

SURVEY PAPER ON POWER GENERATION USING PIEZO ELECTRIC MATERIAL

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Abstract - In the last few years the use of power electronic devices has been increasing rapidly. The devices are being used in large numbers to comfort our daily lives with the energy consumption of these portable electronic devices, the concept of harvesting alternative renewable energy in human surroundings arise a new interest among us. Here we focus on such advanced materials in order to harvest energy from people walking vibration for generating and accumulating the energy. Piezoelectric materials can be used as mechanisms to transfer mechanical energy, usually ambient vibration, into electric energy that can be sorted and used to power other devices. A piezoelectric substance is one that produces an electric charge when a mechanical stress is applied.

Key Words: Energy harvesting, Piezoelectric material, External pressure.

1. INTRODUCTION

In the recent years there has been an increasing interest in research and development of advanced smart phone technology. But as technology evolves so do the problems associated with it. One among those is the fast draining out of the battery. Almost every smart phone user wishes he had more battery life. Now, imagine charging your batteries where ever you go. This is possible by piezoelectric power generation and wireless transfer mobile charging techniques.

Mechanical energy is one of the most ubiquitous energies that can be reused in our surroundings. The sources of mechanical energy can be vibrating structures, a moving object, and vibration induced by flowing air or water. Harvesting mechanical energy from human motion is an attractive approach for obtaining clean and sustainable electric energy. Piezoelectricity is the energy produced when pressure is applied on a piezoelectric sensor piezoelectric charge is produced on the expanded side and a positive charge is produced on the compressed side of the piezoelectric crystal. Once the pressure is relieved, electrical current flows across the material. Wireless power or wireless energy transmission is the transmission of electrical energy from a power source to a load without any physical connector such as wires or conductors.

Energy is harvested from the human movements and is transmitted wirelessly through wireless power transfer technique and is used to charge the mobile battery.

2. LITERATURE SURVEY AND SUMMARY

2.1 ENERGY HARVESTING BY PIEZOELECTRIC ELEMENTS

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 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)

2.2 ULTRASONIC SENSORS FOR DETECTION OF OBSTACLES

Over the last several years, indoor mobile robot systems not only for industrial use but also for home or office use have been developed. When the robot works in a narrow workspace, it often collides with obstacles. One of the causes of the collisions was an arrangement of circumambient obstacles. The robot often works in an unknown workspace where there are no maps prepared previously. A simple obstacle arrangement detection algorithm for the workspace map creation is proposed.

The algorithm uses ultrasonic stereo sonar and a single image sensor. The stereo sonar can measure by the distance detection accuracy that is approximately 13 mm of errors out of 1300 mm and the angular detection accuracy that is approximately a few degrees of errors. The image processing algorithm can measure angles of corners and/or edges of obstacles using a laser line generator as an extra light source. An obstacle arrangement detection algorithm that uses combining ultrasonic stereo sonar and a single image sensor is proposed. It is confirmed the distance measurement accuracy and the position detection accuracy of ultrasonic stereo sonar. In the experimental results, the error rate of distance is approximately 2% and the error of angle detection is in a few degrees. It is also confirmed the spatial feature detection algorithm using an image sensor. It can detect accurate direction of obstacles. (4)

Ultrasonic motion sensors consist of transmitters that emit ultrasonic sound pulses into the monitored area, which would return immediately when it encounters obstacles on the way and a receiver acknowledges the return of the signal. Transmitted sound uses air as medium. Distance measurement is done with respect to the time delay between transmission and reception. This system is based on many such detectors that are arranged in an efficient manner, the outputs of these various sensors are used to determine and decide the movement of the object. The aim of this paper is to realize the design of a sensor array which can detect motion in any environment or medium and also be economically viable and portable. The system is aimed at short range but accurate detection. The system can also be used to trigger external circuitry that can perform certain tasks without human intervention which makes it ideal for use in remote security systems. The sound used are pulses of 40kHz frequency and hence cannot be detected by the human ear, making the system undetectable. The system is useful in environments with moving objects, without which the system continues to scan for moving objects indefinitely till said object is found. This system will be achieved with very little computational power which makes this ideal for many situations. The system after design and construction was found to work as per the conceptual idea. Though there are wide selections of sensor types that can acknowledge motion, this system has the uniqueness of using low powered ultrasonic to achieve the task. This device can sense the movement of animals or objects within the range of detection. System can be implemented on various platforms since it is light weight and very power efficient. It is designed to output data serially so that the output data can be used for further calculations or storage or display. The system was designed and constructed in accordance to the theoretical concept, testing showed promising results that match the conceptual idea. (5)

Ultrasonic sensors are adopted to implement a real-time obstacle avoidance system for wheeled robots, so that the robot can continually detect surroundings, avoid obstacles, and move toward the target area. Secondly, six ultrasound sensors installed on the wheeled robot were utilized to detect large obstacles and to obtain distance information between the robot and the obstacle. The PD controller was used in the wall-following method to achieve the optimized path design. Experimental results verified that ultrasonic sensors of the obstacle avoidance system on the wheeled robot, with ATmega162 embedded microcontroller as the core of the system, can indeed help avoid obstacles and reach the established target area. The main contribution of this study is the establishment of a working platform for an obstacle avoidance system for small robots. The entire development, including hardware assembly, unit testing, system integration, and writing of the embedded microcontroller driving program in assembly language, were carried out systematically. Distance information, obtained by ultrasound sensors, which is suitable for point-to-point detection, is used in the wall following method to ensure that the wheeled mobile robot avoids large obstacles. The system uses a third-generation ATmega162 chips as microcontrollers of the robot to obtain the information of six ultrasonic sensors. (6)

2.3 FOOTSTEP POWER GENERATION USING PIEZOELCTRIC SENSORS

Paper (7) presents the design of power generation using footstep based on available piezoelectric sensors. Human race requires energy at very rapid rate for their living and wellbeing from the time of their arrival on this planet, because of this reason power resources have been worn out and enervated. Proposal for the employment and application of extravagant energy in foots of human is very much to the purpose for extremely populated nations like China and India. Where the streets, rail and bus station are over peopled and packed like sardines moving around the clock. So, using such concept the power can be availed and deployed by converting mechanical energy to electrical energy. We have calculated the various methodologies for foot step generation using piezoelectric sensors. The Experimental setup is discussed with all sub equipment. The results have been discussed in terms of output voltages. The plot between current and voltage shows the extent of power generated. The various merits are power generation is simply walking on the step and no need of fuel, power may also be generated by running or exercising on the step and battery may be used to store the conventional power.(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 micropatterned 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 PVDF-TrFE thin film has large potential in various self-powered pressure sensors. (9)

3. PROPOSED WORK

In this project we are making use of piezoelectric sensors for generating power. The piezoelectric sensors are stacked on top of each other to generate more voltage when the pressure is applied on the stack of sensors. The generated power is divided using a power divider circuit, As in this project we are implementing two applications, the power generated by the piezoelectric sensors is giving supply to the load i.e., for mobile charging, as well as a power supply to the Arduino UNO which is in turn connected to the ultrasonic sensors.

An ultrasonic sensor module, HC-SR04 is used for obstacle detection in the path of the blind person and a buzzer is used to alert the person. It can detect obstacle within a certain specified range of distance.

This project mainly focuses on the perspective to make efficient utilization of human energy which is being unused. Another focus is on energy transfer through wired medium. Non-radiative energy transfer is safe for humans as well as animals. This project serves two applications one is a charging point for your load i.e., your mobile phone and the other application using an ultrasonic sensor, HC-SR04 is being used for obstacle detection in the path of the blind person and a buzzer is used to make the person alert. It can detect obstacle within a certain specified range of distance.

4. METHODOLOGY

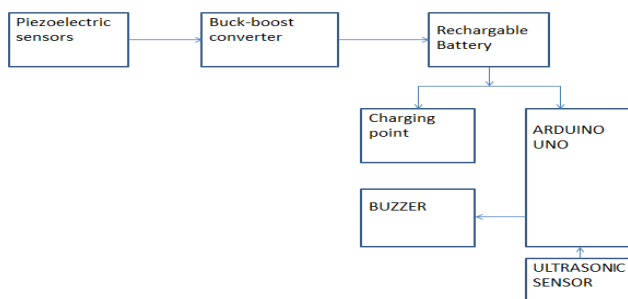


Fig -1: Power generation using piezoelectric materials block diagram

In this project, when the pressure is applied on piezoelectric sensor the power is generated, this power is stored in the battery. We can use the power saved in the battery to charge the mobile phones. On the other hand the battery acts as the supply source to the Arduino to which the ultra-sonic sensors are connected. The ultra-sonic sensors help in detecting the obstacles and alert the blind person about the obstacles along the path he walks.

5. CONCLUSION

Energy is one of the most important issues around the world. Renewable energy sources can be a great media to solve this energy crisis problem. Renewable sources of energy is not rendered free and its price keeps increasing.

Energy generated by movement (when people walk, run, jog, jump) is left unused. Charging of batteries has not been flexible. We cannot carry portable mobile chargers everywhere and find a socket to charge them. The main aim of this project is to develop a much easier and efficient way for power generation. Here, we have illustrated the design of system which can harness the power generated by the human movements and transfer the power to a device. We believe that this research holds the key to an uninterrupted way of using smart phones. This system can also be built shoe independent and as a compact version that can strap on to any shoe.

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