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Harnessing Energy from Piezo Sensors Through Footsteps

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Abstract: Energy consumption represents the development of the universe. Non conventional energy system is very essential at this time to our nation. Modern world requires a large amount of electrical energy to meet the current demand. But the conventional energy resources are diminishing steadily as a result of vast consumption of energy. So, alternate energy sources are required not to fill up the gap between demand and supply of electricity but also they should be clean, Eco-friendly and sustainable. The main aim of this proposed system is to meet the Energy crisis. This paper is about the generation of electricity through foot steps. The idea is to utilize the force (ie weight energy) exerted on the floor when a person walks . The power generating floor intends to translate the mechanical stress applied on the floor to electrical power using piezo sensors. This technique utilizes piezoelectric components where deformations produced by different means are directly converted into electrical energy via piezoelectric effect. In this paper we are generating electrical power as a non conventional method by simply walking or running on the piezo plates.

Keywords: Piezoelectric Effect, Boost Converter, ARM Controller, Photo Sensor, Relay unit

I. INTRODUCTION

Energy Harvesting is the process by which energy is derived from external sources and utilized to drive the machines directly or the energy is captured or stored for future use. With the advent of technology, utilization of energy sources has increased tremendously. Piezoelectric energy harvesting is the new and innovative step in the direction of energy harvesting. Piezoelectricity is the ability of some materials (notably crystals and certain ceramics) to generate an electrical potential in response to applied mechanical stress. This may take the form of separation of electric charge across the crystal lattice.

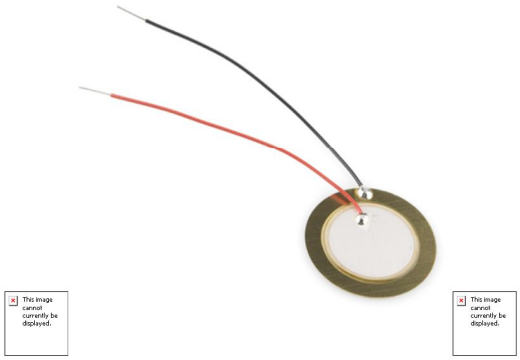


Fig 1. Piezoelectric sensor

The word piezo is traced from the Greek word “piezien”, which means to squeeze or press. In 1880, Curie brothers found that quartz changed its property when subjected to an electric field and generated electric charge when pressure was applied. Since then, researchers have found piezo electric properties in hundreds of ceramic and plastic materials. Harnessing energy from such piezo based resources and making them readily accessible to the end users is one of the prime challenges. There are over 200 piezoelectric materials that could be used for energy harvesting, with the appropriate ones being selected for each application. Although barium titanate was the first piezoelectric ceramic discovered, the ceramic lead zirconate titanate, also known as PZT, is still the most commonly used material for piezoelectric harvesting.

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II. LITERATURE SURVEY

A. Power Generation for Auto Street Light Using PZT- This paper describes the use of piezoelectric plates, and when vehicle pressurizes on the plates reasonable voltage is generated. The AC signal is rectified using bridge rectifiers. The charging circuit charges a 12V battery where the inverter circuit converts this DC voltage to AC voltage. Dark sensing circuit uses to sense the night and switch to inverter so that street light lit on. This paper makes use of a Step up transformer to make the voltage to 250V AC from 15V AC that is converted to 12V DC by a flip flop.

B. Design of footstep power generator using piezoelectric sensors - This paper describes a design where the physical foot interface is layered on chain sprocket arrangement and spring which is connected to the piezoelectric sensors. The sensors generate AC voltage which is converted to DC supply using DC generators; the DC outputs will be stored in two (six volt each) batteries that are connected to an inverter which will convert 12V to 220V AC. The AC output power will used in running of load.

C. Power Generating Slabs: Lost energy conversion of human locomotive force into electrical energy - This paper describes the design which consists of a top plane made up of iron on to which the force of footsteps is exerted. Below the top place helical springs are used. A rack and a pinion arrangement is attached along with the top plane which converts the mechanical force into rotational force. A dynamo is used for producing the direct current. The dc current is produced with the help of a commutator. The produced voltage is stored in a battery.

III. PROPOSED SYSTEM

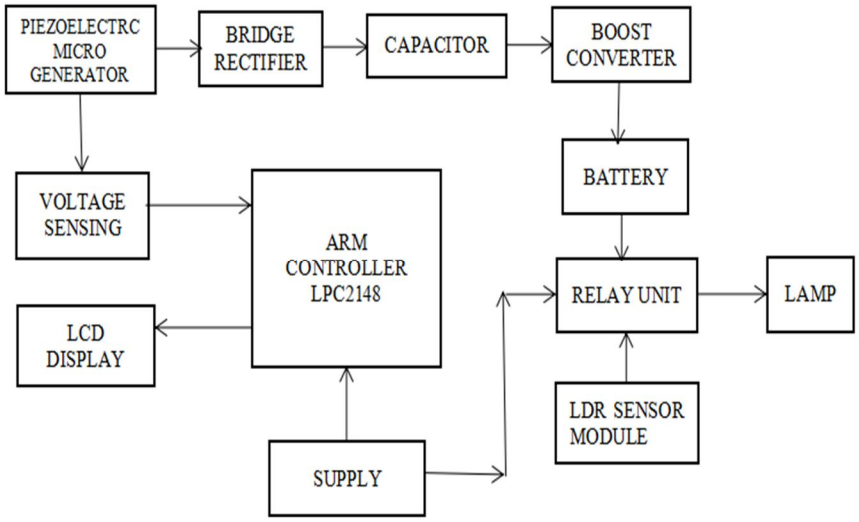


Fig 2. Block Diagram of the proposed system.

The proposed system, is aimed at storing the energy generated during day time in batteries, and can be used during night. The proposed system is developed using a micro controller based boost converter and photo sensor to sense day/night condition. The output of piezoelectric sensor based micro generator will be a very low power ac voltage signal at random frequency. During day time the output of micro generator can be rectified and boosted using a suitable converter, and stored in batteries. During night the relay will switch using a transistor to power the lighting system. The voltage generated by the piezo sensors is measured through the analog port of the ARM Controller and displayed using the 16 * 2 LCD display. The voltage supplied to the analog port should be 3.3V so the generated voltage from the piezo is divided using a set of three, 1kohm resistors in series forming a voltage divider to divide the voltage to suit the requirement. The relay has to be provided with an external supply of 12V to power it up. The LDR sensor module senses the day or night condition and the relay switches the voltage stored in the battery to the lamp during night time. And during the day the relay is off.

A. Piezoelectric Microgenerator

Piezoelectric Effect is the ability of certain materials to generate an electric charge in response to applied mechanical stress. The most commonly used piezo material is in crystal form, but they are also found as plastics and ceramics. Quartz crystals are the most

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commonly used piezoelectric micro generators. The Piezosensors have been placed as 3 channels with each channel consisting of 4 sensors. The entire system is connected in parallel.

B. Boost Power Converter



Fig 3. DC-DC boost converter.

MOSFET acts as a switch which turns ON the boost converter. The snubber circuit is used for the protection of MOSFET. The boost converter consists of an inductor and capacitor which acts as a resonance circuit. When resonance occurs in the circuit, boosting of voltage is done.

C. Relay Unit



Fig 4. Relay unit.

A relay can be defined as a switch. Switches are generally used to close or open the circuit manually . Relay is also a switch that connects or disconnects two circuits. But instead of manual operation a relay is applied with electrical signal, which in turn connects or disconnects another circuit.

D. Photosensor



Fig 5. Photosensor Module.

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Photosensor is a device or a sensor used to detect day and night condition. The resistance of resistor in the photosensor increases in night and resistance reduces in the day time. The output of photosensor is given to the arm controller which controls the transistors.

E. LCD Display

LCD screen is a electronic dip lay module used for displaying results of various parameters like voltage,resistance etc. A very commonly used LCD screen is 16x2 LCD diplay which is a very basic module.

F. ARM Controller

A general purpose 32 bit microcontroller ARM7 TDMI-S is used. High performance and a very low power consumption is offered by the microcontroller. A unique architectural strategy known as a thumb which makes it suited to large volume applications with mory restrictions. Due to their tiny size and low power consumption, LPC2148 are ideal for applications where miniaturization is a key requirement, such as access control and point-of-sale.

G. Battery

The Battery used is a 12V,1.3A sealed lead acid battery which is maintenance free, valve regulated and leak proof and ideally suited to all standby applications. There will be no loss in power output over the battery life. Low self-discharge of about 2-3% per month compared with 20-30% for more common battery systems.

IV. RESULTS AND DISCUSSION

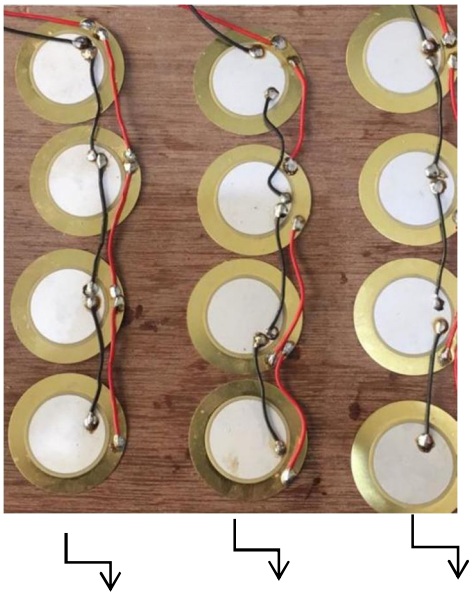


Fig 6. Parallel connection of 12 piezoelectric sensors with 4sensors in each channel.

Table 1. Voltage and current generated by each channel of piezoelectric sensors.

Channel	DC Voltage (Volts)	DC current (mA)	Power(Watts)
1	3.86V dc	150mA	0.579W
2	2.80V dc	150mA	0.42W
3	4.45V dc	150mA	0.6675W

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Trial no:	Capacitor Voltage (Volts)
1	0.85
2	1.57
3	2.05
4	2.44
5	2.64
6	3.03
7	3.20
8	3.27
9	3.34
10	3.85
11	4.08
12	4.16
13	4.46
14	4.50
15	4.70
16	4.84

Table 2. Capacitor voltages for various trials of pressure applied on the piezoelectric sensors.

The above table gives the values of voltage generated across the capacitor on applying pressure on the piezoelectric sensors for various trials. In this way, the energy can be stored in the capacitor by charging the capacitor, and the capacitor may be discharged on the basis of requirement. However the energy harvesting capacity of this circuit is not very much appreciable. To overcome this problem, after bridge rectifier stage, one may use a DC to DC converter. The voltage is boosted to 15V and stored in the battery to drive the lamp.

A. Experimental setup

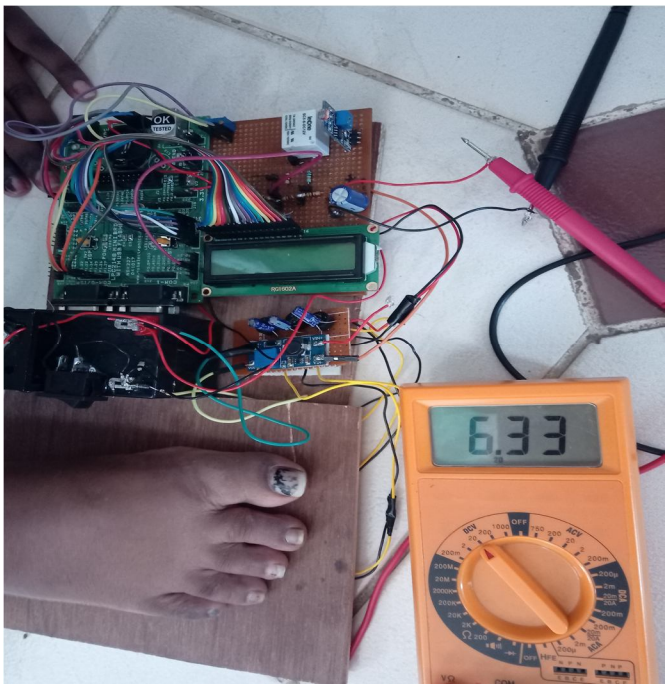


Fig 7 Implemented system to observe the capacitor voltage generated for various trials of pressure applied.

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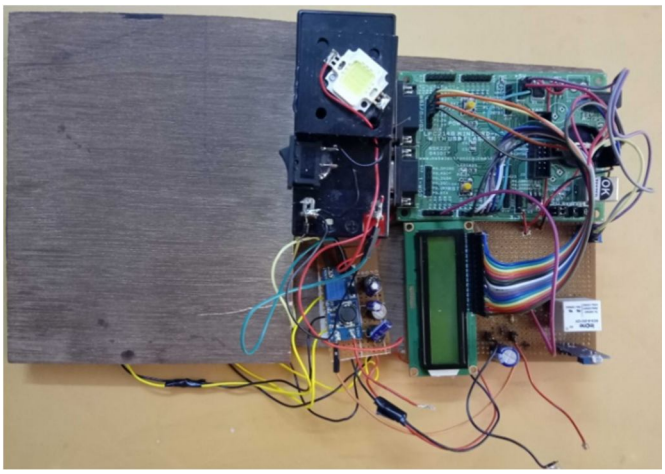


Fig 8. Overall Setup.

The piezo sensors are placed below the wooden plank in the order showed in the following figure.

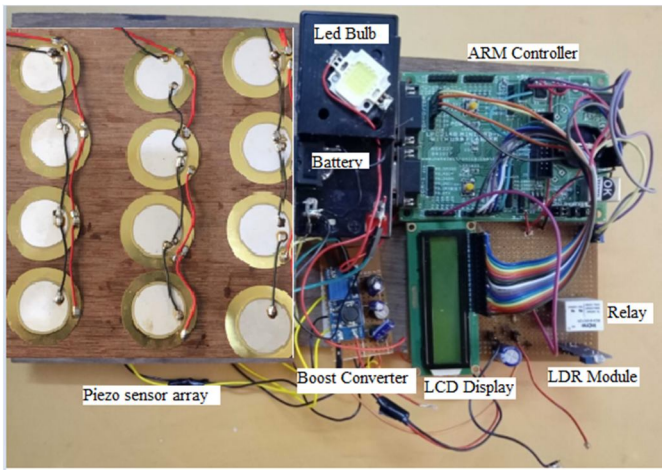


Fig 9. Image shows how the piezo sensors are placed below the wooden plank.

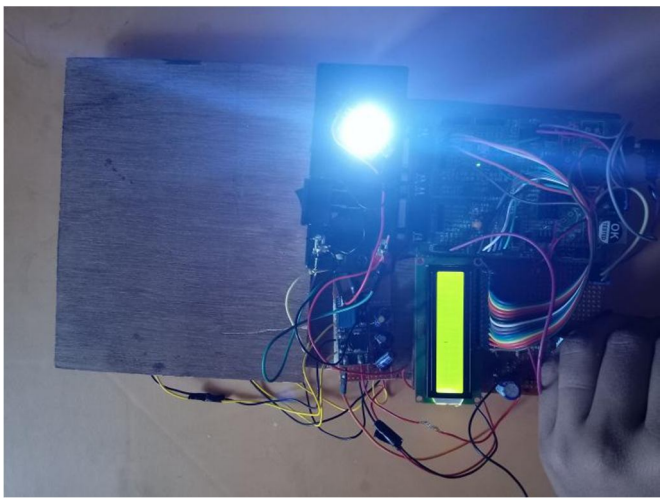


Fig 10. Image shows the light output from lamp when its dark

This above image shows that light glows from the dc led bulb when the photo sensor is closed which represents darkness

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Fig 11. Generated voltage displayed on the LCD.

The above image shows the constant capacitor voltage at a particular instant of time.

V. CONCLUSION

The proposed system is implemented using various module such as Piezoelectric microgeneerator, Boost converter, Battery, Relay unit, LDR and an LCD Display. A low power consuming ARM LPC2148 Controller is used for ADC interfacing and to display the generated voltage on the LCD Display. The voltage generated by the piezo sensors being low, is boosted using a Boost converter to about 15V and stored in the battery to power the 12V DC led bulb. The LDR sensor module detects whether its day or night and the Relay unit performs the work of switching the voltsge stored in the battery to power up the lamp when its night. The implemented system is a resource of renewable energy and power generation using this technology is not only environmental friendly but also clean, cost effective and asafe. Sustainable development is possible by adopting this technology. If this technique is implemented industrially and further research is done on materials and design, the efficiency will be a lot better. Then this system can be viewed as a next promising source of generating power.

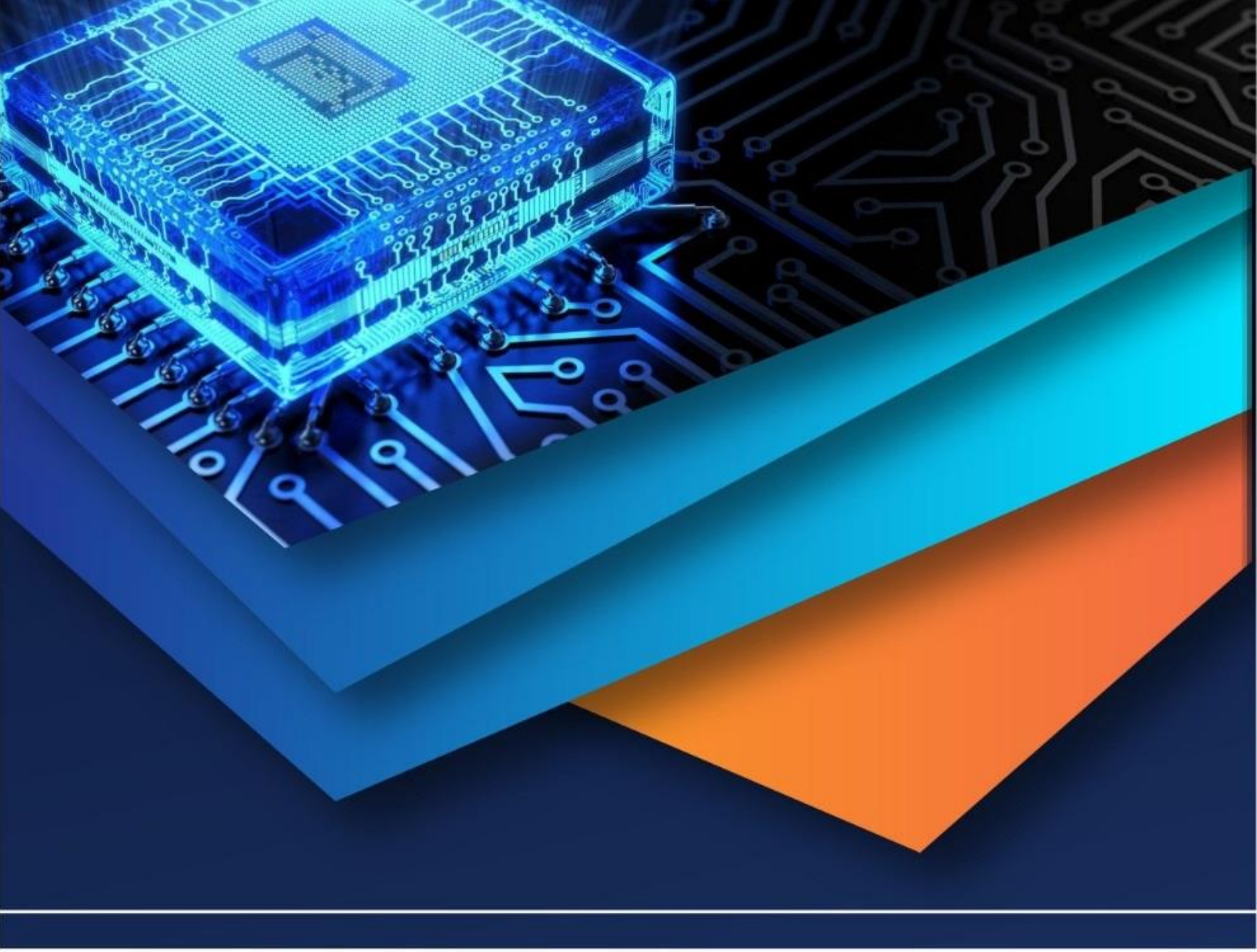
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