# DEVELOPEMNT OF AN IOT BASED IRRIGATION SYSTEM FOR ROOF-TOP FARMING

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**M. Engineering THESIS**

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**DHAKA, BANGLADESH**

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# DEVELOPMENT OF AN IOT-BASED IRRIGATION SYSTEM FOR ROOF-TOP FARMING

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A Project Submitted In Partial Fulfillment of the Degree of Master of Engineering in Computer Science and Engineering

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING
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M.ENGINEERING PROJECT
BY
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DEVELOPMENT OF AN IOT BASED IRRIGATION SYSTEM FOR ROOF-TOP FARMING

## DECLARATION

Declaration I hereby declare that this project is my original work and it has been written by me in its entirety. I have duly acknowledged all the sources of information which have been used in the project. The project (fully or partially) has not been submitted for any degree or diploma in any university or institute previously.

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Abdullah Al Razi

DEVELOPMENT OF AN IOT BASED IRRIGATION SYSTEM FOR ROOF-TOP FARMING

A Project

By

Abdullah Al Razi

# DEDICATION

Dedicated to my parents and wife for supporting and encourage me to believe in myself

# ABSTRACT

## Development of an IoT-Based Irrigation System for Roof-Top Farming

Urban gardening, especially rooftop farming, has become increasingly popular due to the limited space available in cities. However, rooftop farmers face the challenge of providing adequate water to their plants. To address this issue, an automatic watering system has been developed, utilizing soil moisture and air temperature sensors to improve crop quality and yield. The system comprises a wireless module, water tank, motor, soil moisture sensor, temperature sensor, and a Blynk app for remote control. The use of smart irrigation systems enables farmers to monitor soil conditions in real-time, simplifying and improving the productivity of rooftop farming. The system is designed to be affordable, making it a viable option for small-scale farmers. The automated irrigation system offers a solution to the problem of effectively watering plants in rooftop farming. It not only simplifies irrigation, but it also reduces costs and increases accessibility to rooftop farming. With the Blynk app, farmers can easily monitor and adjust soil moisture levels and temperature, ensuring optimal plant growth and reducing water wastage. This system can able to give water anytime from blynk application. Overall, the automatic watering system provides an efficient and effective solution to the challenges of rooftop farming. With the ability to monitor soil conditions and adjust watering levels remotely, this technology makes urban farming more accessible and economical. As more individuals become interested in urban gardening, the automated irrigation system offers a promising solution for sustainable and productive rooftop farming.

সারসংক্ষেপ

# Development of an IoT-Based Irrigation System for Roof-Top Farming

শহুরে বাগান করা, বিশেষ করে ছাদে চাষ, শহরগুলিতে সীমিত জায়গার কারণে ক্রমশ জনপ্রিয় হয়ে উঠেছে। যাইহোক, ছাদের কৃষকরা তাদের গাছগুলিতে পর্যাপ্ত জল সরবরাহ করার চ্যালেঞ্জের (challenge) মুখোমুখি হন। এই সমস্যাটি মোকাবেলা করার জন্য, ফসলের গুণমান এবং ফলন উন্নত করতে মাটির আর্দ্রতা এবং বায়ু তাপমাত্রা সেন্সর (sensor) ব্যবহার করে একটি স্বয়ংক্রিয় জল দেওয়ার ব্যবস্থা তৈরি করা হয়েছে। সিস্টেমটিতে (system) একটি বেতার মডিউল (wireless module), জলের ট্যাঙ্ক (tank), মোটর (motor), মাটির আর্দ্রতা সেন্সর (humidity sensor), তাপমাত্রা সেন্সর এবং রিমোট কন্ট্রোলের (remote control) জন্য একটি Blynk অ্যাপ (application) রয়েছে। উন্নত সেচ ব্যবস্থার ব্যবহার কৃষকদের প্রকৃত সময় মাটির অবস্থা নিরীক্ষণ করতে সক্ষম করে, ছাদে চাষের উৎপাদনশীলতাকে সরল ও উন্নত করে। সিস্টেমটি (system) সাশ্রয়ী মূল্যের জন্য ডিজাইন (design) করা হয়েছে, এটি ছোট-বড় কৃষকদের জন্য একটি কার্যকর বিকল্প হিসাবে তৈরি করেছে। স্বয়ংক্রিয় সেচ ব্যবস্থা ছাদ চাষে কার্যকরভাবে গাছপালা জল দেওয়ার সমস্যার সমাধান দেয়। এটি কেবল সেচকে সহজ করে না, এটি খরচও কমায় এবং ছাদে চাষের অ্যাক্সেসযোগ্যতা (accessibility) বাড়ায়। Blynk অ্যাপের সাহায্যে, কৃষকরা সহজেই মাটির আর্দ্রতার মাত্রা এবং তাপমাত্রা নিরীক্ষণ এবং সামঞ্জস্য করতে পারে, উদ্ভিদের সর্বোত্তম বৃদ্ধি নিশ্চিত করে এবং পানির অপচয় কমাতে পারে। এই সিস্টেম (system) ব্লিঙ্ক অ্যাপ্লিকেশন (blynk application) থেকে যে কোনও সময় জল দিতে সক্ষম। সামগ্রিকভাবে, স্বয়ংক্রিয় জল সরবরাহ ব্যবস্থা ছাদে চাষের চ্যালেঞ্জগুলির একটি দক্ষ এবং কার্যকর সমাধান প্রদান করে। মাটির অবস্থা নিরীক্ষণ এবং দূরবর্তীভাবে জলের মাত্রা সামঞ্জস্য করার ক্ষমতা সহ, এই প্রযুক্তিটি শহুরে চাষকে আরও সহজলভ্য এবং অর্থনৈতিক করে তোলে। যত বেশি মানুষ শহুরে বাগানে আগ্রহী হয়ে ওঠে, স্বয়ংক্রিয় সেচ ব্যবস্থা টেকসই এবং উৎপাদনশীল ছাদে চাষের জন্য একটি প্রতিশ্রুতিশীল সমাধান দেয়।

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# CHAPTER 1
# INTRODUCTION

Roof-top farming is becoming increasingly popular in urban areas, but they come with their own unique challenges. Rooftop farming is the practice of growing plants and crops on the rooftops of buildings. It is a sustainable agricultural method that utilizes unused urban spaces to produce fresh, locally-grown food. Rooftop farming can provide numerous benefits such as reducing the carbon footprint of food production, improving air quality, and enhancing urban biodiversity. One of the biggest challenges is ensuring that plants receive adequate water, which can be difficult to achieve when people forget to water them regularly or have to assess soil conditions manually. However, the rise of smart technology has led to the development of IOT based irrigation systems that can help to automate this process. An IOT based irrigation system utilizes sensors, weather data, and algorithms to remotely monitor soil moisture levels and automatically adjust watering as needed. This system can even be customized to meet the specific needs of individual plants, ensuring optimal growth and health. Additionally, monitoring the water level of the tank can help to ensure water availability to irrigate. Not only does this system offer a more efficient and sustainable solution for rooftop farming, but it also helps to conserve water. By using only the amount of water necessary for optimal plant growth, an IOT based irrigation system can reduce waste and contribute to a more eco-friendly urban environment. Overall, an IOT based irrigation system is a smart and practical solution for anyone seeking to enhance their rooftop farming's health and productivity.

The system overview displayed in Figure 1.1 involves the use of a soil moisture sensor, water level sensor, Arduino Mega, and an ESP8266 NodeMCU. The DHT11 sensor is connected with the NodeMCU, while the other sensors are connected to the Arduino. The system sends data to the Blynk cloud server, which users can access through both a mobile application and web version. The sensors' data are analyzed, and once a threshold value is crossed, the motor driver and water pump are enabled to provide water to the plant. Users also have the option of running the motor pump anytime.

This system provides an efficient way to monitor and regulate the moisture levels of plants.

It allows users to remotely access the plant's condition and water it when necessary, preventing under or over-watering. The inclusion of the Blynk cloud enhances the accessibility and convenience of the system, as users can monitor their plants on-the-go.

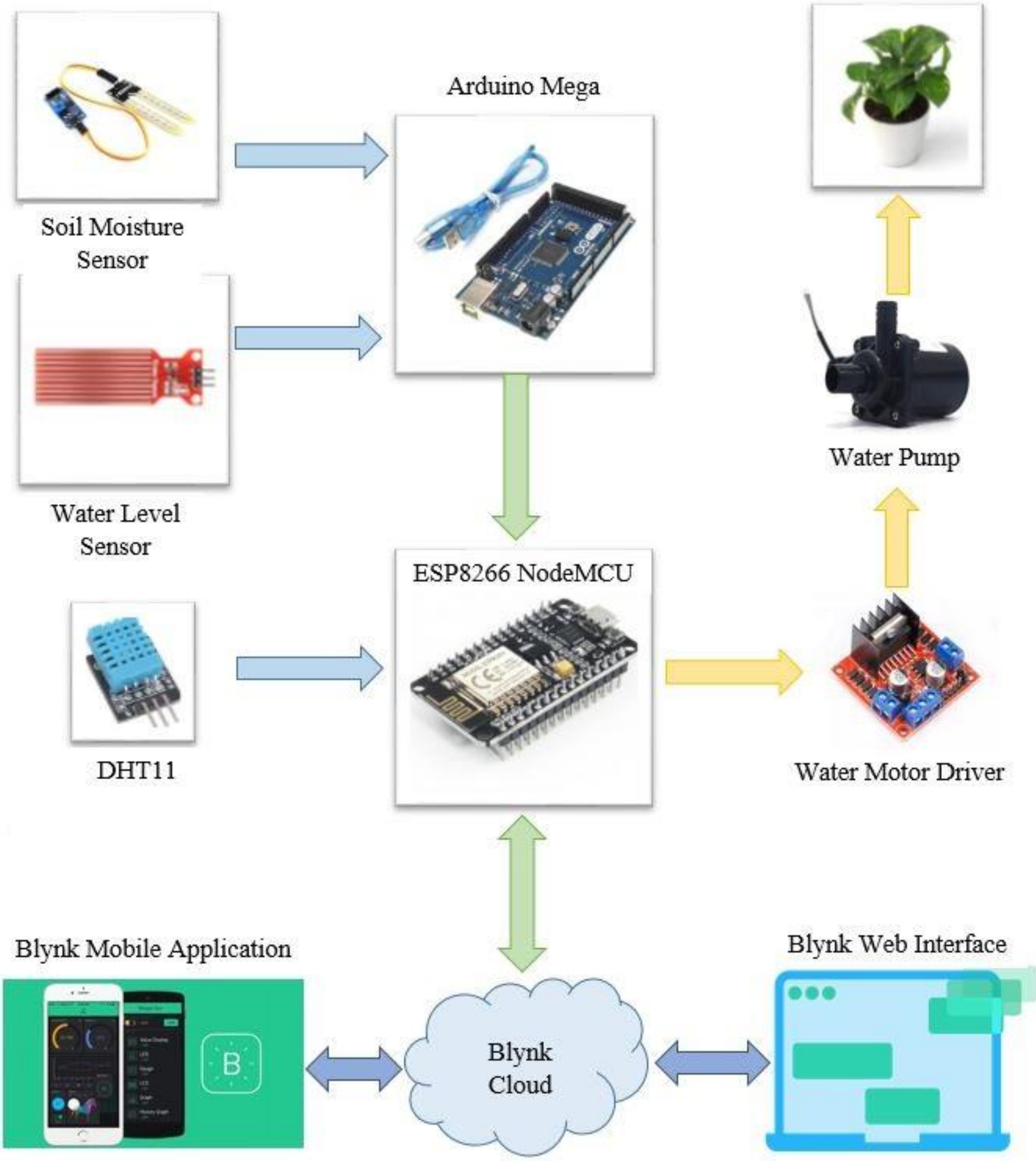


Figure 1.1: IOT Based Automated Irrigation System Overview

Overall, this system is an effective solution to improve plant growth and health while minimizing the need for manual intervention.

## 1.1 Motivation

Irrigation is an essential process for plant growth, but traditional irrigation systems can be inefficient and wasteful. In recent years, the development of IOT technology has opened up new possibilities for more precise and efficient irrigation systems. An IOT-based irrigation system is a type of smart agriculture system that uses sensors and other IOT devices to collect data on soil conditions and adjust the amount of water provided to plants accordingly.

One of the key benefits of an IOT-based irrigation system is that it can monitor soil conditions in real-time, providing farmers with accurate and up-to-date information about the moisture level, temperature, and humidity of the soil. With this information, farmers can make informed decisions about when and how much to water their plants. This is particularly important in rooftop farming, where space is limited and water resources are scarce. By optimizing water usage, an IOT-based irrigation system can help to reduce water waste and ensure that plants receive the right amount of water, promoting healthy growth and higher yields.

Another advantage of an IOT-based irrigation system is that it can be controlled remotely using a smartphone app or web interface. This means that farmers can monitor their crops and make adjustments to the irrigation schedule from anywhere, at any time. This is especially useful for busy farmers who may not have the time to physically check on their plants on a regular basis. With an IOT-based irrigation system, they can easily monitor their crops and ensure that they receive the care they need to thrive.

In addition to soil sensors, an IOT-based irrigation system may also include other types of sensors, such as weather sensors, to provide additional data on environmental conditions that may affect plant growth. For example, if the temperature is too high, the system may automatically adjust the watering schedule to prevent the plants from becoming stressed.

Overall, an IOT-based irrigation system is an innovative and effective solution for managing rooftop farms. By using sensors to monitor soil conditions and remotely controlling watering, farmers can optimize water usage and promote healthy plant growth. As technology continues to evolve, we can expect to see even more advanced IOT-based irrigation systems that further improve efficiency and sustainability in agriculture.

## 1.2 Statement of the Problem

Urban regions have seen a rise in the popularity of roof-top farming as a means of producing fresh, organic food while effectively utilizing available space. However, this form of agriculture presents a significant challenge in ensuring that plants receive adequate amounts of water. The lack of rainfall, combined with the difficulties of accessing the roof-top location, can result in a serious watering deficit that can lead to plant death.

To address this problem, smart irrigation systems based on the Internet of Things (IOT) technology have emerged as a promising solution. These systems utilize sensors, weather data, and sophisticated algorithms to automatically monitor soil moisture levels and adjust watering accordingly. Some systems can even detect the specific needs of individual plants, providing targeted watering to ensure optimal growth.

In addition to promoting healthy plant growth, smart IOT-based irrigation systems offer a range of other benefits for urban agriculture. For example, they can conserve water by minimizing over-watering and reducing runoff, which can be especially important in areas with limited water resources. Furthermore, these systems can be remotely monitored and controlled, making it easier for urban farmers to manage their crops and ensure their success. Overall, smart IOT-based irrigation systems are an important tool for promoting sustainable, efficient, and successful roof-top farming in urban areas.

## 1.3 Objectives

i. To develop an IOT-Based automated irrigation system for roof-top farming which can be controlled & monitored remotely
ii. To develop a system hardware which connected with cloud server
iii. To develop a system which can be monitored and operated the developed system from mobile application and web interface

## 1.4 Organization of the book

The rest is organized in the following order:

Chapter 2 describes literature review and related works on IOT based irrigation system.

Chapter 3 includes system architecture of the whole system by how this system designed.

Chapter 4 depicts methodology and implementation of the system by which way it is working.

Chapter 5 demonstrates the results of the system and evaluation of the project how effectively it works.

Chapter 6 presents the project is concluded and future directions for this project are provided.

# CHAPTER 2
# THEORITICAL BACKGROUND

## 2.1 Concept of Roof-Top Farming

IoT based rooftop farming is a revolutionary concept that aims to bring agriculture to the urban areas, where the population density is high, and the availability of land is limited. The idea is to create an ecosystem that integrates technology, agriculture, and urban living. In this concept, the rooftop of the buildings is transformed into a farm, where plants are grown using IoT-based sensors and automation.

IoT-based rooftop farming involves the use of sensors, automation, and data analysis to optimize the growth of crops. Sensors are used to monitor the environment, including temperature, humidity, light, and soil moisture, and feed the data to the central system. The central system processes the data and provides feedback to the actuators that control the environmental factors. This way, the system ensures that the crops receive the optimal conditions for growth.

One of the biggest advantages of IoT-based rooftop farming is that it allows for precise control over the environment. With the help of sensors and automation, the system can adjust the temperature, humidity, and light intensity to create the perfect conditions for the crops. This results in faster growth, higher yields, and better quality produce. Additionally, the system can also detect anomalies in the environment, such as pest infestations or disease outbreaks, and take preventive measures to protect the crops.

IoT-based rooftop farming is also a sustainable and eco-friendly solution to urban agriculture. By utilizing the rooftops of buildings, the system reduces the need for land, which is a scarce resource in urban areas. It also reduces the carbon footprint of the food supply chain, as the produce is grown locally, eliminating the need for transportation. Moreover, the system can also use organic and sustainable farming practices, such as composting and integrated pest management, to further reduce the environmental impact.

The concept of IoT-based rooftop farming has the potential to revolutionize the food industry by bringing fresh, healthy, and locally grown produce to urban areas. It can also create new opportunities for entrepreneurship and job creation, as urban farmers can grow and sell their produce directly to the consumers. This can lead to a more sustainable and resilient food system, which can withstand shocks such as pandemics, climate change, or economic crises. In conclusion, IoT-based rooftop farming is a revolutionary concept that combines technology, agriculture, and urban living. By utilizing sensors, automation, and data analysis, the system creates the perfect conditions for the crops to grow, resulting in faster growth, higher yields, and better quality produce. Additionally, the system is sustainable and eco-friendly, reducing the carbon footprint of the food supply chain and promoting organic and sustainable farming practices. This concept has the potential to transform the food industry.

## 2.2 Related Works

Several projects have been conducted on IoT-based irrigation systems with the aim of optimizing the irrigation process and reducing the need for manpower. A group of researchers proposed an IoT-based irrigation system mentioned in figure 2.1 that uses threshold values for soil moisture and humidity to automate the irrigation process. The system utilizes sensors to monitor soil moisture and humidity levels, and automatically triggers irrigation when the values fall below a certain threshold. This system reduces the need for manual intervention and ensures that the crops receive the optimal amount of water, leading to improved yields and reduced water wastage Mishra, Khan, et al., 2018.

A group of researchers have proposed a soil moisture monitoring system that is controlled through SMS. If the moisture level falls below a certain threshold, the system will automatically send an SMS alert to the homeowner to turn on the motor. The homeowner can then send a command to turn on the motor and the system will start filling the tank. Once the tank is full, the system will send another SMS to inform the homeowner about the status and the homeowner can send another SMS to turn off the motor. Additionally, the system will also send alerts to the homeowner during rain to prevent unnecessary watering. Overall, this system offers an efficient way to monitor and control irrigation systems remotely through SMS alerts Yasin, Zeebaree and Zebari (2019).

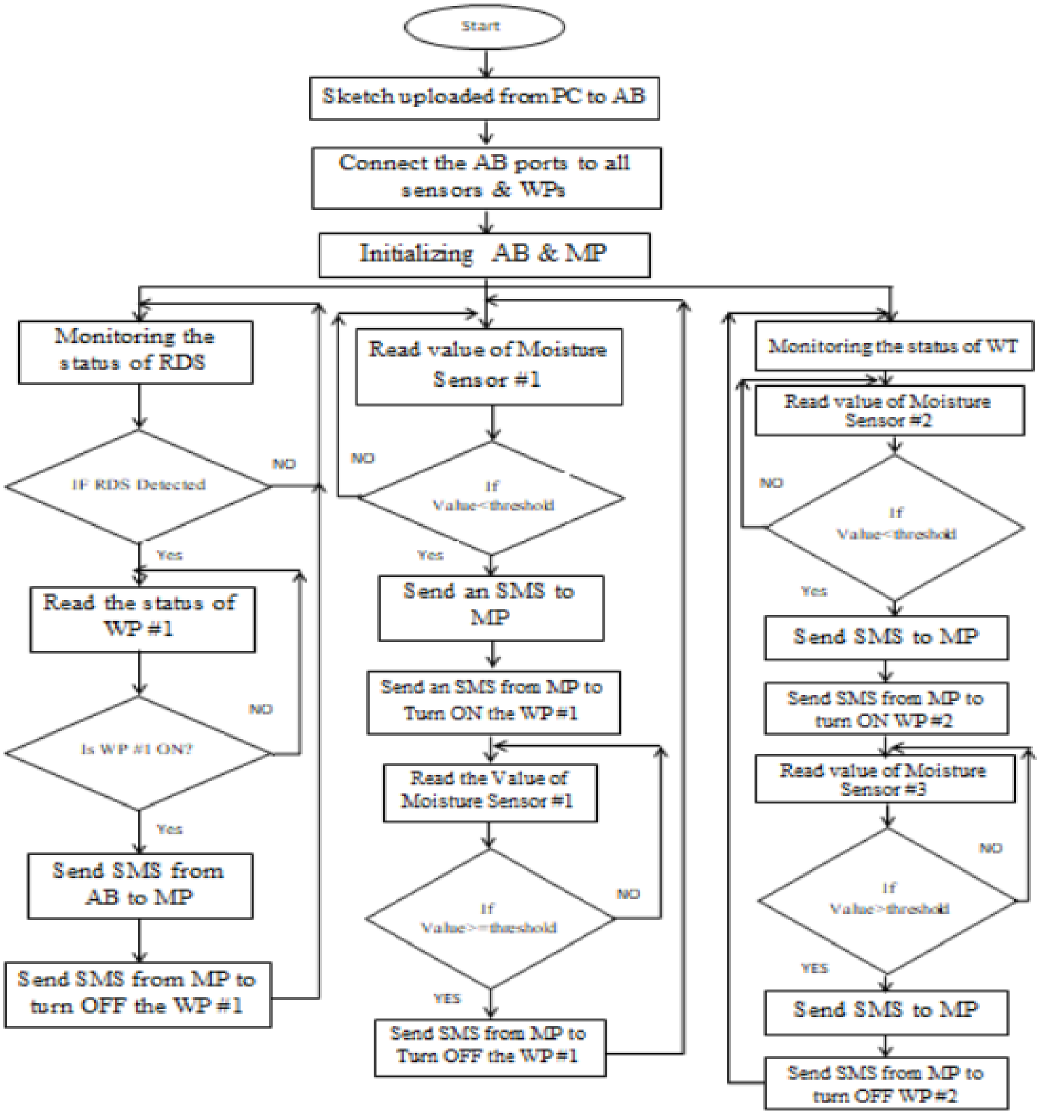


Figure 2.1: Proposed diagram of Arduino and SMS Controlled Irrigation System (Mishra et al.,2018)

The proposed system measures ambient temperature, humidity, soil moisture, and tank water level to assist users in improving the quality and quantity of their agricultural output. By providing this data from the field, the system enables users to make informed decisions regarding irrigation and crop management Saraf and Gawali, 2017. In figure 2.2, the system uses Zigbee for communication and a web-based interface to display data collected from the field, including ambient temperature, humidity, soil moisture, and tank water level. This enables users to remotely access and monitor real-time information to make informed decisions about irrigation and crop management Vaishali et al., 2017.

The proposed diagram is given below –

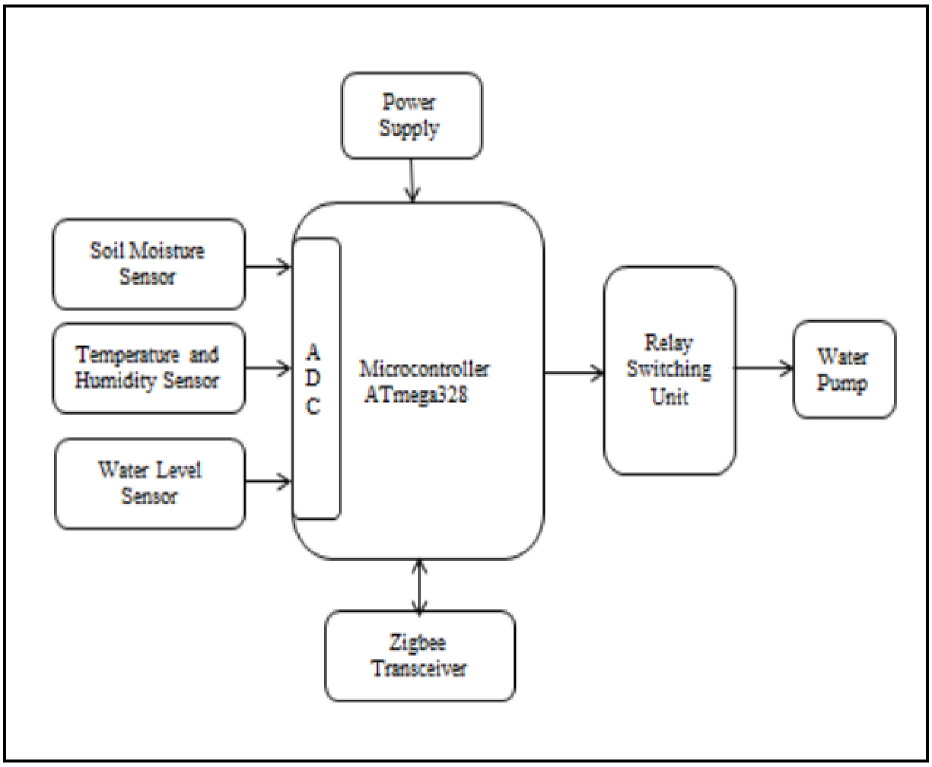


Figure 2.2: Block diagram for wireless sensor node using Zigbee (Vaishali et al., 2017)

IOT-based mobile integrated and intelligent irrigation system with a monitored system operated by an application. The main objective of this project is to utilize a smartphone to remotely monitor and regulate the water supply for plants, utilizing Raspberry Pi as the underlying technology. This enables users to easily control and automate the irrigation system from anywhere with their smartphone, ensuring optimal water supply for their plants Vaishali el at., 2017.

The proposed system uses a combination of moisture, pH, and temperature sensors to measure the soil's moisture content, pH level, and temperature. If the moisture level falls below the threshold level, irrigation is triggered as required. The moisture sensor sends a signal to the Arduino board, which then notifies the user through an IoT platform, in this case, the Thinger.io web platform. By utilizing this system, users can monitor and control irrigation remotely, ensuring that their plants receive the optimal level of moisture and nutrients to thrive. Additionally, the pH and temperature sensors enable users to ensure that the soil is healthy and conducive to plant growth Thakare and Bhagat, 2018.

The block diagram is given below –

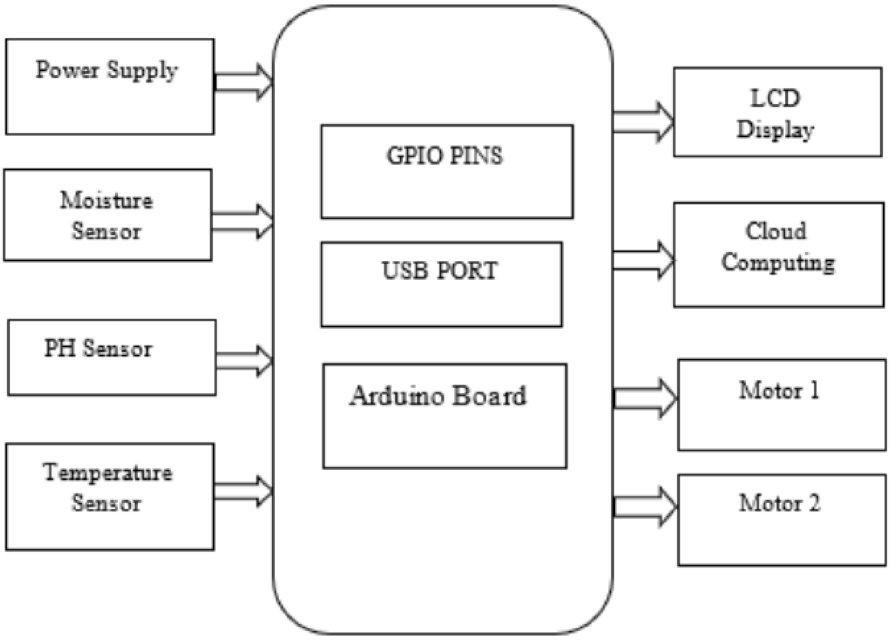


Figure 2.3: Block diagram of Arduino-Based Smart Irrigation Using Sensors and ESP8266 WiFi Module (Thakare and Bhagat, 2018)

The system design addresses various environmental factors such as moisture by utilizing sensors such as water flow sensors, temperature sensors, and soil moisture sensors. Additionally, the system shows in figure 2.3 considers the crop's requirements for water and temperature by incorporating humidity sensors. The Arduino board collects and receives data from the sensors, which can be connected to an interactive webpage that displays current and average values of various crop-related factors. This feature allows users to operate irrigation pumps and sprinklers remotely, maintaining the required standards and helping farmers produce high-quality crops. The system's ability to monitor and control irrigation remotely ensures that crops receive the optimal amount of water, reducing waste and increasing yield. Overall, this system provides an effective solution for managing irrigation and crop growth, enabling farmers to produce more abundant and higher-quality crops Singh and Saikia 2016. The primary aim of the study is to provide an automated irrigation system that can save farmers time, money, and electricity. The current methods of farmland irrigation are labour-intensive and require human intervention. The proposed system uses automated irrigation equipment that can detect changes in the environment's temperature and humidity using sensors. Whenever there is a change in these parameters, an interrupt signal is sent to the micro-controller, which triggers the irrigation process. By eliminating the need for physical labour and providing an automated solution, the proposed system can help farmers save resources and improve the efficiency of their irrigation processes Bhoi el at., 2021.

Another system is designed to calculate the optimal amount of water required for irrigation based on data provided by two sensors. These sensors measure the soil's temperature, humidity, and length of sunshine each day and send this information to the base station. The system then analyzes this data to determine the precise amount of water needed for irrigation, which can help optimize crop production while reducing the use of water and fertilizers. One of the main advantages of this system is its integration of Precision Agriculture (PA) with cloud computing. This enables farmers to make more informed decisions about how to manage their crops by providing real-time information on soil conditions and weather patterns. Additionally, the system can help farmers save time and resources by automating the irrigation process and eliminating the need for manual monitoring. By incorporating PA and cloud computing, farmers can make more informed decisions about how to manage their crops Bhawarkar el at., 2016.

While there are numerous papers proposing irrigation systems with an IoT platform, many of them include additional features that are not necessarily essential to the system's functionality. While it is important to consider different features that can enhance the system, the focus should remain on creating a user-friendly and easily accessible system.

Factors such as cost, store area, and portability are also crucial considerations when designing an IoT-based irrigation system. The cost of the system should be affordable and reasonable for potential users, as this can affect its widespread adoption. The system should also be designed in a way that minimizes the need for additional storage space, as it may not always be available in certain settings.

Furthermore, the system in figure 2.4 should be portable and easily moved to different locations as necessary. This can be particularly important for agricultural settings where different crops may require different levels of irrigation. By designing a system in figure 2.4 that can be easily moved and reconfigured, users can maximize the system's efficiency and effectiveness.

The system flow chart is given below –

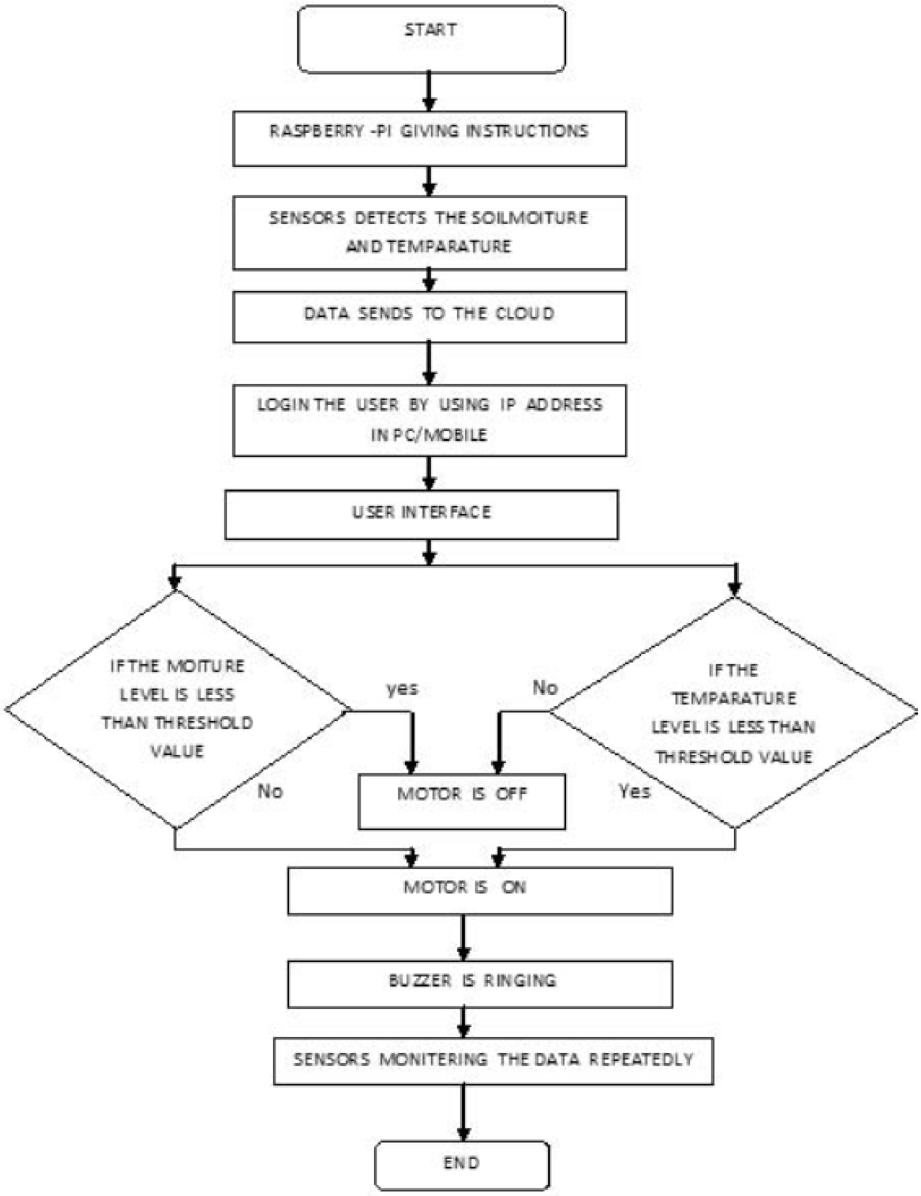


Figure 2.4: Data processing and decision making flowchart of IOT based smart crop-field monitoring and automation irrigation system (Bhawarkar el at., 2016)

There are some gaps in other projects. The comparison between other projects and this proposed project are given below-

1. Blynk application is easy to use whereas other proposed project is very complicated to use.
2. Other projects use many sensors where some sensors are not necessary, so it is not cost

effective.

3. User interface is difficult to understand, so that people have to face difficulties to operate the projects.
4. Many features introduced in many projects but most of them are not usable.
5. Some projects are not moveable, accessible and cannot monitor in real time.
6. Some projects use SMS integrated only, so that each time people have to pay for each SMS which is not cost effective.

In conclusion, while additional features can enhance an IoT-based irrigation system, it is crucial to prioritize creating a user-friendly and accessible system. This involves considering factors such as cost, storage space, and portability, as these can significantly impact the system's adoption and effectiveness.

## 2.3 Background Study

The rise of urbanization and population growth has resulted in a limited availability of land for farming. This has led to the emergence of rooftop farming as a sustainable solution to increase agricultural production. However, rooftop farming faces challenges in terms of irrigation management due to the lack of access to a constant water supply and difficulties in monitoring and controlling irrigation manually. An IoT-based irrigation system can provide an efficient solution by enabling remote monitoring and control of irrigation based on real-time data collected from sensors. Such a system can ensure the optimal use of water resources, resulting in increased yield and sustainability of rooftop farming.

### 2.3.1 Microcontroller

Two micro controllers are utilized in this project shown in figure 2.5. These are ESP8266 NodeMCU and Arduino Mega. A microcontroller board based on the ATmega2560 is called the Arduino Mega 2560. It contains 16 analog inputs, 4 hardware serial ports (UARTs), a 16 MHz crystal oscillator, 54 digital input/output pins (of which 15 may be used as PWM outputs), a USB connector, a power jack, an ICSP header, and a reset button.

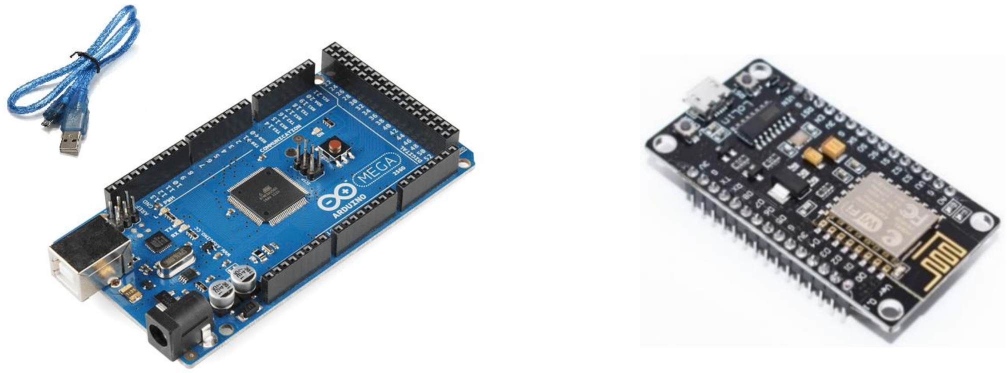

Figure 2.5: Arduino Mega (left) and ESP8266 NodeMCU (right)

NodeMCU is a development board and open-source Lua-based firmware that is specifically designed for Internet of Things (IoT) applications. Hardware based on the ESP-12 module and firmware that utilizes Espressif Systems' ESP8266 Wi-Fi SoC are also included.
NodeMCU is utilized for transferring the sensor value to the software in this project. Arduino Mega is also used to manage some sensors, as there are many sensors involved.

### 2.3.2 Sensors

There are several sensors are used to detect the soil condition and water level of tank. The list of sensors are given below-

1. Soil moisture sensor
2. DHT11 (Temperature & Humidity sensor)
3. Water level sensor

These sensors are used in various applications such as irrigation systems, agricultural monitoring, and water management systems.
Figure 2.6 shows the sensors where the soil moisture sensor can provide information about the water content in the soil, which can be used to optimize watering schedules and reduce water waste.

The temperature and humidity sensor is a useful tool in monitoring environmental conditions for crop management. It provides real-time temperature and humidity readings of the surrounding area, which can aid in decision-making for crop management.

Figure 2.6: Soil Moisture Sensor (left) & DHT11 (right)

This sensor is particularly helpful for farmers and agricultural managers in ensuring optimal conditions for plant growth and preventing potential issues that may arise due to unfavourable environmental conditions.

Figure 2.7: Water level sensor

The water level sensor shown in figure 2.7 which is a useful tool for monitoring the water levels in tanks, reservoirs, or other water storage systems. By keeping track of water levels, this sensor can help manage water usage and prevent overflows or shortages, which can be crucial in water management systems.

### 2.3.3 Other Components

There are some other components are used to irrigate the soil. 12V 8W DC water pump is used with water motor driver L298N to supply the water. The 12V 8W DC water pump is a small and efficient device that can be used for a variety of applications, such as water circulation in aquariums, hydroponic systems, and small fountains. It operates on a low voltage and consumes minimal power, making it ideal for use in low-power setups.

Figure 2.8: 12V 8W DC Water Pump

In figure 2.8, the L298N motor driver is a popular integrated circuit used to control the direction and speed of DC motors and stepper motors. It consists of two H-bridges, each capable of driving a motor with up to 2A of current and 46V of voltage. The L298N is commonly used in various applications, including robotics, CNC machines, and electric vehicles. It offers bidirectional control of motors, which means it can move them forward and backward.

Figure 2.9: Water Motor Driver L298N

Overall, the L298N motor driver in figure 2.9 is a reliable and versatile component that can be used in various projects that require precise motor control.

### 2.3.4 Software Component

The Arduino Integrated Development Environment, or Arduino IDE, is a software used for programming microcontrollers. It provides an easy-to-use platform for writing and uploading code to an Arduino board. The IDE uses the Arduino programming language, which is based on C++ and is designed to be simple and user-friendly. The language includes a set of libraries that simplify the programming process and allow users to easily interact with hardware components such as sensors and actuators. The IDE also includes a code editor with syntax highlighting and automatic formatting, making it easier to write and debug code. Once the code is written, the IDE compiles it into machine language and uploads it to the microcontroller via a USB cable. Overall, the Arduino IDE is an essential tool for anyone looking to create their own custom electronics projects.

The IoT-based irrigation system can be monitored and controlled using mobile and web applications such as the Blynk application. The Blynk app offers a user-friendly interface that enables users to remotely monitor soil conditions and adjust watering schedules for their plants and crops. With real-time data available on the app, users can manage their irrigation systems from anywhere, even if they are not physically present. The app's features allow users to easily control the system and view data on the go, making it a popular choice for IoT-based irrigation systems. The convenience and accessibility provided by the Blynk app make it an effective tool for farmers and gardeners to keep their plants healthy and thriving.

## 2.4 Blynk

Blynk is a versatile mobile and web-based application that allows users to control and monitor IoT-based devices from anywhere in the world. Blynk Server is a powerful tool for creating IoT applications using various hardware platforms. It allows users to connect their devices to the cloud and control them remotely through a mobile app. Blynk Server provides a stable, reliable and secure connection for IoT devices, ensuring that data is transmitted safely and efficiently.

Blynk Server can be installed on a local computer or a cloud server, allowing users to manage their IoT projects remotely. With Blynk Server, users can create custom user interfaces for their IoT devices and control them using a mobile app. The mobile app provides an intuitive interface for controlling devices, displaying real-time data, and configuring device settings. Blynk Server provides a range of features, including support for multiple hardware platforms, real-time data visualization, push notifications, and cloud connectivity. It supports popular hardware platforms such as Arduino, Raspberry Pi, ESP8266, and others. Blynk Server also supports a wide range of sensors and actuators, enabling users to create complex IoT applications.

| Id | Name | Alias | Color | Pin | Data Type |
|---|---|---|---|---|---|
| 1 | **Soil Moisture** | Soil Moisture | | V5 | Integer |
| 3 | **s** | s | | V2 | Integer |
| 4 | **Button** | Button | | V0 | Integer |
| 5 | **Temperature** | Temperature | | V4 | Integer |
| 6 | **Humidity** | Humidity | | V7 | Integer |
| 7 | **water level** | water level | | V6 | Integer |

Figure 2.10: Blynk server pin configuration page

In addition to its powerful features, Blynk Server also provides advanced security features to protect user data. It uses SSL encryption to secure all data transmissions, and users can set up their own SSL certificates for added security. Figure 2.10 shows the pin configuration page. The Blynk Server also supports two-factor authentication, ensuring that only authorized users can access IoT devices. With Blynk, users can create custom dashboards with widgets that display real-time data from the connected devices. The application also allows users to set up notifications for specific events, such as when the soil moisture level falls below a certain threshold.

Blynk's drag-and-drop interface makes it easy for users to create custom dashboards without any programming knowledge. The application's cloud connectivity enables remote access to the connected devices, and its third-party integrations allow for compatibility with a wide range of IoT devices.

Blynk is a powerful and user-friendly mobile and web-based application that is an excellent choice for IoT-based projects in agriculture, home automation, robotics, and other fields. With its easy-to-use interface and powerful features, it is an essential tool for anyone looking to remotely monitor and control their devices.

Overall, Blynk Server is an excellent tool for creating IoT applications, offering a powerful set of features and advanced security options. It provides a stable and reliable connection for IoT devices, making it an ideal choice for developers and hobbyists looking to create innovative IoT applications.

Blynk's web version is another useful tool for displaying real-time data from IoT-based devices, such as an automated irrigation system. Just like the mobile version, the web version provides an easy-to-use interface for monitoring and controlling connected devices. It has similar options as the mobile version, allowing users to create custom dashboards, set up notifications, and control devices remotely.

With Blynk's web version, users can easily view the values of the moisture, temperature, and humidity sensors in real-time, without the need for a mobile device. The web version also allows for more screen, making it easier to view multiple widgets and devices at once.

Another advantage of Blynk's web version is that it can be accessed from any web-enabled device, such as a laptop or desktop computer. This makes it a versatile tool for managing IoT-based projects, particularly for those who prefer working on a larger screen or need to access the application from a device that cannot run the mobile version.

Another advantage of Blynk's web version is its compatibility with various hardware platforms, including Arduino, Raspberry Pi, and ESP8266. This versatility allows users to connect and control a wide range of devices and sensors.

In addition, Blynk's web version has a strong community of developers and users who actively contribute to the platform. This community provides support, resources, and inspiration for users to create innovative projects and share their ideas with others.

Overall, Blynk's web version is an excellent choice for beginners and experienced users who want to create their own IoT projects. Its intuitive interface, compatibility with various hardware platforms, and active community make it a standout option compared to other web versions.

In conclusion, Blynk's web version is a useful tool for monitoring and controlling IoT-based devices, such as an automated irrigation system, from any web-enabled device. Its user-friendly interface and real-time data display make it a valuable addition to any IoT-based project.

In summary, many research studies have been conducted on IoT based irrigation systems, introducing various features. However, some of these features are not necessary to optimize the system. This project aims to bridge the gap by presenting only the necessary features to users. The project minimizes unnecessary features and focuses on optimizing the system. Several sensors are utilized in this project to improve the irrigation system. The soil moisture sensor helps to monitor the moisture content in the soil, ensuring that plants receive the right amount of water. The temperature and humidity sensors provide data on the surrounding environment, enabling users to make informed decisions about irrigation. Blynk server and application are used in this project as they offer a clean and user-friendly system. The system can be easily operated from both mobile and web interfaces. Blynk allows users to create customized user interfaces for their IoT devices and control them using a mobile app. This feature provides an intuitive interface for controlling devices, displaying real-time data, and configuring device settings. Overall, this project minimizes unnecessary features and presents the necessary features to users. Utilizing sensors such as the soil moisture, temperature, and humidity sensors, and utilizing the Blynk server and application, allows for a more efficient and optimized irrigation system.

# CHAPTER 3
# SYSTEM DESIGN

## 3.1 Hardware Component

Hardware components play an important role in project work, particularly in electronics and engineering projects. These components can include sensors, microcontrollers, circuits, power sources, and various other electronic devices. The hardware components in a project must be carefully chosen based on the project requirements and specifications. The selection process involves considering factors such as cost, reliability, functionality, and compatibility with other components. Proper installation and integration of hardware components is also critical to the success of a project. With the right selection and integration of hardware components, a project can be completed efficiently, accurately, and with desired outcomes.

## 3.2 Design

The system architecture of a hardware project typically involves the design and integration of various hardware components to achieve a specific goal. This may include selecting appropriate sensors, actuators, and microcontrollers, as well as designing custom circuit boards or enclosures to house the hardware.

An IoT based irrigation system for rooftop farming typically consists of several components that work together to create a reliable and efficient irrigation system.

The first component is the soil moisture sensor, which helps to monitor the moisture content in the soil. The sensor can be placed at different depths in the soil, depending on the depth of the roots of the plants. The data collected from the soil moisture sensor is transmitted to the microcontroller for analysis.

The microcontroller is the brain of the system, and it is responsible for controlling the irrigation system based on the data received from the sensors. The microcontroller can be programmed to turn on the water pump when the soil moisture level drops below a certain threshold.

Temperature and humidity sensors are essential components of an IoT-based irrigation system. In figure 3.1, these sensors provide important data on the surrounding environment, enabling users to make informed decisions about irrigation. Temperature sensors can detect changes in temperature and can be used to turn on or off the irrigation system, while humidity sensors can monitor the moisture content in the air, providing valuable information for maintaining a healthy growing environment.


Figure 3.1: Hardware components of IoT based irrigation system

The water pump is another important component of the system. It pumps water from a water storage tank to the irrigation system. The pump can be controlled by the microcontroller, which ensures that the right amount of water is delivered to the plants.

To ensure that the system is reliable and efficient, it is important to have a stable internet connection. This allows the system to be monitored and controlled remotely. A Blynk server and application can be used to monitor and control the irrigation system from a mobile phone or a computer.

The motor driver and water pump are crucial components of an IoT-based irrigation system. The motor driver controls the water pump and ensures that the right amount of water is delivered to the plants. The water pump can be turned on or off by the microcontroller based on the data received from the sensors. The motor driver helps to regulate the flow of water to ensure that the plants receive the right amount of water for optimal growth.

Overall, an IoT based irrigation system for rooftop farming should include a soil moisture sensor, microcontroller, water pump, irrigation system, and stable internet connection. These components work together to create a reliable and efficient irrigation system that ensures that plants receive the right amount of water.

## 3.3 Block Diagram

An IoT-based irrigation system typically consists of sensors, microcontroller, wireless moduler, a water pump, and a Blynk server/application. In figure 3.2, the sensors collect data on the environment, which is analysed by the microcontroller to control the water pump and irrigation system. The Blynk server/application allows for remote monitoring and control of the system. Wifi moduler helps to pass the data to blynk server. The block diagram is given below-

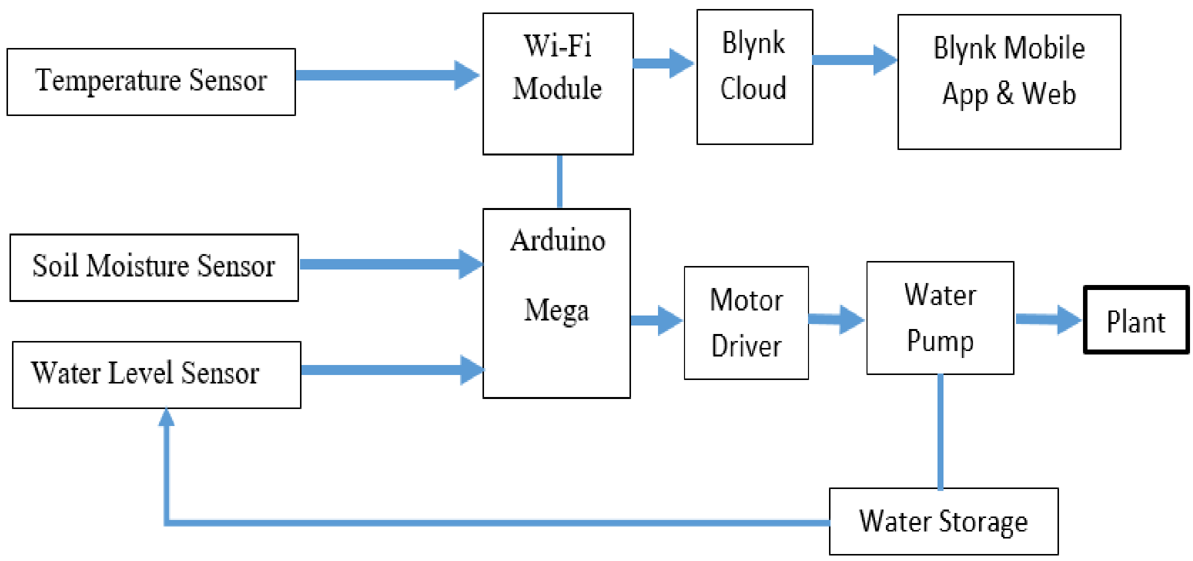


Figure 3.2: Block diagram of IoT based irrigation system

## 3.4 System Wiring Diagram

The system wiring diagram of an IoT-based irrigation system typically includes connections between the microcontroller, sensors, motor driver, water pump, power supply, and Blynk server. Figure 3.3 shows the physical layout of the components and their connections to each other. The wiring connection among the sensors, micro controller, motor driver are as follow-

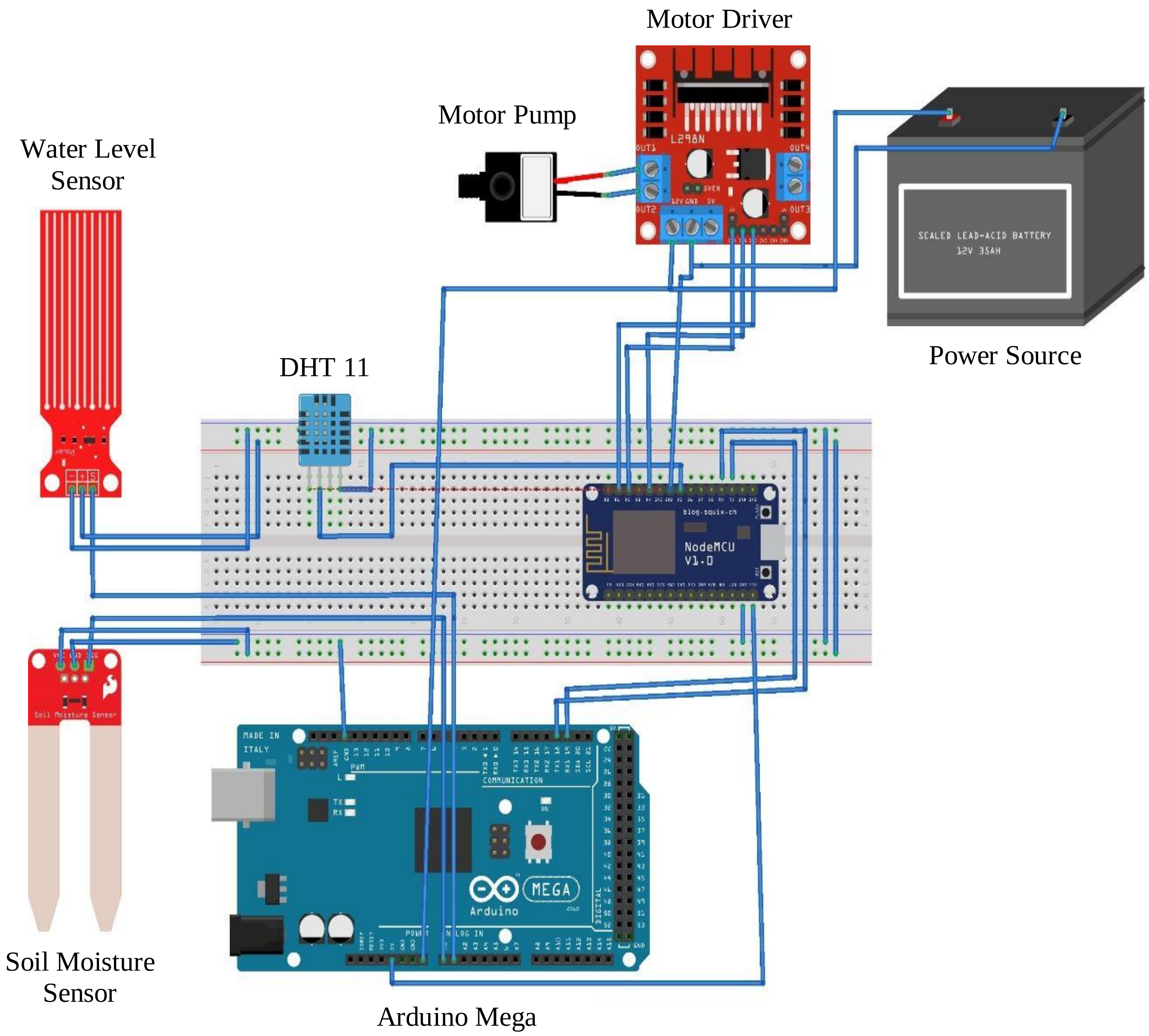


Figure 3.3: System wiring diagram of IOT based irrigation system

### 3.5 Circuit Diagram

Figure 3.4, the circuit design for this project, shows the connections between the sensors, microcontrollers, motor driver, and water pump. The layout of pins and connection to the microcontroller pin value are shown in this circuit diagram.

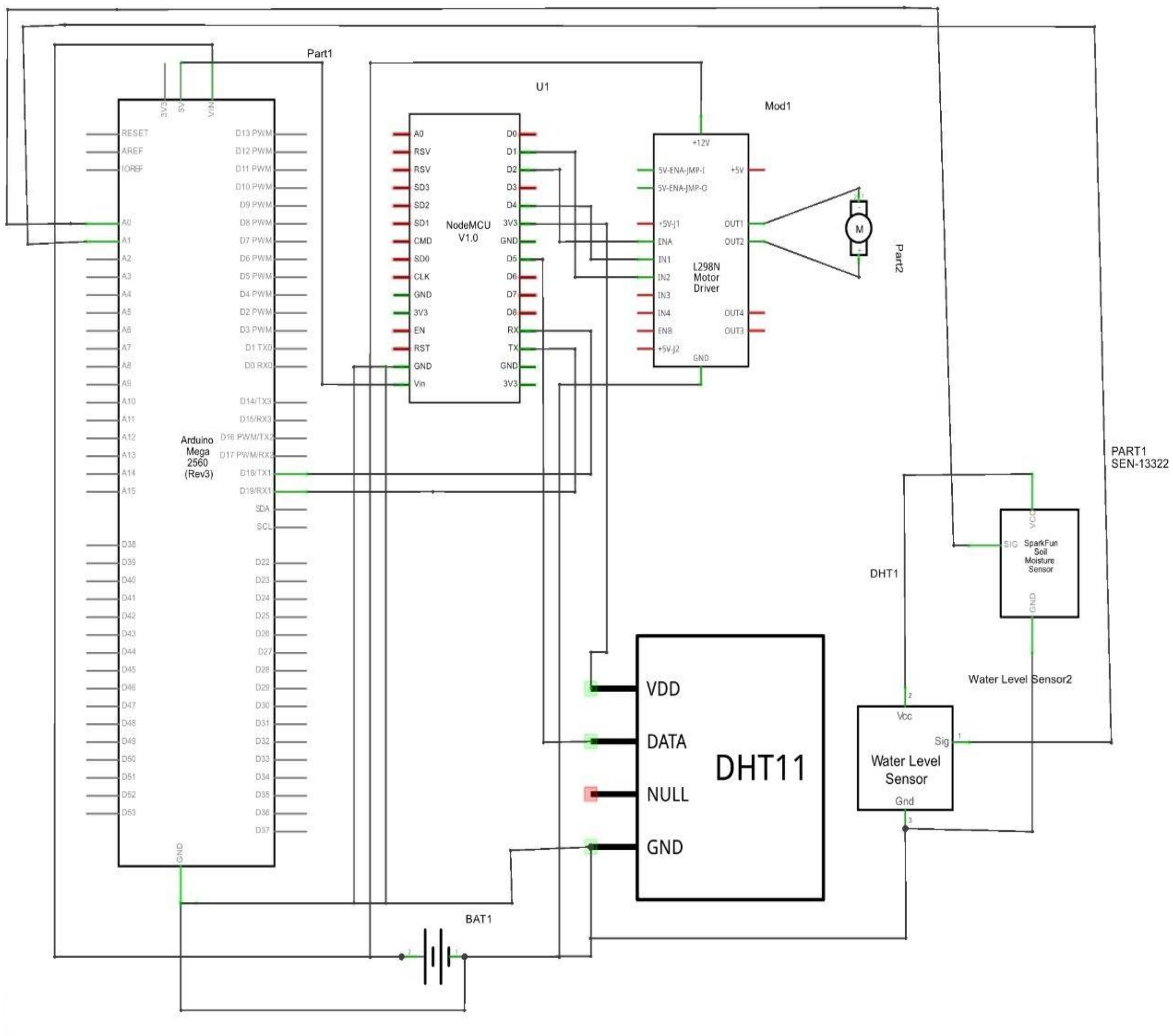


Figure 3.4: Circuit Diagram

# CHAPTER 4
# IMPLEMENTATION

## 4.1 Process of Implementation

The Internet of Things (IoT) has enabled the automation of various processes, including irrigation systems. With an IoT-based irrigation system, farmers and gardeners can monitor their crops and control the watering process remotely. In this project, the steps to implement an IoT-based irrigation system with water level sensor, soil moisture sensor and Blynk app connectivity are given below-

**Design the System:** The first step in implementing an IoT-based irrigation system is to design the system architecture. This involves determining the type of sensors needed and how they will be connected to the control system. In this case, a water level sensor, a moisture sensor, a temperature and humidity sensor. The sensors are connected to a microcontroller and ESP8266 NodeMCU, which process the data and activate the water motor when needed.

**Select Hardware:** Once the system architecture is designed, the next step is to select the hardware components needed for the system. In this project, Arduino Mega selected as a microcontroller, ESP8266 NodeMCU selected as wifi modular, a 12V 8W DC water motor, a temperature and humidity sensor (DHT11), a soil moisture sensor, a water level sensor, a water pump and other necessary components such as wires. It is important to choose hardware that is compatible with the selected sensors and control system.

**Install Sensors:** After selecting the hardware components, the next step is to install the sensors in the soil and water tank. The moisture sensor is placed in the soil to detect the moisture level, and the water level sensor is placed in the water tank to detect the water level. The temperature and humidity sensor can be placed in the environment where the system is operating. Proper installation of the sensors is crucial for accurate data collection.

**Connect Hardware to Microcontroller:** Once the sensors are installed, the next step is to connect them to the microcontroller. In this project, soil moisture sensor and water level sensor are connected to Arduino mega and temperature and humidity sensor is connected with ESP8266 NodeMCU. The microcontroller processes the sensor data and activates the water motor when needed. This can be done by connecting the sensors to the appropriate pins on the microcontroller.

**Program the Microcontroller:** After connecting the sensors to the microcontroller, the next step is to program the microcontroller to communicate with the sensors, control the water motor, and send data to the Blynk app. The programming language used will depend on the microcontroller selected. The code is written to collect data from the sensors, process the data, and activate the water motor when the moisture level is low. There is a threshold value selected for different soil.

**Create a Blynk Account:** The Blynk app allows for remote monitoring and control of the irrigation system. To use the app, the user must first create an account. This can be done by downloading the Blynk app and registering for an account.

**Login to the Account and Create a New Project:** Once the account is created, the user can login to the app and create a new project. The project will serve as the interface for the irrigation system. The user can add widgets to the project to monitor and control the system. Widgets such as the Gauge widget can be added to display the water level, and the Value Display widget can be added to show the moisture level. In this project, four Gauge has created for four different sensors and 1 button has created to turn ON or OFF the motor pump manually in any time user want.

**Connect Microcontroller to Blynk:** To connect the microcontroller to the Blynk app, Blynk API has been used. The API allows data to be sent from the microcontroller to the Blynk app, which can then update the widgets in real-time. To get started, Blynk library has downloaded for selected microcontroller and import it in the code. Each project on the Blynk app has a unique authentication token that token need to include in the code to establish a connection between the server and the microcontroller.

**Test the System:** Test the system to ensure that the sensors are reading the correct values and the water motor is activated when needed. Test the Blynk app connectivity and ensure that the data is displayed correctly. Test the synchronizing system is working fine or not and the motor is activated when the value crossed the threshold value. The data of the system should display in real time. In figure 4.1 and figure 4.2 the same data are displayed both in web application and mobile application. Figure 4.1 shows the mobile application display with the real sensor value and a range of margins from low to high. Figures 4.1 and 4.2 both represent the value as it was before being converted to percentage form.

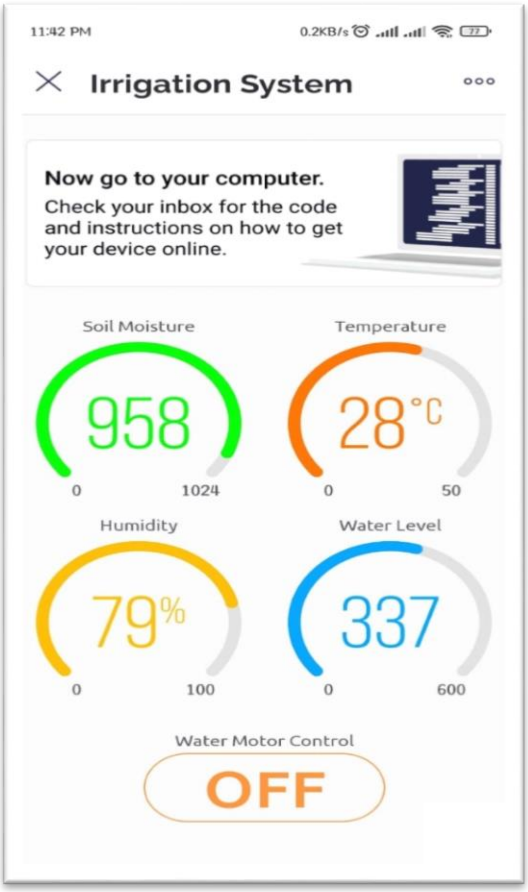


Figure 4.1: Blynk mobile application interface

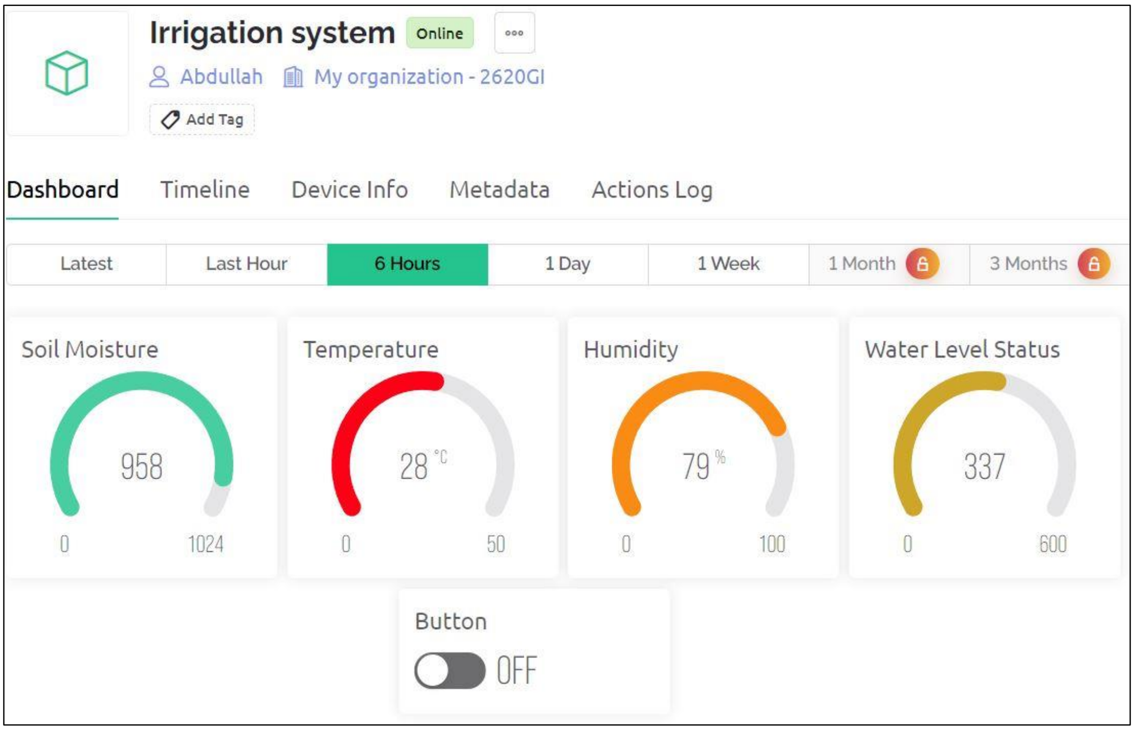


Figure 4.2: Blynk web application interface

In conclusion, implementing an IoT-based irrigation system with water level sensor and Blynk app connectivity can be broken down into several steps. These include designing the system architecture, selecting hardware components, installing sensors, connecting the hardware to the microcontroller, programming

## 4.2 Methodology

This project aims to design and implement an automated irrigation system that will make rooftop farming easier and more efficient. The system is able to control and maintain the irrigation of plants in an automated and remote manner, making use of a water tank, a motor, a soil moisture sensor, a temperature sensor, and a Blynk app for remote control and monitoring.

The first way to control and maintain the irrigation system is through an automatic watering mechanism. The system will give water to the plants automatically when the threshold value doesn't meet. The water tank is used to store the water needed for irrigation, and the motor is connected to the tank, responsible for pumping water from the tank to the plants. The soil moisture sensor is used to measure the water content in the soil, which helps to determine when the plants need to be watered. The temperature sensor is used to measure the ambient temperature, which helps to determine when the plants need to be watered. By using these sensors, the system can determine the optimal conditions for the plants and ensure that they are watered at the right time, reducing waste and increasing efficiency.

The second way to control and maintain the irrigation system is through the Blynk app. The app allows for remote control and monitoring of the system, including the ability to turn the motor on and off, and to monitor the soil moisture and temperature. This means that users can control the system manually by using the power on/off button switch on the app. Users can also monitor the soil condition real-time, which meets the objective 1 of the project. By monitoring the soil condition, users can ensure that the plants are receiving the right amount of water and adjust the system as needed to optimize growth. Additionally, the data will be tested with different conditions of the soil to ensure that the data is passing the exact value or not, meeting the objective 2 of the project.

In summary, this project aims to design and implement an automated irrigation system that will make rooftop farming easier and more efficient. The system will use a water tank, a motor, a soil moisture sensor, a temperature sensor, and a Blynk app for remote control and monitoring. By using an automatic watering mechanism and the Blynk app, users can control and maintain the irrigation system in an automated and remote manner, ensuring that the plants receive the right amount of water at the right time. This will reduce waste, increase efficiency, and help to optimize plant growth, meeting the objectives of the project.

## 4.3 Hardware Connection

This project is an IoT-based irrigation system designed to automate the irrigation process. It utilizes the Arduino Mega and ESP8266 NodeMCU as microcontrollers to collect data from various sensors connected to them. The sensors include soil moisture sensors, temperature sensors, and humidity sensors. The collected data is then transmitted wirelessly through the NodeMCU's Wi-Fi to the Blynk application cloud for remote monitoring and control.

The water motor driver plays a crucial role in this project as it controls the water pump for irrigation. The entire system is designed in an organized way to ensure efficient operation and reliability. The circuit design is carefully planned to ensure that all the components function correctly and safely.

The irrigation system designed in figure 4.3 to save water and optimize the irrigation process is a prime example of how IoT technology can enhance the efficiency of existing systems. With the use of IoT devices, the system can be remotely controlled and monitored, thereby reducing water usage and overall costs. The technology also provides real-time data on soil moisture, temperature, and weather conditions, allowing for precise irrigation scheduling. This not only saves water but also ensures the health of crops and plants. Ultimately, the project demonstrates how IoT technology can be utilized to create sustainable and cost-effective solutions that benefit both the environment and agriculture industry. Figure 4.3 shows the hardware connection of a prototype irrigation system based on the Internet of Things.

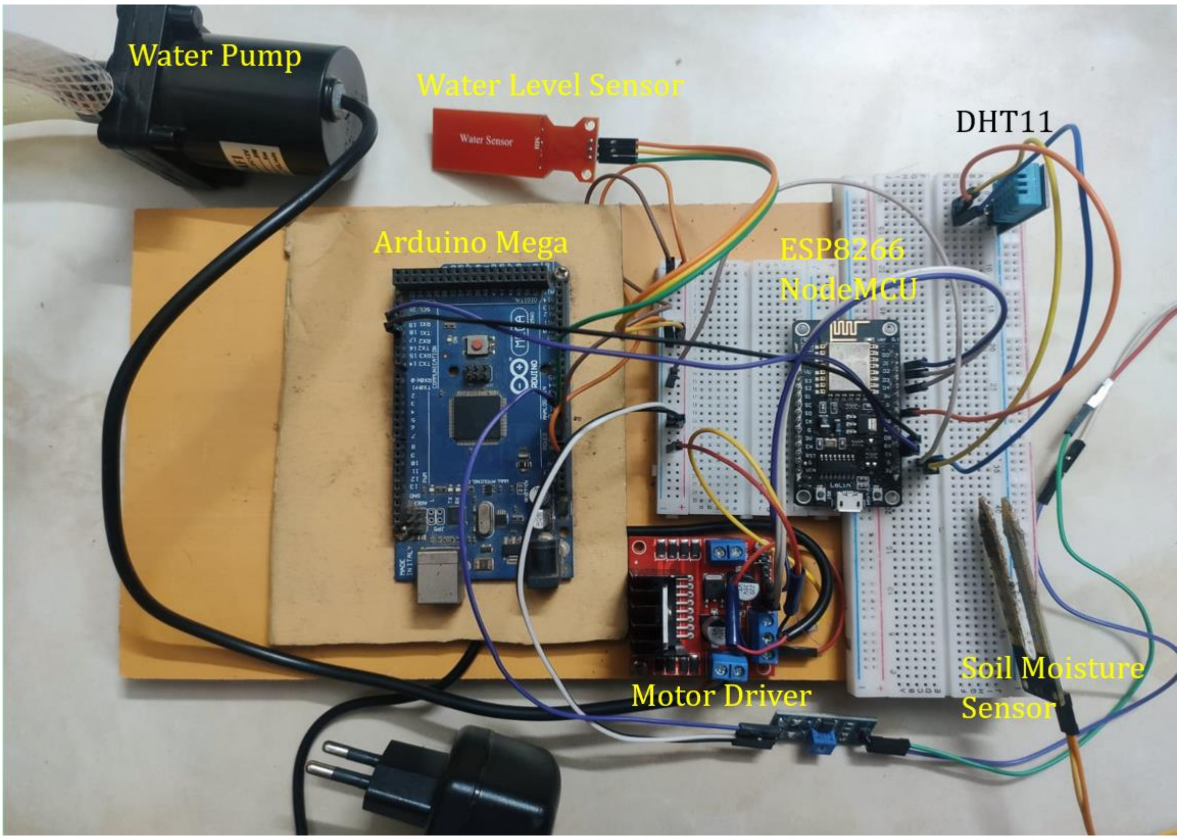


Figure 4.3: Hardware connection of prototype design

In conclusion, implementing an IoT-based irrigation system with water level sensor and Blynk app connectivity requires designing the system, selecting hardware, installing sensors, programming the microcontroller, creating a Blynk account, connecting the microcontroller to Blynk, and testing the system. With proper implementation, the system can help optimize irrigation and reduce water usage, making it more cost-effective and environmentally friendly.

## 4.4 Collecting Sensor Data

In this IoT-based irrigation system, collecting sensor data is a critical step to ensure that plants receive the right amount of water. Several sensors, such as moisture sensors, temperature sensors, humidity sensors, and water level sensors, can be used to monitor the soil condition and water availability.

The moisture sensor measures the amount of water in the soil and transmits the data to the central control system. The temperature sensor detects changes in temperature that may affect soil moisture, and the humidity sensor measures the moisture content in the air. These sensors work together to provide an accurate picture of the soil condition and the need for watering.

In addition, a water level sensor can be used to monitor the water level in the tank. This sensor sends data to the blynk server, which can then use it to determine whether there is enough water to irrigate the plants. This ensures that plants always receive the right amount of water and prevents over- or under-watering.

Collecting sensor data is a crucial part of an IoT-based irrigation system as it enables the system to make informed decisions about when to irrigate and how much water to use. By using multiple sensors, the system can provide a more accurate picture of the soil condition and the water availability, which can help to optimize the irrigation process and reduce water usage.

## 4.5 Collected Data Processing

This project involves the collection of sensor data for an IoT-based irrigation system. The sensors used in this project include soil moisture sensors, temperature sensors, humidity sensors, and a water level sensor for the tank. These sensors collect data on the soil condition, ambient temperature, and humidity, as well as the water level in the tank. This data is then transmitted to the Blynk cloud for processing and analysis.

Soil moisture, humidity, and water level sensors are widely used in various fields such as agriculture, meteorology, and hydrology. These sensors collect data in their respective units, which are then converted to a more understandable form for humans.

The soil moisture sensor, for example, collects data in a range between 0 to 1024. However, this range may not be intuitive for people who are not familiar with the unit. To make the data more meaningful, the code is designed to convert the value into a percentage between 0 to 100. This makes it easier for people to understand the actual moisture content in the soil.

$$\boldsymbol{Soil\ Moisture\ Value\ in\ percentage} = \frac{Soil\ moisture\ value}{1024} \times 100$$

For instance, if the percentage shows 50%, it means that the soil has half of the capacity to hold water.

Similarly, the humidity sensor also collects data in percentage form, as it is more commonly known and understood by people. This is especially important in areas where high humidity can cause discomfort or health issues. For example, in a greenhouse, it is important to monitor humidity levels to ensure optimal growing conditions for plants.

The water level sensor, on the other hand, collects data in a range between 0 to 600. To make this data more understandable, the code is designed to convert the value into a percentage form. For example, if the water level is at 300, the percentage shown would be 50%.

$$\textbf{\textit{Water Level Sensor Value in percentage}} = \frac{\textit{water level sensor value}}{600} \times 100$$

This is particularly useful for people who need to monitor water levels in tanks, reservoirs, or rivers.

To ensure that the data is displayed in an organized way, certain values need to be set in the Blynk application. This can be done through the Blynk app interface by creating a new project and selecting the appropriate widgets. For example, in figure 4.4; a gauge widget can be used to display the soil moisture level over time and a gauge widget can be used to display the water level in the tank.

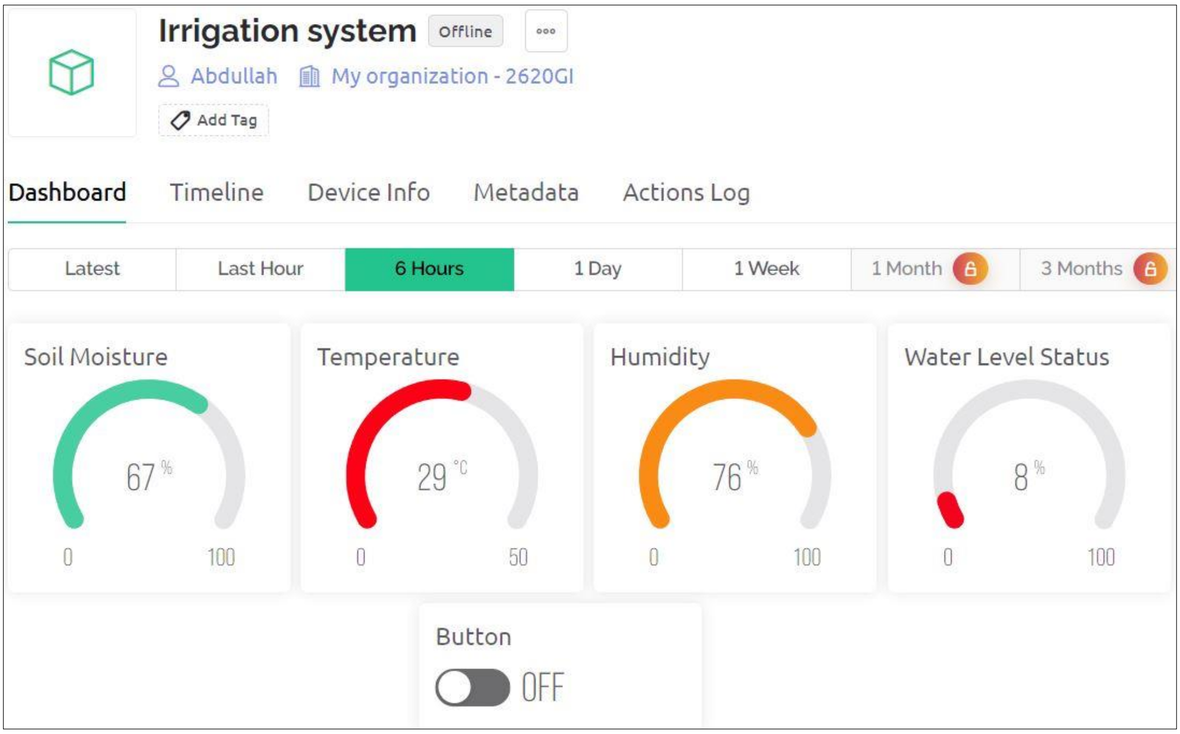


Figure 4.4: Blynk web interface after processing data

The conversion of data from its original units to more understandable forms is crucial in various fields. It enables people to make informed decisions based on the data collected by sensors. The conversion of soil moisture, humidity, and water level data into percentage forms makes it easier for people to understand and act accordingly.

To send the data to the Blynk application cloud, an ESP8266 NodeMCU is used. This microcontroller connects to the sensors and collects the data. It then passes the data via a Wi-Fi connection to the Blynk application cloud. The NodeMCU can be programmed using Arduino IDE, which is an open-source software development platform.

Overall, this project demonstrates how IoT technology can be used to improve the efficiency of irrigation systems. By collecting and analyzing data on soil conditions and water levels, the system can automatically adjust the amount of water delivered to plants, reducing waste and optimizing plant growth. Additionally, the use of the Blynk application allows users to remotely monitor and control the irrigation system via a smartphone app, making it more convenient and accessible.

## 4.6 Data Analysis and Implementation

The aim of this project is to design an IoT-based irrigation system that can collect sensor data related to soil moisture, temperature, humidity, and water level, and send it to the Blynk application cloud for analysis. The system includes a motor driver that automatically starts when the threshold value for soil moisture is not met, as well as a manual control for the water pump.

The system depicted in the given figure was tested using different types of soil, including sandy soil and loamy soil. In both cases, the soil moisture sensor provided accurate readings of the soil moisture levels, enabling the system to check the threshold value and run the water pump as necessary. Soil type is an important factor to consider when designing irrigation systems, as different types of soil can have varying moisture retention capacities. Sandy soil, for example, is known to drain quickly and require more frequent watering, while loamy soil retains moisture for longer periods and may require less frequent watering.

Testing the soil moisture sensor in different types of soil is an essential step in designing and implementing IoT-based irrigation systems. By ensuring that the system is accurate and effective in different soil types, it can be reliably used to improve plant growth and health. Furthermore, the temperature and humidity readings provide information about the actual environmental conditions in which the plants are growing. This information can be used to make informed decisions regarding the use of irrigation, fertilizers, and other agricultural practices.

Figure 4.5: System setup and analysis in silty soil

This system has been tested in silty soil shown in figure 4.5, which is known for its ability to retain water and nutrients. In figure 4.6, system tested in loamy soil. The system utilizes sensors to monitor the moisture level and temperature of the soil, and adjusts the irrigation schedule accordingly. The results of the test showed that the system was effective in maintaining optimal soil moisture levels and reducing water usage, while also improving plant growth and yield. This demonstrates the potential of IoT technology in agriculture to improve resource efficiency and productivity in various soil types.

Figure 4.6: System setup and analysis in loamy soil

When the humidity is too high, plants tend to lose excessive water through evaporation, which can lead to various problems. Firstly, the high humidity levels can cause the plants to absorb more water through their roots than they require, leading to a condition called nutrient burn.

Nutrient burn can be harmful to the plant, as it results in burned leaf tips, dying flowers, brown edges, and withered leaves. Nutrient burn occurs when the plant absorbs too many nutrients due to overwatering or when the humidity levels are too high, and the plant absorbs more water than it requires. The excess nutrients accumulated in the plant's tissues cause damage, leading to the symptoms mentioned above. It is crucial to maintain the right humidity levels for healthy plant growth and prevent nutrient burn. By monitoring the humidity levels and adjusting the watering schedule accordingly, gardeners can help prevent these problems and ensure the health and productivity of their plants.

Moisture levels in the soil are directly influenced by soil temperature. Warmer temperatures can result in more moisture in the soil, which can speed up the evaporation of water and increase the need for irrigation. Lower temperatures can lower the need for irrigation and slow evaporation, but they can also slow plant growth and nutrient availability.

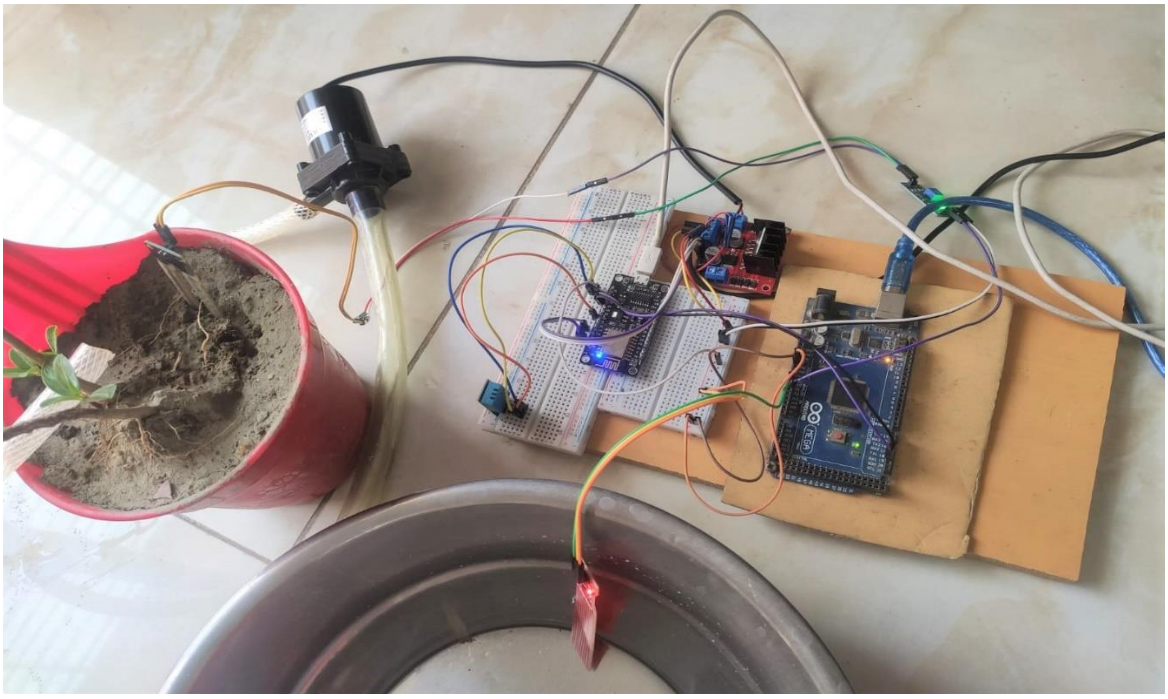

Figure 4.7: Prototype design and implemented irrigation system

In summary, The IoT-based irrigation system shown in figure 4.7 utilizes various sensors such as soil moisture, temperature, humidity, and water level sensors to collect data on the soil condition. The collected data is then analyzed to determine the water needs of the plants. The soil moisture sensor measures the moisture level in the soil and provides a reading from 0 to 1024, which is then shown on the Blynk app as a value from 0 to 100. All sensors are connected to a microcontroller that sends the data to the Blynk app for analysis. The system is designed to operate the water pump only when the soil moisture data falls below a certain threshold value, ensuring optimal water usage and plant growth. The data is processed and presented in an understandable format on both the mobile application and web interface, allowing users to monitor and operate the system with ease. The IoT-based irrigation system is an advanced system that collects data from various sensors to determine the water needs of plants. The system is designed to operate the water pump only when necessary to ensure optimal water usage and plant growth. The data collected is processed and presented in an understandable format on both the mobile application and web interface, allowing users to monitor and operate the system with ease.

## CHAPTER 5
## RESULTS AND DISCUSSION

### 5.1 System Result

The automatic irrigation system was put to the test to determine if it was functional. After testing it for an extended period, it was discovered that the system worked perfectly. The system was designed to start the motor automatically when the threshold value exceeded the preset limit, and it functioned as intended.

The system was monitored throughout the testing procedure to make sure it performed as planned. Figure 5.1 represents the test outcome where the threshold value was set to a predetermined upper limit and the system was observed to see if it would activate the motor when the threshold was exceeded. After extensive system tracking, it was found that once the threshold was exceeded the motor would start on its own.

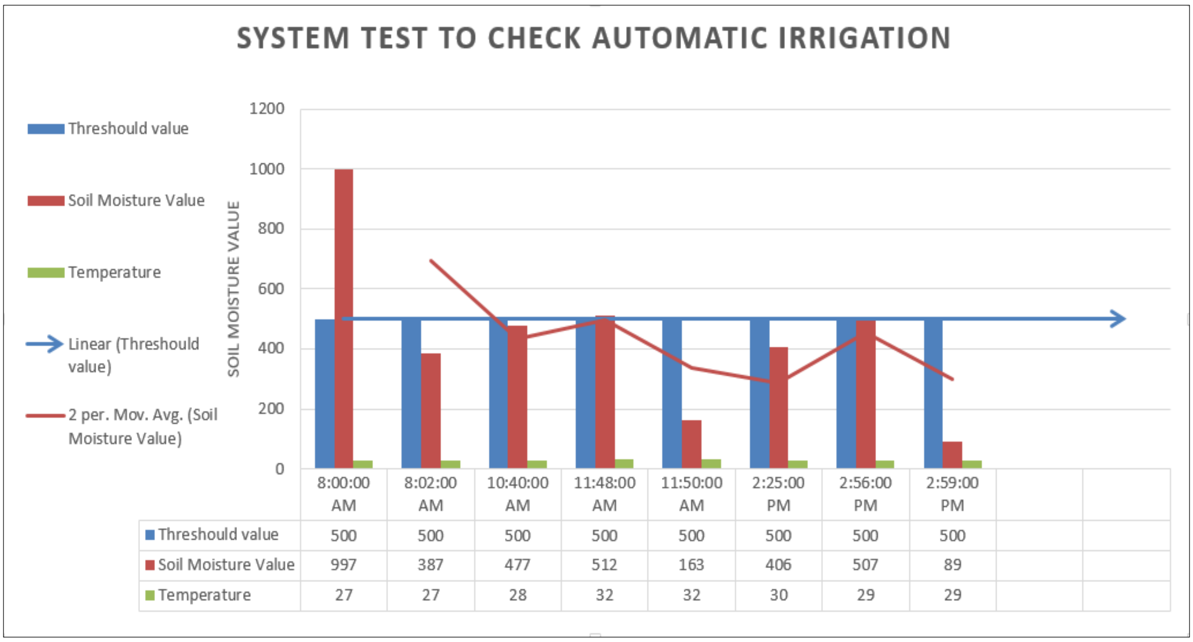


Figure 5.1: Automatic irrigation testing result

During the test, the automatic irrigation system was observed to start the motor each time the threshold value was crossed. The rise in soil moisture value was found to be influenced by temperature, with the temperature playing a crucial role in the speed at which the soil moisture value increased. In the morning, when the temperature was low, the soil moisture value rose slowly, but in the afternoon, when the temperature was high, the soil moisture value increased at a faster rate. The temperature acted as a catalyst for the increase in soil moisture value, and the system responded accordingly by starting the motor to maintain the moisture threshold. In table 5.1 shows the date and the result of the system.

Table 5.1: Automatic irrigation testing data and result of system

| Time | Threshold value | Soil Moisture Value | Temperature | Motor Run | Test Result |
|---|---|---|---|---|---|
| 8:00:00 AM | 500 | 997 | 27 | Yes | Passed |
| 8:02:00 AM | 500 | 387 | 27 | | Passed |
| 10:40:00 AM | 500 | 477 | 28 | | Passed |
| 11:48:00 AM | 500 | 512 | 32 | Yes | Passed |
| 11:50:00 AM | 500 | 163 | 32 | | Passed |
| 2:25:00 PM | 500 | 406 | 30 | | Passed |
| 2:56:00 PM | 500 | 507 | 29 | Yes | Passed |
| 2:59:00 PM | 500 | 89 | 29 | | Passed |

In conclusion, the automatic irrigation system was tested and found to be fully functional. It performed its intended task of starting the motor automatically when the threshold was crossed. This discovery provides assurance that the system will work effectively and efficiently in the future, ensuring that crops receive adequate irrigation without requiring constant human intervention.

## 5.2 System Evaluation

This IoT-based irrigation system is an innovative solution that allows for efficient irrigation by leveraging the power of technology. This system uses sensors and actuators to automate the process of watering plants, thus reducing water wastage and increasing crop yield. Here is an evaluation of the system based on seven points:

**Efficiency:** The IoT-based irrigation system is an excellent solution for efficient water usage. It uses sensors that can detect the moisture level in the soil and water the plants accordingly. This ensures that the plants get just the right amount of water they need, without any wastage. The system's efficiency in terms of water usage can lead to significant cost savings for farmers and gardeners, as well as environmental benefits. By reducing water wastage, the system helps conserve one of our most valuable natural resources. Overall, the IoT-based irrigation system is a sustainable and practical solution for optimizing irrigation processes while minimizing water usage.

**Accuracy:** The system is accurate in terms of measuring the moisture level in the soil. The sensors used in the system are highly sensitive and can detect even slight changes in the moisture level. The sensors data passes to Blynk application server through ESP8266 NodeMCU and the data shows in both mobile application and web dashboard. Comparing the figure 5.2 and figure 5.3, both are shown the same result.

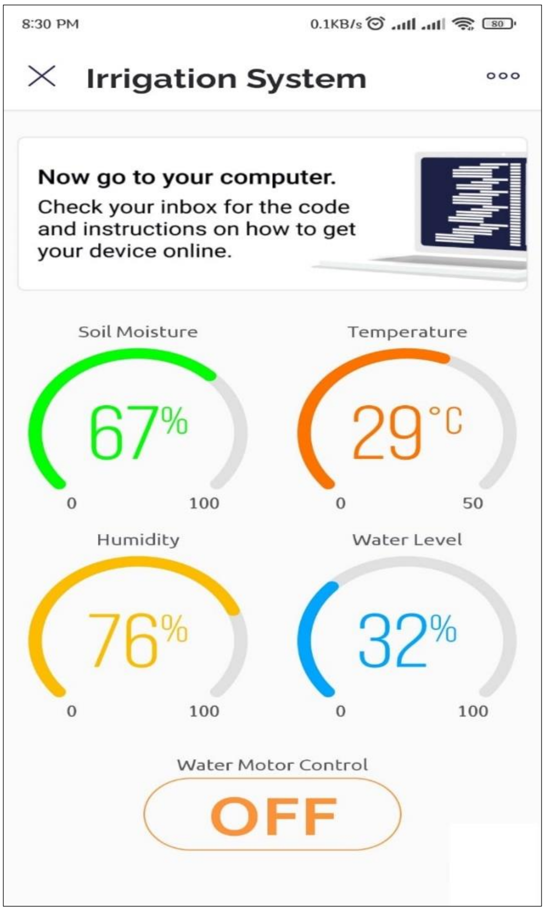


Figure 5.2: System output in Blynk mobile application

The data synchronization between the mobile and web dashboards was found to be consistent and accurate, with data syncing almost simultaneously. While there were occasional delays maximum 1-2 seconds, the same results were shown in both dashboards. Figure 5.1 and Figure 5.2 were provided as examples of the consistent data synchronization between the two platforms. These findings demonstrate the reliability of the system and the effectiveness of the data synchronization process.

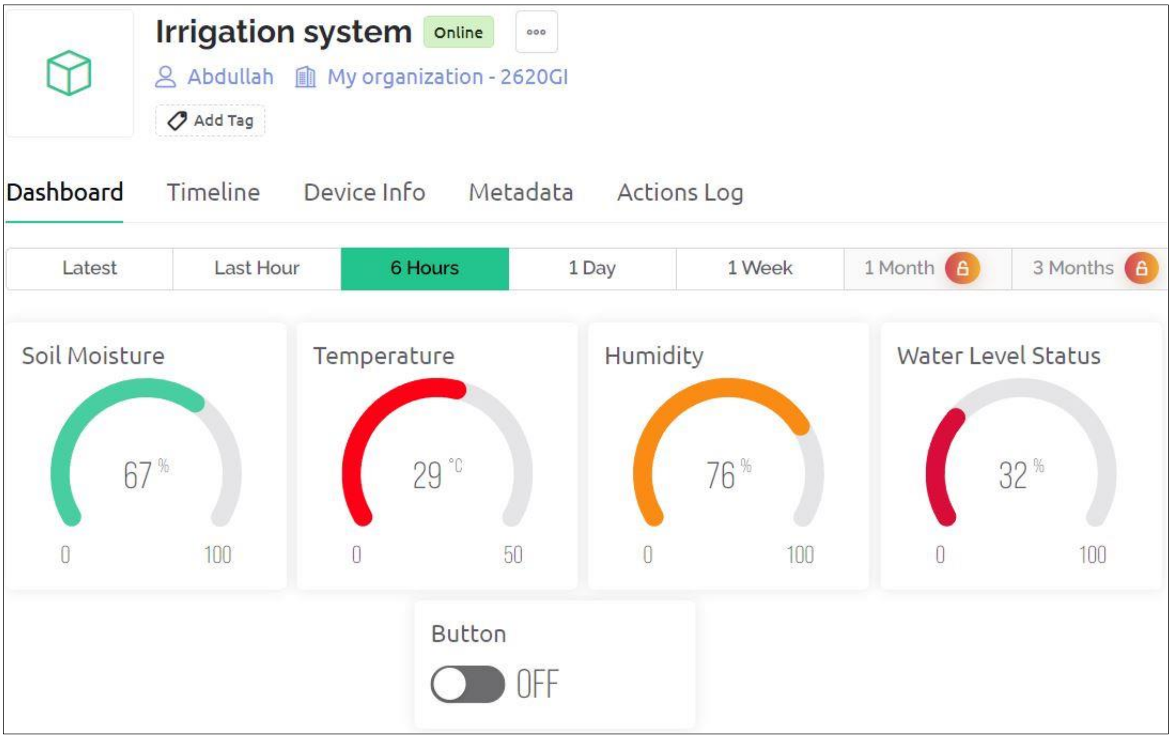


Figure 5.3: System output in Blynk Web Dashboard

**Cost:** The cost of implementing the IoT-based irrigation system can be high initially, but it can lead to significant cost savings in the long run. This is because the system reduces water wastage and increases crop yield, which translates into cost savings for the farmer.

**Maintenance:** The system requires regular maintenance, including the calibration of sensors and the replacement of faulty components. However, this is a small price to pay for the benefits that the system provides.

**Reliability:** The system is highly reliable, as it is based on automated processes. This means that the system can be left unattended, and it will continue to operate efficiently. It is important to note that sensor data can be affected by various factors, including environmental conditions, calibration, and sensor type. Therefore, regular evaluation of sensor data is critical to ensure that the data remains accurate and reliable. It is also essential to use appropriate calibration methods to ensure that the sensors are providing accurate data.

**Ease of use:** The IoT-based irrigation system is very easy to use. Once the system is installed, the user can control it remotely using a smartphone or computer. This means that the user can monitor and adjust the system's settings from anywhere, at any time.

Moreover, the system was evaluated by checking the soil moisture sensor data in different conditions. This evaluation involved creating different situations to test the accuracy of the sensor. The system was tested in different types of soil and at different moisture levels. Each time the soil moisture sensor was tested, it gave accurate results. This evaluation indicates that the system can accurately measure soil moisture levels in various conditions.

Additionally, the water level in the tank is accurately displayed, indicating that it is about half full. The manual trigger for switching the motor ON and OFF is also functioning correctly. When the motor is manually activated through the Blynk application, it remains ON until it is switched OFF. Therefore, the system's data and functionality appear to be working correctly.

In summary, the evaluation of sensor data output is crucial in ensuring that the data collected is accurate and reliable. This project has highlighted the importance of evaluating sensor data by testing the system in different conditions and comparing data from different sensors. The results indicate that the system is accurate and reliable, which is essential in making informed decisions. But there is a limitation in web dashboard of Blynk. The data of the web is not showing real time, it needs more time to synchronize the value whereas mobile application can work smoothly and perfectly to show the real time value.

## 5.3 System Benefits

Water scarcity is becoming a major issue, especially in urban areas, and the demand for water is increasing day by day. The traditional irrigation systems require manual intervention, which is inefficient and wasteful. To overcome this problem, an IoT-based irrigation system has been developed that can automatically irrigate crops when the soil moisture sensor detects that the soil needs water. This project provides numerous benefits and solutions, including water conservation, real-time information about soil conditions, and ease of use.

**Water Conservation:** The IoT-based irrigation system ensures that crops receive the right amount of water at the right time. It prevents water wastage by watering plants only when they need it. This system can save up to 80% of water compared to traditional irrigation methods.

**Real-time Information:** The IoT-based irrigation system gives real-time information about soil moisture, temperature, and other environmental conditions. This information can be accessed via a mobile application or web version, making it easy for the user to keep track of the soil conditions.

**Easy to Use:** The user interface of the mobile application is very user-friendly, making it easy for users to monitor and control the irrigation system. The application provides notifications about the status of the irrigation system, and users can control the system remotely.

**Suitable for Roof-top Farming:** This system is ideal for rooftop farming because it does not require a lot of space. The system can be easily installed on the roof and can be used to irrigate crops, making it an excellent choice for urban agriculture.

**Automatic Irrigation:** The IoT-based irrigation system is automatic, meaning it does not require manual intervention. The system automatically waters the crops when the soil moisture sensor detects that the soil needs water.

**Real-time Monitoring:** The IoT-based irrigation system provides real-time monitoring of soil conditions. This information is useful for farmers to make informed decisions about crop management, such as fertilization, irrigation, and pest control.

**Remote Monitoring:** The IoT-based irrigation system allows farmers to monitor and control the irrigation system remotely. This feature is particularly useful for farmers who are not on-site or who are managing multiple farms.

**Remote water pump controlling:** In addition to the benefits and solutions mentioned earlier, the IoT-based irrigation system also allows users to control the motor pump remotely using the mobile application or web version. This feature offers a great deal of flexibility to the user, allowing them to start and stop the pump as needed. The system provides different options for turning the pump on and off. Users can choose to turn the pump on immediately. With the ability to control the motor pump remotely, users can easily manage their irrigation system without the need for manual intervention.

The system is designed to be user-friendly, with a simple interface that makes it easy to operate. Overall, the remote control feature of the IoT-based irrigation system adds an extra layer of convenience to the system. It allows users to manage their irrigation system with ease, saving time and effort while ensuring that their crops receive the optimal amount of water.

# CHAPTER 6
# CONCLUSION

## 6.1 Project Summary and Outcomes

The use of IoT technology in agriculture has revolutionized farming practices, with IoT-based irrigation systems being one of the most promising developments in recent years. This system utilizes various sensors, such as moisture, temperature, and humidity sensors, to collect data on soil conditions, which is then transmitted to a central control system. The control system then analyzes the data and decides whether or not to activate the irrigation system, depending on the plant's needs. One of the significant benefits of an IoT-based irrigation system is its ability to monitor the soil condition and adjust the amount of water accordingly. This ensures that plants receive the right amount of water to grow and thrive, reducing water waste and improving plant health. By accurately controlling the water supply, farmers can reduce water usage and save money, while also producing better quality crops. Another significant advantage of an IoT-based irrigation system is that it can be controlled remotely via a smartphone app, making it a convenient solution for managing plants. This feature allows busy people to monitor their plants and adjust the watering schedule as needed, giving them peace of mind and saving them time. Moreover, this technology can also be used in rooftop farms, where monitoring and watering can be challenging due to their height and location. In addition to reducing water usage, IoT-based irrigation systems are also an environmentally friendly option that can help reduce costs. By accurately monitoring and adjusting the water supply, these systems can prevent water wastage and reduce the risk of over-irrigation, which can lead to soil erosion and nutrient leaching. These systems can also reduce the need for chemical fertilizers, which can be harmful to the environment and expensive. In conclusion, IoT-based irrigation systems offer a convenient solution for managing plants and are an environmentally friendly option that helps to save water and reduce costs. By incorporating sensors and advanced analytics, these systems can accurately monitor soil conditions and adjust water supply, ensuring optimal plant growth and reducing the risk of over-irrigation. Moreover, the ability to control these systems remotely via a smartphone app makes them a convenient option for busy people who want to monitor and manage their plants. With their many benefits, IoT-based irrigation systems are a promising development in the world of agriculture and are sure to revolutionize farming practices in the coming years.

## 6.2 Future Works

Future work for the IoT-based irrigation system could involve integrating machine learning algorithms to improve the accuracy of the system's decision-making process. SMS system could be used to facilitate as additional feature. The system could use historical data to make more informed decisions about watering schedules and adjust them based on predicted weather conditions. Additionally, the system could incorporate more sensors to monitor other environmental factors such as sunlight, wind, and rainfall, to provide more precise control over the irrigation process. These advancements could further optimize the system's efficiency and reduce water usage while improving plant health.

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