the adjacent vertices. A new color is defined if the colors in the color set are unsuitable for coloring the selected vertex. The new color is assigned to the selected vertex and added to the color set. It is returned to the previous step if the uncolored vertex exists. The algorithm takes the graph's vertices one by one and assigns colors to them in such a way that no two neighboring vertices have the same color. It is the quickest and easiest, but it does not work well for all types of graphs because it is dependent on the input sequence.

5.2. Welsh-Powell

- For any connected graph, each vertex's vertex degree is calculated, and the degrees are added to the degree set.
- For coloring, the uncolored vertex with the largest degree in the degree set is chosen.
- The active color is initially chosen from the color set's first color. The active color is applied to the selected vertex.
- Then, from the adjacency matrix, find the uncolored vertices that are not adjacent vertices of the colored vertex and add them to the set of vertices V'. If an uncolored vertex is found, the next color in the color set is chosen as the active color, and the process returns to the second step. Otherwise, the program will be terminated because the graph's vertices are all colored.

  This algorithm colors the vertices that are not contiguous with the same color and ranks them in descending order depending on their degrees. This procedure is repeated until all of the vertices have been assigned a color. Although this approach is efficient since it employs the smallest chromatic

number, it cannot ensure that it will deliver the best solution for every network.

5.3. Largest Degree Ordering (LDO)

- Initially the color set is empty for any graph. First a color set has to be created. Each vertex's vertex degree is calculated, and the degrees are added to the degree set.
- For coloring, the uncolored vertex with the largest degree in the degree set is chosen.
- To begin, the selected vertex is colored using the colors from the color set. A new color is defined if the color set is empty or the colors in the color set are not appropriate for coloring the vertex (all colors in the color set are used from adjacent vertices). The new color is assigned to the selected vertex and added to the color set. It is returned to the second step if the uncolored vertex exists. It selects and colors the vertex with the most neighbors. Assigning non-conflicting colors to the vertices with the most edges is tricky.

5.4. Incidence Degree Ordering (IDO)

- For any connected graph, each vertex's vertex degree is calculated, and the degrees of the vertices are added to the degree set. There is only one color in the color set at first.
- For coloring, the uncolored vertex with the largest degree in the degree set is chosen. The first color is applied to the selected vertex.
- For each uncolored vertex, the number of colored adjacent vertices is calculated. After that, the uncolored vertex with the most colored neighboring vertices is chosen. If more than one vertex fulfills this requirement, the vertex with the highest degree is chosen.
- To begin, color the selected vertex with the colors from the color set. A new color is defined if the colors in the color set are insufficient to color the vertex. The new color is assigned to the selected vertex and added to the color set.
- If the uncolored vertex still exists, the algorithm will go back to the third step. Otherwise, the algorithm will be terminated.This algorithm begins by coloring the vertex with the highest degree, then proceeds to the vertex with the most colored neighbors.

5.5. Degree of Saturation (DSatur)

- Each vertex's vertex degree is calculated, and the vertices' degrees are added to the degree set in a connected graph.
- In the degree set, the uncolored vertex with the largest degree is chosen for coloring. The first color is applied to the selected vertex.
- For each uncolored vertex, first calculate the number of adjacent vertices that are colored with different colors. The uncolored vertex with the greatest number of adjacent vertices colored with different colors is then chosen for coloring. If more than one vertex fulfills this requirement, the vertex with the highest degree is chosen.
- To begin, the selected vertex is colored using the colors from the color set. A new color is defined if the colors in the color set are insufficient to color the vertex. The new color is assigned to the selected vertex and added to the color set.
- If the uncolored vertex still exists, the algorithm will go back to the third step. Otherwise, the algorithm will stop executing project outcomes and results have to be explained in this section. Please include subsections if necessary. Please provide sufficient results, outputs, images, graphs, charts, tables, etc. to support the strength of your project. Outcomes should support your objectives. The following can be included in this section.

6. RESULT ANALYSIS

The evaluation is done on the basis of how many courses were slotted in the schedule. If the number of courses slotted in an algorithm is high, the more efficient it would be. The schedules generated by greedy, Welsh Powell, Largest Degree Ordering, Incidence Degree Ordering and Degree of Saturation respectively on the given dataset are as follows.

In Table 6, the results of the algorithm were compared. The Greedy, Welsh-Powell, LDO, IDO and DSatur could color 51, 117, 122, 106 and 45 classes respectively out of 122 possible classes with ratio of 0.42, 0.96, 1, 0.87 and 0.37 respectively. So, the best working algorithm is the LDO algorithm. Even though each of the algorithm showed results without conflicts, LDO stood out for the highest ratio among other algorithms used.

***Table 1:* Routine Generated by Greedy**

101A 402A	101B 402A 403B	323A 402A 403B	323B	401A	401B
101A 302A 403A	101B 302A 303B 405A	201A 302A 305B 405A	202A 317A	202A 301A 317B	202A 301B 403B
101A 405B	101B	305A	305B	317A	405A
201A	201A 301A	301A			
203A	203A 301B	301B 305A	305B	305B 323A	323A

***Table 2:* Routine Generated by WP**

306B, 302A 460B, 402A, 203A	306B, 302A 460B, 402A, 203A	306B, 302A 460B 402A, 203A	302B, 206A, 460A, 318A, 404B	302B, 206A, 460A, 318A, 404B	302B, 206A, 460A, 318A, 404B
323B 462B 306A 204A 402B	462B, 317B 306A, 204A, 402B	462B, 306A, 204A, 402B	323A, 318B, 404A, 401B, 201A, 101B	323A, 318B, 404A, 401B, 201A, 101B	323A, 318B, 404A, 401B, 201A, 101B
460B 305B 304A 202A 401A 101A	460B, 305B, 304A, 202A, 401A, 101A	460B, 305B, 304A, 202A, 401A, 101A	305B, 303A, 405B, 403A, 205A	405B, 305A, 301B, 403A, 205A	405B, 305A, 301B, 403A, 205A
305A, 301B, 405A 403B	403B, 303A, 317B, 405A	303A, 317B, 405A, 403B	301A, 304B	301A, 304B	301A, 304B
317A, 303B	303B	303B			

***Table 3:* Routine Generated by LDO**

306B, 302A 462B, 402A, 203A	306B, 302A 462B, 402A, 203A	306B, 302A 462B, 402A, 203A	302B, 206A, 460A, 318A, 404B	302B, 206A, 460A, 318A, 404B	302B, 206A, 460A, 318A, 404B
323B, 462A, 306A, 204A, 402B	323B, 462A, 306A, 204A, 402B	323B, 462A, 306A, 204A, 402B	323A, 318B, 404A, 401B, 201A, 101B	323A, 318B, 404A, 401B, 201A, 101B	323A, 318B, 404A, 401B, 201A, 101B
460B, 305B, 303A, 202A, 401A, 101A	460B, 305B, 303A, 202A, 401A, 101A	460B, 305A, 301B, 202A, 401A, 101A	305B, 304A, 405B, 403A, 205A	305B, 304A, 405B, 403A, 205A	317B, 304A, 405B, 403A, 205A
305A, 301B, 405A, 403B	305A, 301B, 405A, 403B	305A, 303B, 405A, 403B	303A, 317B	301A, 317B	301A
301A, 304B	317A, 304B	317A, 304B	317A, 303B	303B	

***Table 4:* Routine Generated by IDO**

301A, 401A, 405B	101A, 201A, 301A, 323B, 401B, 403A	101B, 201A, 301B, 303A, 403A	202A, 302A, 303B, 402A, 403B	202A, 302A, 303B, 402A, 403B	202A, 302A, 317B, 402A
101A, 301A, 305B, 403A	101B, 201A, 301B, 303A, 401A, 403B	301B, 303A, 401A	203A, 302B, 305A, 401B, 404A	205A, 302B, 317A, 401B, 404A	302B, 317A, 404A
101A, 203A, 303B, 402B, 405A	101B, 203A, 303B, 305A, 402B	317A, 402B	204A, 304A, 305B, 404B, 462A	204A, 304A, 305B, 404B, 462A	204A, 304A, 404B, 462A
205A, 304B, 405A	205A, 304B, 305A, 405A	304B, 305A	306A, 317B, 405B	306A, 317B, 405B	306A
318A, 460A	318A, 460A	318A, 460A	318B, 460B	318B, 460B	318B, 460B

***Table 5:* Routine Generated by DSatur**

101A, 203A, 301A				
101A, 203A, 301A				
101A, 201A, 317A, 301B, 403A, 405B	101B, 305A, 323B, 403B, 405A	323A, 303B, 401A	303A, 305B, 401B	
101B 201A, 305A, 303B, 403A, 405B	201A, 317A, 305B, 405A, 403B	323A, 401A	303A, 323B, 401B	303A, 323B, 401B
101B, 205A, 301B	317B	305B		

Table 6: ***Result Comparison***

Algorithm	Total Classes(N)	Slotted (n)	Ratio (n/N)
FF		51	0.42
WP		117	0.96
LDO	122	122	1
IDO		106	0.87
DSatur		45	0.37

6. CONCLUSIONS

In this research, five of the graph coloring algorithms were compared in the context of the university course scheduling of Military Institute of Science and Technology. Among them the LDO algorithm worked the best giving all classes a color with a ratio of 1 without collisions. This research pointed out the best working algorithm in scheduling courses in Military Institute of Science and Technology. This research can expand to a scheduler which can meet the dynamic requirements of the instructors. Moreover, studies can be done on courses having a common classroom, like if any two courses use a common laboratory or room, these two courses will be connected in the graph. Coloring optional courses may be implemented in the course scheduling problem.

ACKNOWLEDGEMENTS

Authors would like to express their gratitude to the Ministry of Defence, Bangladesh; Ministry of Education, Bangladesh; and Department of CSE, Military Institute of Science and Technology (MIST), Dhaka, Bangladesh.

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AUTHOR BIOGRAPHY

Dhrubo Barua has completed the B.Sc. degree with the Department of Computer Science and Engineering, Military Institute of Science and Technology (MIST). His research interests include data analytics, artificial intelligence, computer vision and human computer interaction.

Fabiha Mukarrama Binte Mannan is doing B.Sc. degree with the Department of Computer Science and Engineering, Military Institute of Science and Technology (MIST). Her research interests include graph theory,a database and management system ,artificial intellegence and human computer interaction.

Saraf Anika has completed the B.Sc. degree with the Department of Computer Science and Engineering, Military Institute of Science and Technology (MIST). Her research interests include graph theory, algorithms, networking and human computer interaction.

Md. Mahbubur Rahman (Member, IEEE) received the Ph.D. degree in information computer science from the Japan Advanced Institute of Science and Technology (JAIST), Japan, in 2004. He is currently a Running Professor with the Department of Computer Science and Engineering (CSE), Military Institute of Science and Technology (MIST), Bangladesh. He has authored more than 75 research articles in reputed journals and conferences globally. His research interests include computer networks, image processing, pattern recognition, bioinformatics, and machine learning.

Swapnil Biswas received his BSc degree from Military Institute of Science and Technology (MIST), Dhaka, Bangladesh. He is currently pursuing his MSc from the same university. He is also associated with the Department of Computer Science and Engineering (CSE), Military Institute of Science and Technology (MIST), Bangladesh as a Lecturer.

CSE TECHNICAL PAPER
The MIST Journal of Computer Science and Engineering

Design and Develop of a Communication Module for A Military Surveillance Robot

Shoeb Ahmed Tanjim[1], Shaqran Bin Saleh[2], Md. Muhtasim Fuad[3], M. Akhtaruzzaman[4]

Department of CSE, Military Institute of Science and Technology (MIST), Dhaka, Bangladesh

emails: [1]*shoebtanjim@gmail.com;* [2]*shaqran39@gmail.com;* [3]*fuadnafiz98@gmail.com; and* [4]*akhter900@cse.mist.ac.bd*

INFO

History:

Started: 17th April 2021
Proposal defense: 10th June 2021
Final defense: 27th March 2022
Submitted: 03rd April 2022
Published: 30rd June 2022

Keywords:

Real-time communication
Long distance communication
Military Surveillance system
Image Transmission
IoT

ABSTRACT

This project focuses on the design and development of a real-time communication module for a military surveillance robot. Surveillance robots are used to monitor the behavior, activities, and other changing information that are gathered for the general purpose of managing, directing, or protecting one's assets or position. In a military scenario, a surveillance robot will play an important role in keeping an eye out by collecting critical information about the hostile situation and making intelligent decisions for the military. To work properly in a hostile situation, real-time communication between the robot and the control center is critical. One of the major challenges is to integrate all hardware modules in a small and compact space. Another problem is that the robot has to be able to take videos, audio feedback, and take commands from controls. The outcome of the project is a real-time communication module along with a GPS tracking system. The major objective is to build a system that can provide live audio and video feedback from the ground. Also, it has to take action according to commands. The network system with a 2.4GHz channel has the potential to serve real-time video transmission along with long-range command transmission. The outcome from this project will be a real-time communication module that can also provide live audio and video feedback. Also, it can listen to commands that will be sent to it and take actions based on them.

এই প্রকল্পটি একটি সামরিক নজরদারি রোবটের রিয়েল-টাইম যোগাযোগের নকশা এবং তার উন্নয়য়নের উপর গুরুত্বআরোপ করে। একটি সামরিক নজরদারি রোবট আচরণ, কার্যকলাপ, এবং অন্যান্য পরিবর্তনশীল তথ্য নিরীক্ষণের জন্য ব্যবহার করা হয় সম্পদ বা অবস্থান পরিচালনা, নির্দেশনা বা সুরক্ষার উদ্দেশ্য। সামরিক বাহিনীতে, প্রতিকূল পরিস্থিতি সম্পর্কে গুরুত্বপূর্ণ তথ্য দেওয়া এবং বুদ্ধিমান সিদ্ধান্ত নেওয়ার ক্ষেত্রে নজরদারি রোবট একটি গুরুত্বপূর্ণ ভূমিকা পালন করে। একটি প্রতিকূল পরিস্থিতিতে সঠিকভাবে কাজ করার জন্য, রোবট এবং কন্ট্রোল সেন্টারের মধ্যে রিয়েল-টাইম যোগাযোগ একটি গুরুত্বপূর্ণ বিষয়। একটি প্রধান চ্যালেঞ্জ হল একটি ছোট এবং কমপ্যাক্ট জায়গায় সমস্ত হার্ডওয়্যার মডিউল একত্রিতকরণ। আরেকটি সমস্যা হল যে রোবটকে ক্যামেরা থেকে ভিডিও তোলার পাশাপাশি অডিও ফিডব্যাক ও কন্ট্রোল থেকে কম্যান্ড নেওয়া। প্রকল্পের ফলাফল হল একটি রিয়েল-টাইম যোগাযোগ মডিউল। প্রধান উদ্দেশ্য একটি সিস্টেম তৈরি করা যা লাইভ অডিও এবং ভিডিও ফিডব্যাক প্রদান করতে পারে। এছাড়াও, কন্ট্রোল সেন্টার থেকে কম্যান্ড নেওয়া এবং সে অনুযায়ী ব্যবস্থা নেয়। একটি 2.4GHz চ্যানেলের নেটওয়ার্ক সিস্টেমে রিয়েল-টাইম ভিডিও ট্রান্সমিশন সহ দূর-পাল্লার কমান্ড ট্রান্সমিশনের সক্ষমতা রয়েছে। এই প্রকল্প থেকে ফলাফল হবে একটি রিয়েল-টাইম যোগাযোগ মডিউল যা লাইভ অডিও এবং ভিডিও ফিডব্যাক প্রদান করতে পারে। এছাড়াও, এটি কমান্ড নিতে পারে এবং তাদের উপর ভিত্তি করে পদক্ষেপ নিতে পারে।

1. INTRODUCTION

A robot is electromechanical equipment or gadget that can execute a variety of physical tasks and is controlled by a computer program or an electronic circuit. Robots are becoming an important component of human life in today's world (*Sanaullah, Akhtaruzzaman, & Hossain, 2022*). This technology is employed in defense forces, entertainment, space exploration, security systems, and a variety of perilous mission executions (*Akhtaruzzaman et al., 2011, 2017, 2020*). When it comes to robots, the utilization of wireless communications is steadily increasing. Because of its advantages, the device's use of cables and other components has been decreased, making it more sturdy and compact. It is also feasible to control gadgets from a distance. The usage of wireless communication in surveillance systems is now an added benefit. The surveillance module is designed to provide information about any circumstance or person. It uses Line of Sight (LOS) technology as well as other mechanics to handle audio and video transmission, providing the control station a great deal of autonomy. Modern internet-based technology makes it simple for us to create an integrated network environment for a wide range of robotic system applications (*Zaman et al., 2022*). To cope with the internet's limited bandwidth and random transmission delay, internet-based (IoT) robots need a high degree of autonomy and artificial intelligence to be successful in real-world applications (*Ahmed et al., 2021*).

1.1 Motivation

When it comes to security, the military is unquestionably the most important consumer when it comes to conceptualizing innovations. In terms of safety, robots are indispensable. The primary goal is to improve the security forces in any hostile environment. Surveillance is now carried out using a robot equipped with a camera. But in previous communication modules, the integration of audio, video, and sensor feedback was not done. With the help of a remote surveillance robot, the robot's camera can travel to any area to keep an eye on competitors and provide live and real-time feedback on the environment through video and audio receptors. The communication is done via RF technology. There are sophisticated software and hardware applications in use. To convey wireless radio frequency communications, it has a transmitter, receiver, and transceiver. Due to growing enemy attacks, monitoring of military regions is vital in today's world, but the quality of that monitoring, i.e. surveillance, is not very good, resulting in an increasing ratio of soldier lives at risk. As a result, effective surveillance is required to improve the quality of surveillance. High-definition video transmission is more effective at this.

1.2 Problem Statements

From a communications perspective, military operations call for smart information dissemination solutions. In a challenging scenario, reliable communication between a robot and remote control is crucial. A major problem of surveillance robots is to stay connected even if there are obstructions between the robot and the control station. For a military operation, a robot must be in a compact size. So designing the system so that it can fit in a compressed place is one of the challenging tasks. Another major problem is to control the robot from distant places and track and inspect its accurate location of it. Also designing the system resilient to external environments so that it doesn't become dysfunctional is a critical problem to solve. The robot should be able to provide live audio and video with a proper post-processing of the environment that it is located. Moreover, as surveillance robots are controlled by ground stations, the robot must be able to receive commands as well as respond to those commands with proper actions.

1.3 Objectives

The goal of this project is to design and develop a communication module that works in real-time at a long distance. The goal of this project can be split into the following three objectives:

- To integrate a Line of Sight (LOS) communication system.
- To integrate audio, video, and localization sensors to provide live feedback from the ground.
- To develop a portable base command module for remote access.

1.4 Research Methods

For this thesis, it is necessary to figure out what is the requirements and how to find those requirements. Also, what will be the various tools that are required to build the system. To fulfill the objectives of this thesis, a flow chart has been designed to represent the overall process of the research for this thesis. For this system, a flow of how the research is conducted is shown in *Figure 1*.

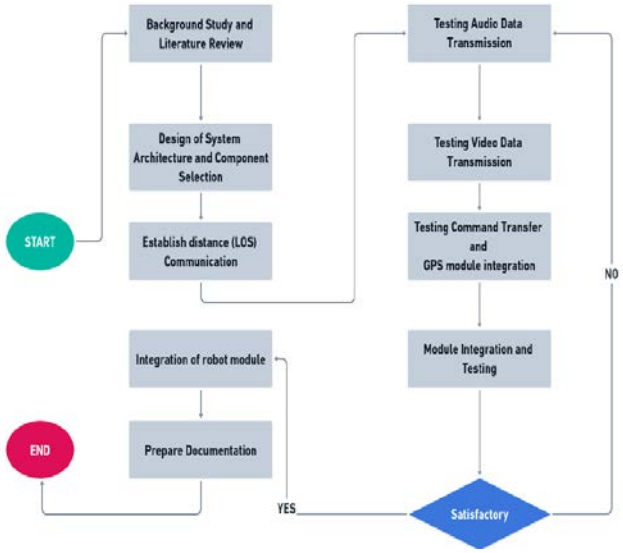

Figure 1: Research Methodology

The process of this thesis started with the background study and literature review. The second part of the thesis methodology is to design the complete system diagram and select the necessary components for the system. The third part deals with the implementation of establishing Line of sight communication. For the implementation of this part, it was necessary to build two separate modules for the surveillance robot part and the robot controlling part. The fourth part of the methodology includes implementing the audio data part and

testing the audio send and receive system. In the fifth part, video data transmission has been implemented into the system. A major part of the system is to implement the command transfer between the remote control and surveillance robot. Then the different modulus has been integrated and tested, then the tests are compared with the expected results, when the test results are not satisfactory, then the process has again started from the audio data transmission part, and various modifications are done for better results. When the results have been satisfactory, the prepared modules for communication have been integrated into the robot module and tested the full integration. In the final part of the research, documentation has been developed describing different modules and components of the system.

1.5 Manuscript organization

The organization of this technical paper is as follows, the 2nd section describes the analysis of previous research articles and their findings. The 3rd section describes the component selection for building the surveillance robot and the remote control base. The 4th section describes different system diagrams, flowcharts, and dataflow activities related to the system. The 5th section describes the implementation of the system both in the hardware part as well as on the software part. After implementation, the section also describes different testing done on various components of the system. Finally, Section 6 closes with a conclusion, some limitations of the system, and possible future works.

2. LITERATURE STUDIES

Hasan et al. *(2018)* studied the development of a surveillance robot and its control from long distances. In this research, they studied the development of the controlling of the robot from unlimited distance basing the whole system on the World Wide Web (www). Here the users are to be able to interact with the robot through the web server and can designate the destination point of the robot and also receive the robot position information through the network. For interaction with the robot, users can use several kinds of terminals like PC, PDAs or mobile phones. Here, the web server provides services of human-robot interaction. In the study, the accuracy of the system is satisfactory. The minimum accuracy of the system is 24% and the maximum accuracy of the system is 74%. The accuracy of the system is measured in terms of image transmission capabilities.

Thomessen, Niitsuma, and Suzuki *(2015)* engaged in to study of Multimodal man-machine communication (4MC). This is based on audio, and haptic data. The main goal is to use sensor bridging to offer natural, intuitive, and effective communication between the industrial robot system and the remote operator, and thus create a virtual environment that provides the remote operator the feeling of being right next 8 to the robot cell. The remote operator receives complicated information simultaneously through different human senses using multi-modal man-machine communication mixed with sensor bridging.

Mahamuni *(2020)* studied and proposed a prototype model of the surveillance system using wireless sensor networks (WSN). The objective of the study was to achieve an energy-efficient performance of a system by the optimization of the node schedule in WSN. the components in the prototype model included a PIR motion sensor which was used for the purpose of motion detection, Arduino MEGA 2560, and XBee Series1 module. The objective evaluation was carried out by the calculation of Coverage Lifetime (CL) and the subjective evaluation was carried out on the basis of real-time observation after which the final conclusion will be made.

A study by *(Chikurtev et a.l, 2019)* gave the proposal of a communication system for remote controlling of service robots. The system's goal was to maintain a stable and secure connection between a robot and its operator or user. The communication system needed to be adaptable, with high connectivity and mobility. The idea was to develop a flexible system that was able to connect and integrate the different technologies and external systems so as to maximize their capabilities. Additional services should be utilized to create a web page with management functions so that the robot may be accessed via the Internet.

Kumari and Sanjay *(2020)* presented a smart surveillance robot using object detection where it acquires the video and audio from the mobile phone installed on the robot. The "IP WEBCAM" android smartphone app was utilized. Furthermore, utilizing the python Open CV and YOLO object detection algorithms to detect any things present in the video stream in real-time, users were able to interface IP WEBCAM and detect any objects present in the video feed. The proposed framework's main contribution was to combine a portable robot with processing innovation to improve observation and administration. The data supplied by ROBOT analyzed the constant photographs using camcorders, reducing the calculating effort, cost, and asset requirements significantly *(Kumari & Sanjay, 2020)* in his study of a smart surveillance robot using object detection where it acquires the video and audio from the mobile phone installed on the robot. The "IP WEBCAM" android smartphone app was utilized. Furthermore, utilizing the python Open CV and YOLO object detection algorithms to detect any things present in the video stream in real-time, users were able to interface IP WEBCAM and detect any objects present in the video feed. The proposed framework's main contribution was to combine a portable robot with processing innovation to improve observation and administration. The data supplied by ROBOT analyzed the constant photographs using camcorders, reducing the calculating effort, cost, and asset requirements significantly.

Azeta et al. *(2019)* studied an android based mobile robot for the purpose of monitoring and surveillance. An android gadget and a robot made up the surveillance system. The Wi-Fi module allows a remote operator to control the robot. An Arduino microcontroller is used to control the robot's movement, as well as an Android smartphone running the Android operating system and other necessary gear such as chassis, motors, and power supplies. The robot is controlled by sending commands to the smartphone, which are transmitted to the Microcontroller, which then navigates the robot in the desired direction. The camera on the smartphone delivers video input to the remote operator over the internet at the same time, allowing the operator to navigate the Robot.

(Ghute, Kamble, & Korde, 2018) in their study discussed the design of a military surveillance robot. They presented a robot design that was based on autonomous programming and smart app control, allowing it to be controlled using mobile devices. Arduino and Raspberry Pi were used to feeding the programming. 8 Servo Motors, an Arduino Mega, an Arduino Pro Mini, and a Raspberry Pi3 model are the major components of the robot. The humanoid robot's main control board is made up of Arduino and Raspberry Pi. The Arduino programming output was supplied to a variety of sensors, allowing the robot to sense its environment. The camera, microphone, and speaker were all fed through the Raspberry-Pi output.

(Kaur & Kumar, 2015) presented a modern approach for surveillance at remote and border areas using multifunctional robots based on current 3G technology used in defense and military applications. The robotic vehicle had the ability to substitute the soldier at border areas to provide surveillance. The robotic vehicle works both as an autonomous and manually controlled vehicle using the internet as a communication medium.

In a study by *(Prakash & Walambe, 2018)* the implementation of a surveillance robot using a Robot Operating System presents map generation based on a Kinect sensor.The major software components utilized to test, program, and display the operation of the Surveillance Robot's key features are ROS (Indigo version) and Gazebo. The Gazebo software that comes with the ROS installation is used to simulate our robot model. The Teleop package in ROS was used to create the remote controller. The keyboard was used to control the robot's movements. It is also possible to use a joystick as an input device. The occupancy map was generated using the ROS package mapping. The mapping module offers ROS programs for creating an occupancy map using data from laser scans and odometry. The plan was to teleoperate the robot through a region initially, saving laser and odometry data in the process. The map will be built using a node and the saved data. The main controller application was written in Python and installed on the robot prototype's main computer (a Raspberry Pi 3). The programming was primarily concerned with directing the robot's movement using data acquired from a wireless gamepad controller used by the operator. The ROS program for the on-board Kinect sensor to take photos of the environment was utilized for object detection. These photos will then be put into a pre-trained object identification program, which will run concurrently with the simulation. For image recognition, Tensor Flow has been employed.

Additionally, a study was done by *(Ku & Cheng, 2007)* on the development of a network robot by using WLAN and Mobile IPv6 techniques. The mobile IPv6 technology was implemented on a robot to afford the smooth handoff on a fixed IPv6 address to shorten the time of the broken connection through different WLAN areas. Besides, the implemented mobile IPv6 function also solves the status of the triangular routing to achieve the optimization of the routing of the packet transmission. When the robot moves to different floors for secure checking, the robot needs to solve the problem that it can cross the different WLAN coverage. The control center hopes that the robot does not need to change its IP address and can make the connection continually. Hence, the Mobile IP technique is used to solve this problem. Hence the handoff between the WLAN of the robot will be solved to handle the status of the mobility of the robot. The ROS program for the on-board Kinect sensor to take photos of the environment was utilized for object detection. These photos will be then put into a pre-trained object identification program, which will run concurrently with the simulation. For image recognition, Tensor-Flow will be employed. The handoff operation when the Robot crosses the WLAN was the most crucial aspect. The connection between the Control Center and the Robot is initially simple to establish. To test the robustness of Mobile IPv6, the handoff operation was triggered every thirty seconds in three minutes by changing the WLAN coverage. 2.4 depicts the five handoff latency according to the packet record's experimental study.

3. COMPONENT SELECTION

After finding the initial findings of the existing research papers and currently implemented projects, a set of components is being chosen to integrate into the system. This chapter discusses the selection of the different components for the surveillance robot and the remote control system. To classify the different modules of the system, the overall composition is divided into six modules, each of the modules is described below.

3.1 Power Supply Module

To properly supply power to the robot and the remote control, the power supply is essential. All the components of the system require 5.0 Voltage to run properly. The power components are given below:

1. Lithium-ion Battery
2. Buck Module

3.2 Sensor Module

In the composition of the surveillance robot, the role, and importance of the sensor module are huge. In this robot, the sensor module comprises various sensors which were essential for video and audio feedback, calibration, and geolocation of the surveillance robot. Selected sensor modules are,

1. Raspberry Pi NoIR Camera
2. IR Transmitter
3. USB Microphone
4. GPS Module
5. Joystick

3.3 Processing Module

The whole robot functionality is controlled by this module. The processing module deals with the sending and receiving of various data between the surveillance robot and the base station. The two main processing modules are Raspberry Pi and Arduino. The selected components are, Raspberry Pi, and Arduino Nano.

3.4 Feedback Module

This module is one of the most important in the design and development of the robot. To interface the environmental surrounding and the entire surveillance module, this feedback

module comes to play. The act of interacting with the environment and fulfilling the purpose of the surveillance involves the work of providing live real-time audio and video. Along with that provide indicating signals to the LEDs. So this module involves

1. Display
2. Speaker
3. LEDs

3.5 Communication Module

The Communication Module is in charge of communicating between modules on different robots. This module establishes the communication between the robot and the base station. Its Work involves the transfer of video, audio, sensor data, and control command signals. Here the module involves an antenna where a 2.4gHz band. For the transmitting end, a directional antenna and for the receiving end an omnidirectional antenna were used. This module involves High Gain Wireless USB LAN and 2.4Ghz outdoor CPE. The components selected are given below:

1. High Grain Wireless USB LAN
2. 2.4GHz Outdoor CPE

4. CONCEPTUAL FRAMEWORK

The best way to visualize the different parts of the system was to develop a system architecture of the whole system. As there are two major parts of the system, the surveillance robot part, and the remote control module part, two distinct system diagram is designed for both of the systems.

4.1 System Architecture

Figure 2 shows the system diagram for the surveillance robot part. The main processing unit of the surveillance robot is a Raspberry Pi 3. This Raspberry Pi 3 is responsible for collecting all the video and audio data, processing those, and streaming those to the remote server. The antenna attached to the raspberry pi is omnidirectional, it is used to establish a connection with the remote antenna and send data to that module and also listen for possible commands send by the remote control. The Raspberry Pi NoIR camera is used to collect the video streams. The array of IR LEDs helps to capture video in low light or in dark. Audio input is taken by a mini USB microphone. The GPS sensor tracks the location of the robot and sends the geolocation to the raspberry pi. IMU sensor calculates the orientation of the robot and sends the axis to the server. The raspberry pi is responsible for processing all the data it is getting from different components and processing and optimizing those data before sending them to the remote control system. The ESP 32 connects the motor driver with the raspberry pi. A motor driver is used to control the motors of the system.

Figure 3 shows the system architecture for the remote control base station. The base station will be responsible for getting the data from the surveillance robot. This will also have a raspberry pi as its main processing unit. The wireless access point will get the data that is sent by the robot. the wireless access point will then send those data to the raspberry pi. The Raspberry pi display will display the video feedback, along with audio visualization, IMU sensor readings, and GPS location of the robot. A major part of the base station is the control system for the robot.

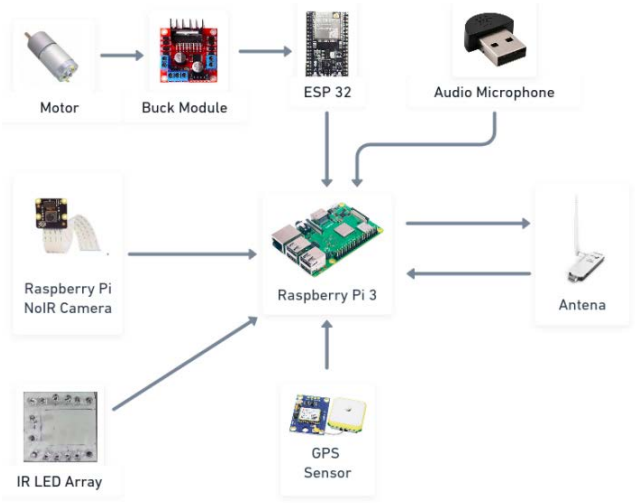

***Figure 2:* Robot System Architecture**

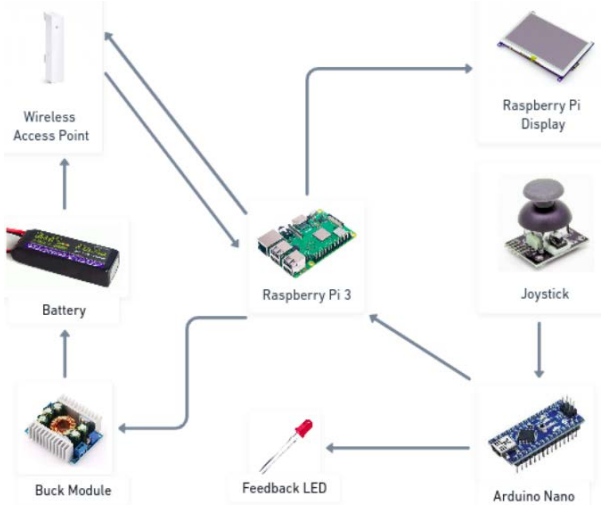

***Table 3:* Base Station System Architecture**

A joystick is used for controlling the robot. The joystick data is collected via Arduino Nano. Also, the feedback from the robot is indicated by the LED lights. With the system architecture, the necessary modules have been identified. Also, it is made clear how each component will work and how each component is sending and receiving the information with each other. The separate system architecture for the surveillance robot and the remote control has made the development of the system clear and made each implementation of the system easy. Also, it helped to understand the system in broad view.

4.2 Flow Chart

The flow diagrams are used to describe how the data flows through the system, and how each of the tasks fits from the start to the end cycle for the system. to better visualize the flow of operations for the complete system, two flowcharts are being developed. The description for the flowcharts is provided below The flowchart for the surveillance robot is shown in Figure 4.

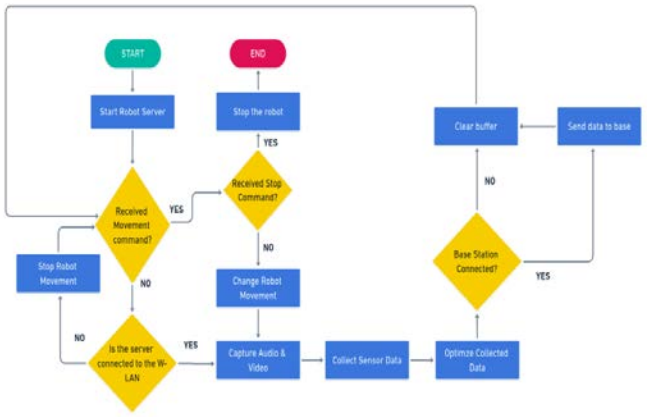

Figure 4: The flow chart for the Surveillance Robot

The robot will start with the support of the power supply and the manual action of the user. The server will run inside the Raspberry pi. The server will start listening for commands from the remote control. The listening of the command part will run in a loop until any command is received from the base station. If it doesn't receive any command for a specific amount of time. It will stop the movement of the robot and shut down the server. In the listening process, if it receives the stop command, it will stop the robot and the process will be stopped. On the other hand, if it receives some movement command, it will start moving according to the movement command. It will start collecting video and audio information from the environment. It will also start receiving signal data from different sensors inside the robot. It will continuously collect the information, and optimize the data. If the base station is not collected with the robot, it will clear the buffer and start to receive fresh data from the system. If the connection between the base station is successful, then it will send the data to the base. The flow diagram for the base station is shown in Figure 5.

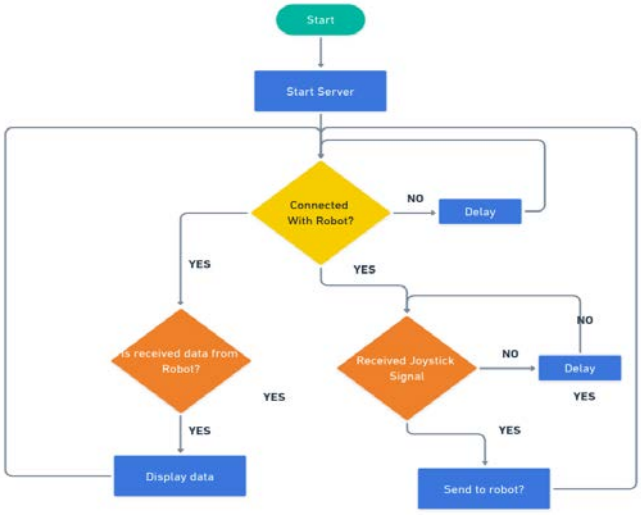

Figure 5 The flow chart for the Remote Base Station

The flow for the remote control system also starts with a manual action by the user. Then it will start its server which is the raspberry pi server. It will also power up the wireless access point, which will be used to receive the data send by the surveillance robot and send commands back to the robot. It will first check if the surveillance robot is connected to the base station or not. If the surveillance robot is not connected, then it will take some delay as no operation and check again to see if the robot is connected with the base station or not. Then it starts receiving data from the robot, it will process the data in the running server, and it will display the data on the display. Also, it will listen for any joystick command, if a joystick command is received, then it will send it immediately to the remote robot, or it will delay and wait for listening to any commands sent by the joystick.

5. IMPLEMENTATION

5.1 Surveillance Robot

This part describes how the communication module is built for the surveillance robot. The first part describes how the Hardware part is being implemented.

5.1.1 Hardware Implementation

The hardware implementation of the front view of the surveillance robot is shown in Figure 6.

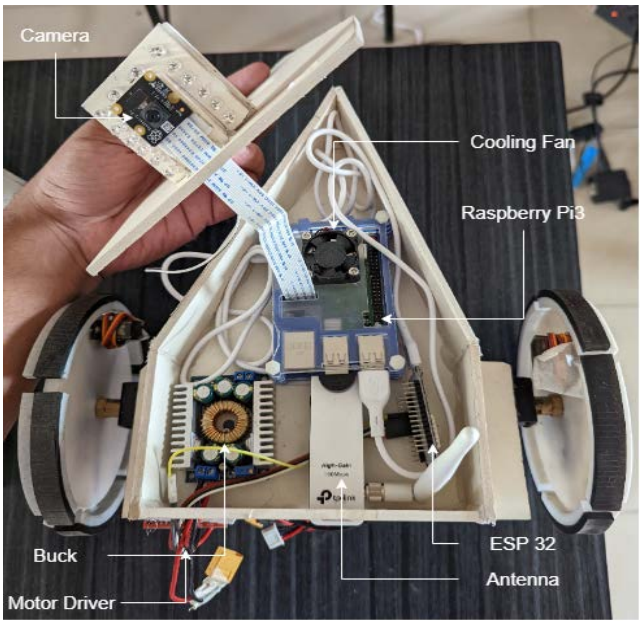

Figure 6 The hardware implementation for the robot

The central processing unit of the surveillance robot is the Raspberry pi 3 B+. The buck module is used to regulate the voltage of the system. A motor driver is attached to control and drive the motors. This antenna is responsible for sending data to the remote control station. The USB microphone is attached to one of the USB ports of the raspberry pi. The Raspberry Pi noIR camera is connected via the CSI port of the Raspberry pi. A set of IR-led arrays are attached around the Raspberry Pi Camera. The IR-led arrays are powered by the 5V port of the raspberry pi. This helps to provide the camera to see when there is low light or at dark.

5.1.2 Software Implementation

The software implementation on the surveillance robot end is composed of multiple servers and implementations for collecting audio, and video feedback. The software implementation also includes video optimization and audio

correction. For video transmission, the first server creates three separate routes, the routes are for different qualities of video, one route streams the regular video to the station. One route is used to stream low-resolution video. And one route is implemented to stream grayscale videos. OpenCV library is used to capture videos by the Raspberry PI No-IR camera.

5.2 Base Station

For the base station, the hardware implementation includes building the mobile control box.

5.2.1 Hardware Implementation

The main structure of the base control is a mobile control module. The front of the base station is shown in Figure 7.

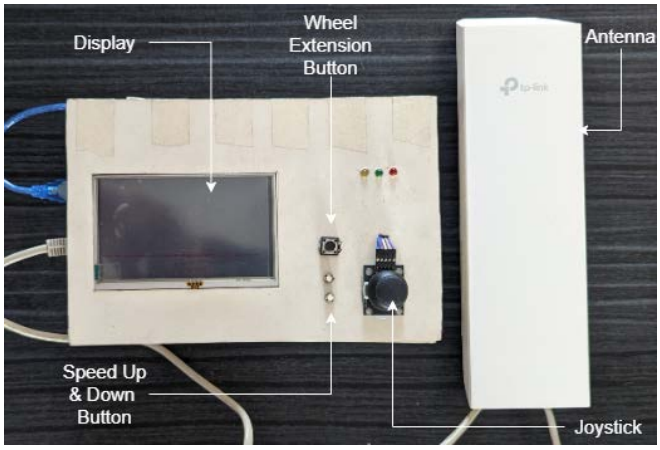

***Figure 7** The hardware implementation for the base station*

The touchscreen Raspberry Pi display takes up the majority of the space for the control module. The front side of the base station also includes the joystick from which the robot will be controlled. Three LED lights provide necessary updates regarding the robot connection.

5.2.2 Software Implementation

The software part of the base station includes designing and developing the dashboard to display all the contents. This part also includes setting up the Wi-Fi for the wireless access point. The TX-RX communication has to be implemented inside the Arduino to establish the connection between the Arduino and raspberry pi. The dashboard is shown in Figure 8.

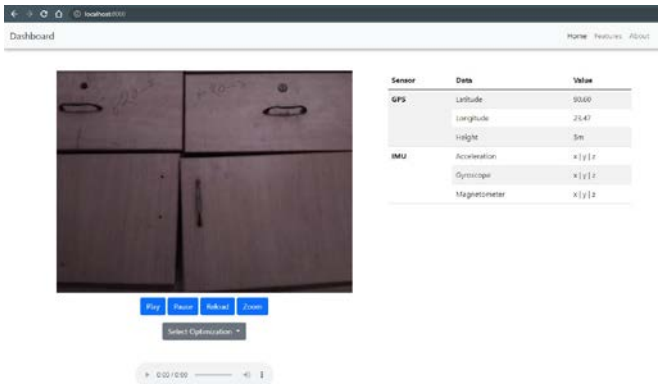

***Figure 8** The software implementation for the base station*

6. CONCLUSIONS

The robot has been put through its tests in various environments in order to assess its capabilities. The video was tested on various qualities. Also, the required bandwidth for various modes of transmission is also being calculated. The results showed that the video is best transmitted on grayscale video quality. Also, the antenna used in the research best works around 200 meters to 600 meters. In the process of developing the entire system, and after the testing and evaluation part the project's limitations and flaws were evident. The camera was stable to the body and not movable. The surveillance robot was designed without an aiding object detection system. The development of any design can be continued to be done till a satisfaction level is reached. Sensors including GPS, temperature, pressure, condition, observation, and a lot more highlights can be incorporated. With artificial intelligence and the advancement of deep learning techniques, the application of autonomy has a large component scope. In the current world, the usage of renewable energy needs to be increased. So the inclusion of a renewable energy power supply can be an added environment-friendly feature. Phi, the Golden Ratio (GR), shows mystic and influential behaviour in design and computing (*Akhtaruzzaman & Shafie, 2011*). Considering GR in designing the robot may show improved results in overall design.

ACKNOWLEDGEMENTS

Authors would like to express their gratitude to the Ministry of Defence, Bangladesh; Ministry of Education, Bangladesh; and Department of CSE, Military Institute of Science and Technology (MIST), Dhaka, Bangladesh. The authors also would like to acknowledge their supervisor, Dr. M. Akhtaruzzaman for his constant supervision, affectionate guidance, and great encouragement and motivation. His keen interest in the topic and valuable advice throughout the study were of great help in completing the research.

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AUTHOR BIOGRAPHY

Shoeb Ahmed Tanjim is currently studying as a final year B.Sc. student in the department of computer science and engineering at the Military Institute of Science and Technology (MIST). His research interests include artificial intelligence, image processing, robotics, and IoT.

Shaqran Bin Saleh has passed SSC from Saint Joseph Higher Secondary School and College School in 2015 with GPA of 5.00 out of 5.00 and passed HSC from Notre Dame College in 2017 with GPA 5.00 out of 5.00. Shaqran Bin Saleh is currently studying as a final year B.Sc. student in the department of computer science and engineering at the Military Institute of Science and Technology (MIST).

During his graduation, Shaqran Bin Saleh participated in various competitions, club activities, through which he brought his name and fame to the institution. Shhaqran Bin Saleh would like to pursue his higher studies in abroad and gain world-class knowledge and experiences to contribute in the development of his Motherland.

Md. Muhtasim Fuad has passed SSC from Cantonment Public School and College in 2015 with a CGPA of 5.0 out of 5.0 and passed HSC from Cantonment Public School and College in 2017 with a CGPA of 5.0 out of 5.0. He is currently studying as a final year B.Sc. student in the department of computer science and engineering at the Military Institute of Science and Technology (MIST).

During his graduation, Md. Muhtasim Fuad participated in various competitions, most importantly Competitive Programming, Hackathons Robotics design, and development, through which he brought his name and fame to the institution. Md. Muhtasim Fuad would like to pursue his higher study abroad and gain world-class knowledge and experiences to contribute to the development of his Mother Land.

Dr. M. Akhtaruzzaman is an Assistant Professor in the Dept. of Computer Science and Engineering, Military Institute of Science and Technology, Bangladesh. He is also associated with DREAM Robotics Ltd., Dhaka, Bangladesh as a Consultant and Research scientist. He was awarded the PhD and MSc. from IIUM, Malaysia, and the BSc. from IIUC, Bangladesh. He has published 50+ research articles and awarded several Gold Medals as the recognition of his research works. His field of interest includes robotics, mechatronics systems, control engineering, AI, fuzzy systems, and quantum computing.

CSE TECHNICAL PAPER
The MIST Journal of Computer Science and Engineering

EDITORIAL COLUMN

Sustainability: Engineers' Obligations

Dr. M. Akhtaruzzaman
Department of CSE, Military Institute of Science and Technology (MIST), Dhaka, Bangladesh
emails: *akhter900@gmail.com; akhter900@cse.mist.ac.bd*

Engineering plays a vital role to the sustainable development. The main challenge is to guarantee meeting current social needs by optimal uses of natural resources. Producing foods, providing shelters, ensuring medical cares, supporting industrial productions, generating energy, facilitating transportation, confirming effective waste management, etc. are imperative while conserving environmental qualities must be well-thought-out and ensured. Sustainable development is a continuous demand which can be attained by the professional engineers and scientists, undoubtedly. Engineers should attempt to augment the biophysical and socioeconomic borough and promote the principles of sustainable development. Engineers have obligations to their society for improving health, safety, and social welfare not only for local but also for global society through practicing sustainable development. Engineering judgments, risk assessments, decision making, and practices are fully incorporated with designing and developing sustainable structures, machines, devices, products, and processes; thus engineers must be accountable to their assigned duties.

Engineering is the art of applying sciences and mathematics for the optimum utilization of the assets and resources of nature so that the properties of matter and sources of energy are made useful ensuring the enhancement of the quality of life in terms of reliability, tranquility, and comfortability. To find a solution of a problem, as engineers have to consider a number of factors imposed by legislature, they need to consider the constraints of sustainable development while designing structures, goods, and products.

What is Sustainability? It mainly reflects the ability to make any development sustainable. At the same time, it must ensure current social needs while future generation do not have to compromise with their own ability to meet their regular needs. It is true that many of the lifestyles and developments in our modern societies are not be able to sustain indefinitely. Why is that? Because we are beyond sometimes violating our domestic capabilities in providing proper refinements of our emissions. Recognizing the needs within constraints and ensuring fairness in accessing limited resources must be the main concern and commonly considered as the core of the concepts of sustainability and sustainable development.

Consistent with social, environmental, and economic aspects, sustainable structures are rapidly rising practices in modern construction and transport industries all over the globe. In every cases, green developments are trying to be adopted by architects, designers, engineers, constructors, and owners. Lifecycle analysis demonstrated that sustainable design and development make a better economic sense of environment. Owners are intended to proliferate the standards of existing architectures with green renovation to make those sustainable. The expectation is to maintain the trend by adopting and accelerating green development with true understanding of the effect of sustainability and sustainable development. No doubt, engineering has to be practiced by synchronizing the properties of sustainable environment.

Lifting up the development activities to a certain state of pattern which can be sustained endlessly is the core theme of the sustainable development. In reality, such changes may not possible but it should be an approach to the development that seeks to resolve human necessities without hampering the environmental capacity to cope with the consequences of artificial activities. Sustainable development encompasses Social, Environmental, and Economic (SEE) accountability which is mostly known as the Triple Bottom Line (TBL) concept as presented by the Venn diagram shown in Figure 1.

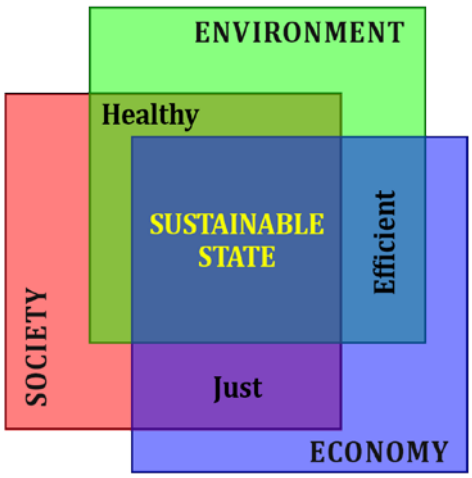

Figure 1: ***The Triple Bottom Line (TBL) concept***

The Venn diagram of TBL concept presents the interconnectivity among society, economy, and environment which are the most indispensable elements for living. The level of excellence of these three sections ensures the quality of life. A decent environment is must to live healthy in a society; a society with growing economy is just a society; and good environment with economic aptness is efficient for social growth. So, the sustainable state is environmentally healthy, economically efficient, and socially justified in all aspects.

A true and meaningful life style is also strongly influenced by the fundamental laws and ethical base which are totally ignored in the TBL approach. So, the term needs to be encompassed as a new essential component of the sustainability. The thought of Quadruple Bottom Line (QBL) approach, shown in Figure 2, needs to be perceived with 'Law and Ethics' as a new essential element to define the stability of sustainable state.

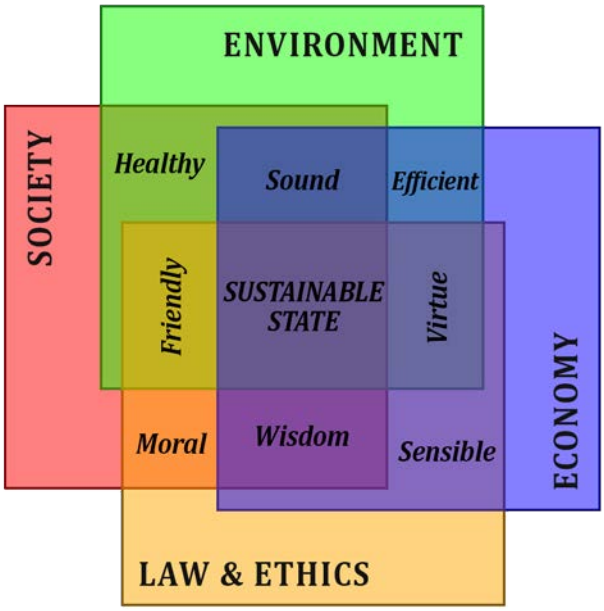

Figure 2: The Quadruple Bottom Line (QBL) concept

There are no arguments about the Healthy and Efficient states as presented in the TBL concept. Society having a good Environment is definitely healthy while a good environment with progressive economy is highly efficient for social development. A society can be defined as moral-society if the basic rules, regulations, and ethical base are strong. This also makes a society more acceptable and reliable by the inhabitants. Economy with ethics creates a sensible state which helps society to perceive rationally and intuitively through fair judgment.

The state of society intermingling with a good environment and strong morality is defined as friendly state. The state is basically unstable as society will lose its stability without economical robustness. Wisdom can be explained as the ability of reasoning through true understanding, knowledge, commonsense, insights, and experiences which is likely if economy and laws-ethics are firm for a Society. The worth of acting right and evading wrong is the virtue which can be recognized by accumulating economy and ethics with proper knowledge and understanding of environment. Society with good environment, and an efficient economy define a sound state. Above all, a society will be in the sustainable state if it is environmentally healthy, socially moral, economically efficient, and ethically sensible. So, how should the state or quality of life be defined? Are we in the Sustainable State? If not, what are the parameters need to be ensured to establish the state? The answers are far more clear now.

Ethics incorporates the actions that a responsible person must select, the values that a respected person must adopt, and the character that a righteous person must possess. In actual sense, every individual needs to be honest, kind, courteous, fair, trustworthy, and respectful. Engineers have further obligations because of their extended responsibilities of the professional job and interactions with employers, clients, consumers, professionals, and general public. Engineers and professionals have the special commitments as they have licenses to use their specialized knowledge and skills to enhance the values of life. Above other obligations, according to the engineering codes of ethics, engineers must hold the principal control for the safety, health, and welfare to general public. This obligation illuminates the public-commitments of other occupations, for example: ensuring public health by the medical professionals, and confirming justice by the legal professionals.

It is required to receive necessary guidance for the engineering societies in prioritizing the public benefits. If an engineer finds any risk to public as well as social safety, (s)he must report to the responsible authorities. If the issue is not handled or not possible to handle by the constitution, the engineer must blow the whistle.

Engineers provide solutions to practical problems in maximizing social values while diminishing environmental impacts. They face numerous challenges because of the adversarial effects of resource depletions, population jumps, environmental pollutions, ecosystem damages, and space contaminations. Engineering leadership and roles are also associated with multidisciplinary teams including non-engineers and cross-national boundaries in achieving sustainable state. Since a purely echo-friendly approach is largely unrealistic for the sustainable development, engineers need to take a broader approach comprising poverty mitigation, social justice, local connections, and global networks. Engineers must utilize valuable opportunities of globalization and promotes social enhancements through sharing experiences and knowledge.

Nowadays, sustainable development is the orthodox for global economic growth and environmental fortification. Environment is a complex interrelating-system of land, air, water, organic-inorganic matters, and living organisms. To promise a healthy environment which is the right for future generations requires collaboration among businesses organizations, government, and inhabitants. Balanced and coordinated approach will ensure health, wealth, and environmental integrity of a community. Individuals must save energy, choose echo-friendly products, and adjust their life style. Organizations need to improve environmental management strategies, reduce emissions and wastes, and

adopt environmentally responsible activities. Government has to take lead by imposing legislation; delivering various services; establishing public policies; participating in regional, national, and international activities; and organizing own operational duties. Engineers and scientists are obliged to safeguard the environment by formulating safe chemical substances, reusable products, and renewable energy resources to certify a quality life for us and future generations.

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AUTHOR BIOGRAPHY

Dr. M. Akhtaruzzaman is an Assistant Professor in the Dept. of Computer Science and Engineering, Military Institute of Science and Technology (MIST), Bangladesh. He is also associated with DREAM Robotics Ltd., Dhaka, Bangladesh as a Consultant and Research scientist. He was awarded the PhD and MSc. from IIUM, Malaysia, and the BSc. from IIUC, Bangladesh. He has published 50+ research articles and awarded several Gold Medals as the recognition of his research works. His field of interest includes robotics, mechatronics systems, control engineering, AI, fuzzy systems, and quantum computing.

ABOUT CSE, MIST

Computer Science and Engineering (CSE) Department started session in 2000-2001 as Computer Science and Information Technology (CSIT) under the Faculty of Electrical & Computer Engineering. From a modest beginning, offering undergraduate BSc program to only military students, the department has now evolved as one of the largest departments of MIST with both military and civilian students. The department of CSE now offers BSc program at the undergraduate level, MSc. and MEngg. at the postgraduate level, as well as PhD degree. The first batch of BSc graduates was awarded their degree in the year 2004. Since then, a total of over 981 students have graduated and the alumni are contributing immensely to the various industries, academia and Armed Forces of Bangladesh.

The department of CSE boasts of having highly qualified faculties, along with state-of-the-art learning infrastructure which provides an ideal platform for students to the perfection of their skills in the field of computer sciences. The faculties are drawn in from diverse nationalities, diverse prior professional exposure (military, industry and academia), diverse educational qualification and background, thus provide large areas of expertise for students to benefit. The department provides an ideal environment for the student to specialize in contemporary fields of computer science, namely artificial intelligence, robotics, machine learning, data analytics, network and data security etc. The department also collaborates with both the industry and government departments and agencies thereby establishing a symbiotic leadership for both stake holders which are especially beneficial for students.

The department of CSE provides a conducive learning environment for the students in the form of state-of-the-art classrooms and well-equipped laboratories. While the classrooms provide an opportunity to learn the technical aspect on the subject, the laboratories provide opportunity for the students to have an "hands on" experience on technology and thus innovate. The air-conditioned classrooms with broadband Wi-Fi, projection system, smart board, document readers are an ideal place for collaborative learning. In addition to the existing 08 laboratories, Artificial Intelligence (AI) Lab, Postgraduate Research Lab, Network Lab, and a Cyber-gym are being funded by the Department of ICT, Bangladesh. The Cyber-gym will provide an ideal platform for students to specialize in the field of cyber-attack and cyber defense. As the labs are well equipped with modern instruments and facilities, the department contributes not only in better practical education to the students but also in providing technical assistance and advice. Testing, evaluation, and consultancy to a real-life problem and practical situation aid faculty members and laboratory technicians to increase their professional knowledge and skills.

ISSN 2957-6857

CSE TECHNICAL PAPER
The MIST Journal of Computer Science and Engineering
Volume 01, June 2022