A PROBABLE SOLUTION FOR ENERGY HARVESTING FROM HUMAN MOVEMENT

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ABSTRACT
There is no alternate to adequate electric power to avoid procrastination of the development pace of a nation. From this urge, governments of different countries are taking different initiatives for production of more and more electricity. But as we know the law of conservation of energy states that no energy can be created or destroyed, it only takes one form to another. So in traditional way, generation of electricity means to burn fossil fuels or utilization of nuclear energy. In these cases, limitation of resources and environmental hazard has always been a great concern. Though solar power is already a well-known alternate renewable source, its abundance is weather dependent and requires large area. Piezoelectric power generation can be a very good alternative for fossil fuels or other traditional ways of electricity generation. It is 100% clean, non- hazardous, easy to implement, inexpensive and eco-friendly source of energy. There is no byproduct in this power generation. It occupies less space and is easily portable. It can be implemented in various ways to generate energy. This system can be used at domestic level as well as at industrial level.

Key Words: Alternative energy, Piezoelectricity, Footstep energy harvesting, Piezo-shoe, Miniature energy generator

1.0 INTRODUCTION
In our daily life through our natural physical activities, we put instances of multifarious energy releasement. For example, we create sound energy while we talk, mechanical energy while we walk or eat and even when we breathe. A big portion of this released energy is always wasted in several ways. How charming it would be if we could convert some of these energies into electricity for ourselves without any byproduct! [1]

To make it more conclusive to realize let us consider a figurative situation in our daily life while we are dancing on the stage of a dance club [2], outcry in stadium, do jogging and randomly move our hands, legs etc. These discrete movements of our organs are enough to charge our mobile phones, laptops or other electronic gadgets.

2.0 PIEZOELECTRICITY
To realize how the tiny movements of our body organs can generate electricity, we need to look back to 1880 when Pierre and Paul-Jacques Curie observed that there are certain crystals including quartz, tourmaline, and Rochelle salt found in nature as shown in Fig:1 [3-4]. which produce voltage difference across the sides of it when it is squeezed and decompressed at opposite polarity.

Fig 1: Piezoelectric Crystals

Piezoelectric effect is ideally a reversible process. It can be categorized in two types i.e. Direct piezoelectricity and Inverse piezoelectricity. In case of direct piezoelectricity effect, whenever mechanical force is applied on the crystal surface, local positions of the positive and the negative charges are altered and hence polarization occurs. An electric field is thereby created as shown in [Fig:2]. In Inverse piezoelectricity effect, the applied external field creates pressure on the charges and thus produces elastic tension due to which the

physical dimensions of the crystal changes.

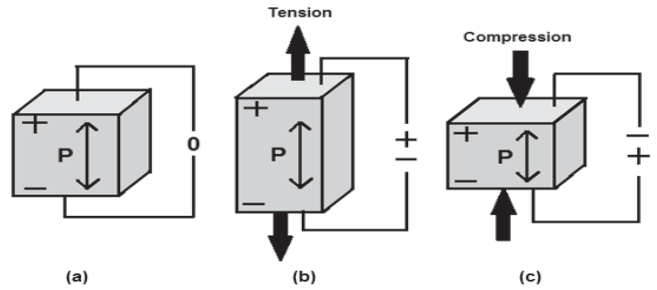

Fig 2: Piezoelectric Process

For example, lead zirconate titanate crystals shows considerable piezoelectricity when their physical dimension is deformed even by about 0.1% of the original dimension [5]. On the other hand, the same crystals change about 0.1% of their static physical dimension when an external electric field is applied to the crystal. The inverse piezoelectric property is used in generation of other electric signals such as production of ultrasonic sound waves [6].

3.0 PROCESS DESCRIPTION

Materialization of this anecdote is no more a megalomania in the present world. For our initial research purpose, we used a common sports shoe [Fig:3] and attached a sheet of piezoelectric material inside it carefully, so that whenever any user walks, pressure is applied and thereby causes a change in the physical dimension of the sheet within a tolerable range which results in generation of electricity.

Fig 3A: Shoe Specimen (side view)

Fig 3B: Shoe Specimen (top view)

4.0 SYSTEM IMPLEMENTATION

The system introduces storage capability because generally the amount of power generated through every footstep by the shoe is small and in mw range. So, storing the power in every step can be quite handful while stored for a considerable time. The control unit in Fig:5 controls the voltage to suite the charging capability of the battery, capacitor etc. The System is designed including piezo electric material where strain is converted into electricity.

Fig 4: Simplified block diagram for piezoelectric energy harvesting from footsteps

where generated power is stored and can be utilized whenever necessary [Fig:5]. Every footstep applies pressure on the piezo material in the shoe. This pressure results in generation of electric power which is rectified and then stored [Fig:4]. As load, a LED strip is attached with the circuit mounted on the shoe. So, putting on the shoe exhibits blinking of the strip in every footstep which is shown in [Fig:6] and [Fig:7].

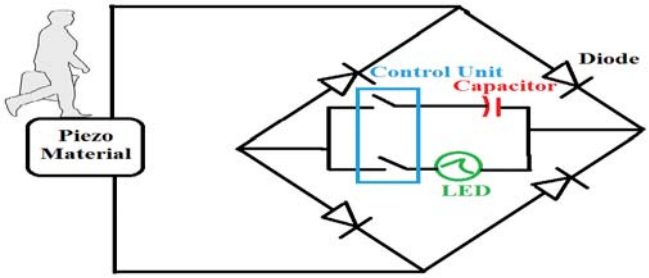

Fig 5: Basic circuit diagram of the system

Fig 6: LED illumination while walking

Fig 7: LED illumination while walking (dark environment)

The designed system can generate 240 mw of electricity for a single step while there is only one piezo sheet is used. But if more sheets are used and applied in a single shoe, a reasonable amount of electric energy can be harvested which can be utilized for minor needs in our daily life.

5.0 OUTPUT ANALYSIS

For a single step :

Peak Generated Voltage: 20V
Peak Charging Current: 12mA
Average Charging Period: 02 sec

4700uF capacitor is used practically. Where Single step charged the capacitor voltage up to 0.05V. Any object of weight more than 5kg made the maximum displacement of the piezo sheets in this arrangement. So, to run 5V load system will require 1000 steps as the charging current is small. It is mentionable that the dimension of the piezo film used here is 5cm x 7cm only. So, by applying more films in series or parallel and also using multiple layers of films, the power output can be increased to a very handful amount.

6.0 FUTURE WORK

Piezoelectric arrays can be laid underneath railway stations, airports, pavements, side-walks [7,8], speed-breakers for voltage generation [9]. The voltage thus generated from the array can be used to charge the Lithium batteries, capacitors etc. These batteries can be used as per the requirement. Capturing untapped energies from such potential sources through piezo electric material system can be stored in highly rated batteries and can be used later as per consumer requirement.

7.0 CONCLUSION

Researches have been going on across the world to unlock the mysteries lying inside our nature and to extricate every potential. The efficiency of modern devices in capturing energy from the environment has increased with the development of new materials and techniques [10]. We think this tempting utilization of piezo properties is not only a scope but also a demand of time in consideration of totally ecofriendly, lifetime durability, zero maintenance cost for a densely populated developing nation like us. To make this phenomenon a real entity it requires support and patronization from government and entrepreneurs.

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