Foot Step Power Generation

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Abstract: ***The increase in energy consumption of portable electronic devices and the concept of harvesting re-newable energy in human surrounding arouses a renewed interest. This technical paper focuses on one such advanced method of energy harvesting using piezoelectric material. Piezoelectric materials can be used as mechanisms to transfer mechanical energy, usually ambient vibration, into electrical energy that can be stored and used to power other devices. A piezoelectric substance is one that produces an electric charge when a mechanical stress is applied. Conversely, a mechanical deformation is produced when an electric field is applied. Piezo-film can generate enough electrical density that can be stored in a rechargeable battery for later use. Piezoelectric materials have a vast application in real fields. Some of the latest applications are mentioned below. Currently, there is a need to utilize alternative forms of energy at passenger terminals like airports and railways across the world. Cleaner, more sustainable forms of electrical power are needed in order to keep costs lower, to maintain positive and productive relationships with neighbors and to insure a healthier environment for future generations. The use of piezoelectric devices installed in terminals will enable the capturing of kinetic energy from foot traffic. This energy can then be used to offset some of the power coming from the main grid. Such a source of power can then be used to operate lighting systems. The increasing prevalence and portability of com- pact, low power electronics requires reliable power sources. Compared to batteries, ambient energy harvesting devices show much potential as power sources. A piezoelectric generator can be developed that harvests mechanical vibrations energy available on a bicycle. The electrical energy thus produced can be used to power devices aboard the bike, or other portable devices that the cyclist uses. Electrical energy can also be generated from traffic vibrations (vibrations in the road surface) using piezoelectric material***

Keywords: ADC – Analog to Digital Converter

1. Introduction

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 tapped and converted in the usable form such as in electrical form. This device, if embedded in the footpath, can convert foot 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. In this context, pedal power is an excellent source of energy and has been in use since the nineteenth century making use of the most powerful muscles in the body. Ninety-five percent of the exertion put into pedal power is converted into energy. Pedal power can be applied to a wide range of jobs and is a simple, cheap, and convenient source of energy. 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

2. A Need for the System

- Proposal for the utilization of waste energy of 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, temples, etc. are all over crowded and millions of people move around the clock. This whole human/bioenergy being wasted if can be made possible for utilization it will be great invention and crowd energy farms will be very useful energy sources in crowded countries. Walking across a "Crowd Farm," floor, then, will be a fun for idle people who can improve their health by exercising in such farms with earning. The electrical energy generated at such farms will be useful for nearby applications
- The utilization of waste energy of foot power with human motion is very important for highly populated countries
- India and China where the roads, railway stations, temples, etc. are all over crowded and millions of people move around the clock.

3. Working

The basic working principle of our project is based on the piezoelectric sensor. The cardinal block diagram of the working is demonstrated below in the block diagram figure 1.

3.1 Block Diagram

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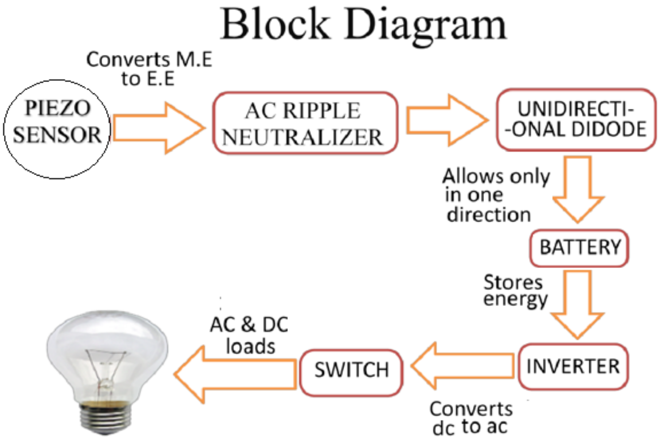

Figure 1: Cardinal Block Diagram

3.2 Approach towards the Working Model

To implement this we adjust the wooden plates above and below the sensors and moveable springs as shown in figure 2. Aachieving non-conventional energy using foot step is simply converting mechanical energy into electrical energy. The Foot step board consists of 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 stored in the 12v rechargeable battery which is connected to inverter. The battery charging system used here is conventional battery charging unit which is also used 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 and by using this AC voltage we can operate AC loads.

Figure 2: Arrangement of wooden plates over the sensors and movable springs

3.3 Energy Storing Table

The power generated by the foot step generator can be stored in an energy storing device. The output of the generator is fed to a 12 V lead acid battery, through an AC-DC converter bridge. The FSEC was operated by applying foot load and energy was stored in the battery which was completely discharged initially. A 100 W, 230V bulb was connected to the battery through an inverter. The duration of lighting, the bulb for number of footsteps and corresponding energy stored, are given in Figure 3.

No. of foot steps	Duration of lighting a 100 watt 230 Volt bulb (s)	Total Energy (J)	Energy/ Step (J)
250	6	600	2.4
500	12	1200	2.4
750	18	1800	2.4
1000	25	2500	2.4

Figure 3: Energy Storing Table

The piezoelectric material converts the pressure applied to it into electrical energy. The source of pressure can be either from the weight of the moving vehicles or from the weight of the people walking over it. The output of the piezoelectric material is not a steady. So a bridge circuit is used to convert this variable voltage into a linear one. Again an AC ripple filter is used to filter out any further fluctuations in the output. The output DC voltage is then stored in a rechargeable battery. As the power output from a single piezo-film was extremely low, combination of few Piezo films was investigated. Two possible connections were tested - parallel and series connections. The parallel connection did not show significant increase in the voltage output. With series connection, additional piezo-film results in increased of voltage output but not in linear proportion. So here a combination of both parallel and series connection is employed for producing 40V voltage output with high current density. From battery provisions are provided to connect dc load. An inverter is connected to battery to provide provision to connect AC load. The voltage produced across the tile can be seen in a LCD

3.4 List of Components Used

1) Piezoelectric Sensors – The setup subsumes 16 sensors which are connected in parallel as shown in figure 4 below.

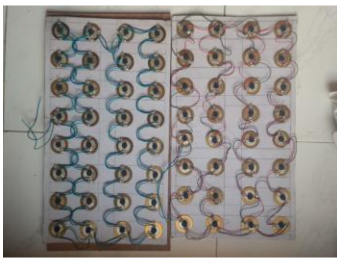

Figure 4: Arrangement of Piezoelectric Sensors in parallel circuit

2) Battery – The circuit contains lead acid battery of 12 volts 7 amps connection with the circuitry.
3) Rectifier – We are using a bridgeway rectifier of DB107 rating for this application

4) Voltage Regulators – Voltage regulators 7805 and 7812 voltage regulators are used.
5) Unidirectional Current Controller – Diode 1N4007 is used to serve the purpose of abstaining the current to one single direction.

4. Calculation of Maximum Theoretical Voltage Generated

When a force is applied on piezo material, a charge is generated across it. Thus, it can be assumed to be an ideal capacitor. Hence, all equations governing capacitors can be applied to it.

In this project, on one tile, we connect 3 piezo in series and 10 such series connections are connected in parallel.

Thus when 3 piezoelectric discs are connected in series, its equivalent capacitance becomes

$$1/C_{eq} = 1/C_1 + 1/C_2 + 1/C_3$$

We know that, $Q = C \times V$

So, $C = Q/V$

$$\therefore V_{eq}/Q = V_1/Q + V_2/Q + V_3/Q$$

Thus, $V_{eq} = V_1 + V_2 + V_3$

Now it can be seen that the net voltage generated in series connection is the sum of individual voltages generated across each piezoelectric disc.

When output voltage from 1 piezo disc is 13V; then,

$$V_{eq} = 13+13+13$$
$$V_{eq} = 39 \text{ Volts}$$

Thus the maximum voltage that can be generated across the piezo tile is around 39V.

5. Analysis Done on the Piezo Tile

People whose weight varied from 40kg to 75 kg were made to walk on the piezo tile to test the voltage generating capacity of the Piezo tile. The relation between the weight of the person and power generated is plotted in figure 5. From the graph it can be seen that, maximum voltage is generated when maximum weight/force is applied. Thus, maximum voltage of 40V is generated across the tile when a weight of 75 Kg is applied on the tile.

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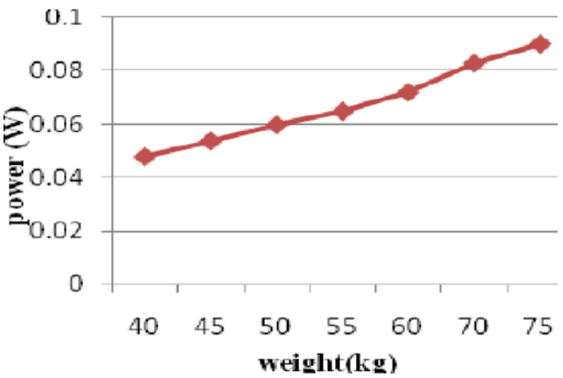

Figure 5: Weight V/s power graph of piezo tile

6. Conclusion

The project "Power Generation Using Foot Step" 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 project we can drive both AC as well as DC loads according to the force we apply on the piezo electric sensor.

A piezo tile capable of generating 40V has been devised. The weight applied on the tile and corresponding voltage generated is studied and they are found to have linear relation. It is especially suited for implementation in crowded areas. This can be used in street lighting without use of long power lines. It can also be used as charging ports, lighting of pavement side buildings.

As a fact only 11% of renewable energy contributes to our primary energy. If this project is deployed then not we can overcome the energy crises problem by some extent. Moreover, this also contributes to create a healthy global environmental change.

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