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Piezoelectric Based Mobile Charging System

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***Abstract* - In present condition, the shortage of electricity is the big problem for industrial growth as well as rural developing. Shortage of electricity has its effects on India's developing growth. To solve such types of problem we need to develop strong electricity generating techniques with the help of wasting human energy for our better future. In this project we are generating electrical power as non-conventional method by simply walking or running on the foot step. Non-conventional energy system is very essential at this time to our nation. Nonconventional energy using foot step is converting mechanical energy into the electrical energy. Due to this a lot of energy resources have been exhausted and wasted. Proposal for the utilization of waste energy foot power with human locomotion is very much relevant and important for highly populated countries like India and china where the roads, railway stations, bus stands, temple, etc. Are all over crowded and millions of people move around the clock.**

Keywords: Walking, foot step, energy harvesting, quartz, Electrical Energy, Non-Conventional Energy, Shortage of Electricity.

I. INTRODUCTION

For an alternate method to generate electricity there are number of methods by which electricity can be produced, out if such methods Piezo electric energy generation can be an effective method to generate electricity.

Walking is the most common activity in human life. When a person walks, he loses energy to the road surface in the form of impact, vibration, sound etc, due to the transfer of his weight on to the road surface, through Piezo electric falls on the ground during every. This energy can be tapped and converted in the usable form such as in electrical form. This device, if embedded in the Piezo electric path, can convert Piezo electric impact energy into electrical form.

Human-powered transport has been in existence since time immemorial in the form of walking, running and swimming. However modern technology has led to machines to enhance the use of human-power in more efficient manner. However, human kinetic energy can be useful in a number of ways but it can also be used to generate electricity based on different approaches and many organizations are already implementing human powered technologies to generate electricity to power small electronic appliances.

II. LITERATURE REVIEW

The fundamental idea of research work in paper [1] is to present an approach to energy harvesting, which basically uses piezoelectric technology and is implemented in a shoe. It takes advantage of the energy that the user waste when walks and thus is able to convert it into electric energy and can be use in an electronic device that requires low power. For measuring the power generated and construction, by the plantar pressures of the foot during the walking or running cycle. As seen in the results there is more power in the running test than in the walking test because higher speed and jumping while running produce higher pressure and more power. Also, it is observed that there is not much difference between the right foot and the left foot since almost the same power is generated. It can be concluded that the greater the weight of the person, the more the pressure generated in the piezoelectric sensors and then the power is great. [1]

This is a process of designing a hybrid energy harvesting system for small powered battery applications. The system is constructed with two separate systems that are the mechanical harvesting system and piezoelectric harvesting system. They are coupled together with an efficient power management circuit with the intention to generate electricity through walking while acting as a battery charger. The system has shown positive results when used to charge up a small battery powered electronic gadget such as a mobile phone. The proposed prototype has clearly demonstrated its ability to charge up a mobile phone. This project integrates both the mechanical harvesting system and piezoelectric harvesting system in order to convert kinetic energy from human movement into electrical energy while at the same time the electrical energy generated is processed by their respective efficient power management circuits. Although both the harvesting systems are playing an important role in generating a power source, yet the efficient power management circuits are essential in processing and regulating in order to produce a more constant supply. Besides that, the practicability of this prototype is experimented. When a person is using this prototype to charge the battery in the mobile phone throughout

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the day, the battery level does not decrease and at the same time increases from an initial 50% to 69% state of charge. Hence, this prototype has demonstrated the feasibility on energy harvesting from human movement and the potential of this prototype as an endless power source for charging and powering up low powered electronic gadgets. Even though the amount of resources saved such as energy and money are rather trivial in the short term, yet the impact would be notable on the long run. [2]

Energy harvesting technology provides a promising choice to replace the batteries used in modern wearable devices. New kind of piezoelectric energy harvesting devices aiming for high power output at low frequency with broad bandwidth. By accessing the performance of the device at different frequencies, we have demonstrated two energy harvesting devices with power output at 10 microwatts level. A complete energy harvesting system is also designed to adjust the output voltage for practical applications. Energy from human motion has been successfully harvested to power an LCD device and an LED lamp. Those demonstrations reveal potential applications of the energy harvester in other wearable devices. Demonstrate two kinds of piezoelectric energy harvester that can be used as alternative power source for wearable devices. With the piezoelectric beam fabricated, the output voltage is adequate for power collecting circuit. The prototypes of the energy harvester are examined in real scenario and the results show good performance. The joint rotation driven energy harvester is available with a wide frequency range. The hand-terminal driven energy harvester is sensitive to small vibration. The devices designed are compatible with current commercial energy harvesting IC solution, thus a complete energy harvesting system was demonstrated. The design of the energy harvester exploits the motion of human body and was proved effective by the experiment. The results reveal potential applications of the energy harvester in wearable devices. [3]

Our daily lives now include street lights, which are getting smarter. In order to create an energy-efficient and smart system, the majority of systems are now replaced with LED bulbs and different technologies including automation and communication based on sensors. This article offers the best option for the intelligent street light functionalities. With the help of green energy harvesting, electrical or electronic networks may be powered without a grid connection. The thermoelectric generator's (TEG) performance is mostly what determines how much thermoelectric energy can be collected. Here, they propose burning non-biodegradable garbage to provide electrical energy, as well as using piezoelectric sensors to capture energy.Therefore, in this case, we want to generate electricity from waste materials, solar energy, human power, and battery storage to power the street light [4].

This study focuses on and discusses the electrical energy generation and storage from piezoelectric materials. These materials have the ability to transform mechanical energy directly into electrical energy, which may then be stored via an energy harvesting technique or circuit. The conversion of energy from ambient vibration is a current, exciting research subject. It is the most widely used electromechanical transducer material for low power consumption applications, such as wireless and sensors, due to its ability to integrate with electronics and microsystem with high voltage and supporting standalone circuit. In order to subsequently provide electronic/electrical equipment, this study focuses on how to harvest energy from piezoelectric materials and store it in an energy storage device like a battery. To verify the efficiency of energy extraction, a simulation in MATLAB Simulink is provided together with experimental findings. As a result, this approach could be useful for providing low power gadgets with energy [5].

The importance of energy harvesting in extending the life and improving the performance of wireless sensor networks and low-power electronic devices is emphasized in this research. Although there are many applications for wireless sensors, their reliance on ordinary batteries poses problems because of their short lifespan and the difficulty of replenishing them in remote areas. A viable alternative is energy harvesting, which entails absorbing and transforming ambient energy sources including solar, electromagnetic, thermal, wind, and kinetic energy into electrical power. The focus of this study is on piezoelectric energy harvesting, transducer design, rectifier circuits, and storage units while providing an overview of different energy harvesting strategies. Energy harvesting offers a strong substitute for conventional batteries that may be used for a variety of energy needs, from low to high power applications [6].

In this study, piezoelectric tile, which is made with a piezoelectric transducer, is used to generate power from a foot overbridge. More frequently, it is seen that people cross the bridge on foot. Installing piezoelectric tile (Piezotile) allows to generate a significant quantity of power. A single piezotile has the capacity to generate up to 7 watts of electricity, and over time, installing several piezoelectric tiles will enable to generate a significant amount of power. PID controller is used to improve system stability and increase accuracy in the piezoelectric transducer by analyzing the mechanical system of the piezo tile convert to the electrical circuit. It has the capacity to produce enormous amounts of electricity, and this power source has several uses in buildings, homes, street lights, emergency power grids, and so on. Since energy is erratic and much of it has been extinguished in nature, the idea behind green energy is to convert large amounts of energy into electrical energy. One type of piezoelectric transducer is the

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piezotile, which converts mechanical force from the foot into electrical energy [7].

A comparative review of various designing and modelling techniques of piezoelectric devices for the generation of high-power is done in paper [8]. Comparison of Finite Element Method, Finite Volume Method and a Coupled-Piezoelectric Circuit is done here. Also, a B-Probe method and a CVR method for calculating the power produced by the high piezoelectric device, High Piezoelectric Electromagnetic Vibration-Powered Generator model and Electromagnetic model, and low power design schemes for producing high power by, a piezoelectric device are compared here in this paper for the purpose of designing and modeling of high power piezoelectric devices which are widely used. The growth of the piezoelectric device is categorized into three phases. The prediction of piezoelectric effect by Pierre and Jacques Curie in 1880 and the reverse of this process was given by Gabriel Lippman in 1881 became the first phase of the growth of the piezoelectric devices. The rapid growth of quartz crystals and Rochelle salt became the second phase. The third phase was the introduction of water-soluble crystal. Various designing and modeling techniques of piezoelectric devices for producing high power are compared in this paper. Advantages and disadvantages of various methods are discussed here. Comparison of FEM, FVM, and CPC-FEM techniques is done here for designing of high power piezoelectric device. Comparison of HPVG model and Electromagnetic generator model is done here. B-Dot Probe method and CVR method, and low power designing schemes are compared here. High power piezoelectric devices have a very large range of applications. [8]

A flexible pyramidal piezoelectric structure composed of a PVDF-TrFE piezoelectric film which can generate high output voltage is simulated and fabricated. Compared to the flat, square columnar and trigonal-line micro patterned thin films, the pyramidal structure has stronger variation strain and produces higher piezoelectric signals. When it was subjected to the same mechanical load, the pyramidal structure generates output voltage that is 9 times larger than that of the planar film. The optimized flexible piezoelectric film has broad application in self-powered pressure sensor. The piezoelectric performance of the PVDF-TrFE thin film is enhanced by micropatterning. The flat, square columnar, trigonal-line and pyramidal structures are simulated. The output voltage of the pyramidal structure is the highest under the same compression force. The piezoelectric pressure sensors based on the flat and pyramidal structures are designed and fabricated and the piezoelectric performance is evaluated. The output voltage of pyramidal structure is about 1.4 V that is approximately 9 times larger than that of the flat structure which shows an output voltage of 0.15 V under the same force. The experimental and simulation results are consistent. The flexible piezoelectric structure based on pyramidal PVDFTrFE thin film has large potential in various self-powered pressure sensors. [9]

III. PROBLEM STATEMENT

For an alternate method to generate electricity there are number of methods by which electricity can be produced, out if such methods footstep energy generation can be an effective method to generate electricity.

Walking is the most common activity in human life. When a person walks, he loses energy to the road surface in the form of impact, vibration, sound etc, due to the transfer of his weight on to the road surface, through foot falls on the ground during every step.

This energy can be trapped and converted in the usable form such as in electrical form.

IV. SCOPE OF PROJECT

This project required study from two aspects. First is to study the characteristics, concept and the effect of the piezoelectric. The behavior of the voltage and current produced by the piezoelectric element will be emphasize in this project. Next, is to measure the sensitivity of the piezoelectric element. This measurement will analyze the piezoelectric element weather the vibration from a footstep is enough to cause the piezoelectric to produce voltage and current. Both of this study then will be combined to produce a piezo power generator.

V. METHODOLOGY

Phases in Piezo Generator

There are four phases involved in this project. Each one of the phase will be achieved step by step.

Phase 1

This is the first stage of this project which is to identify the piezoelectric concept. The action to be taken in this stage is to do a deep research on how the piezoelectric works. A part from that, the situational analysis is essential to do in order to identify the piezoelectric concept.

Phase 2

The second stage in this project is to identify the measurement criteria for evaluating the produce current and voltage by the piezoelectric element. At this stage, a thorough search will be made via internet and from the library to collect all available information on the measuring knowledge. The

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collections of the technical report regarding the subject matter in the world are essential in order to identify the common criteria on measuring the current and voltage. The major deliverable for this stage is the criteria on measuring the produced current and voltage from the piezoelectric element. A part from that, the formula of converting from the vibration to current and voltage will be achieved at this stage.

Phase 3

To develop an energy converter from vibration is the third stage of this project. An agile methodology for developing the converter is adopted in this phase. This is to reduce time as well as to ensure the tool developed is parallel with the user requirements. The major deliverable for this stage is the completion of energy generator called Piezogenerator.

Phase 4

The final stage for this project is the implementation and user testing on the system. This system is test in the lab. Figure shows the full phases in this project.

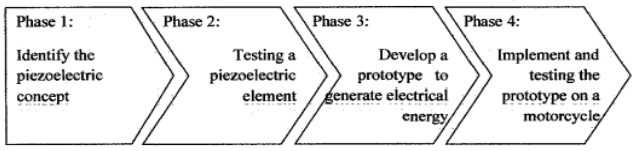

Figure 1: Phases of Piezo Electric Power Generation

VI. SYSTEM DESIGN

The basic working principle of our project is based on the piezoelectric sensor. To implement this, we adjust the wooden plates above and below the sensors and moveable springs. Non-conventional energy using Piezo electric is converting mechanical energy into the electrical energy.

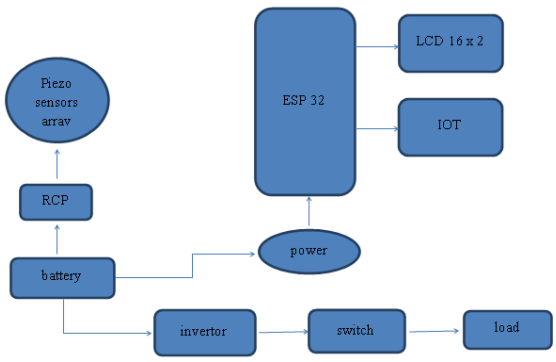

Figure 2: Block Diagram

Piezo electric board it consists of a 16 piezo electric sensors which are connected in parallel.

When the pressure is applied on the sensors, the sensors will convert mechanical energy into electrical energy. This electrical energy will be storing in the 12v rechargeable battery connected to inverter.

We are using conventional battery charging unit also for giving supply to the circuitry. This inverter is used to convert the 12 Volt D.C to the 230 Volt A.C. This 230 Volt A.C voltage is used to activate the loads. By using this AC voltage, we can operate AC loads.

Following figure shows the flowchart of the system:

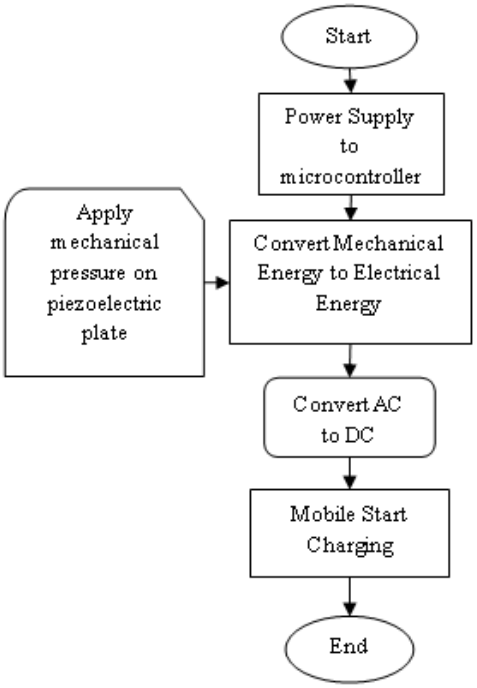

Figure 3: Flowchart

VII. RESULT AND DISCUSSIONS

This project presents Piezo Electric Power Generation and it is designed and implemented with ESP32 Microcontroller in embedded system domain. Experimental work has been carried out carefully. The result shows that higher efficiency is indeed achieved using the embedded system.

The power generated by the Piezo electric generator can be stored in an energy storing device. The output of the generator was fed to a 12 V lead acid battery, through an ac-dc converter bridge. Initially, the battery was completely discharged. Then, the project was operated by applying Piezo electric load and energy was stored in the battery. The System also displays the message on LCD.

The Following figure shows the hardware setup of the proposed system:

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Figure 4: Hardware Result

VIII. CONCLUSION

Power generation using Piezo is successfully tested and implemented which is the best economical, affordable energy solution to common people. This can be used for many applications in rural areas where power availability is less or totally absence. As India is a developing country where energy management is a big challenge for huge population. By using this we can drive both A.C as well as D.C loads.

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