Power Generation using Piezoelectric Material

Priyanka Baniya[1], Shivanjali Barge[2], Rahul Patil[3], Prof. Poonam Yewale[4]

[1,2,3,4]*B.E Electronics & Telecommunication*

Abstract - In this paper we tried to developed a piezoelectric generator that can produce energy from vibration & pressure available on it. To meet the needs of the development of new energy sources and demand, this paper introduces a piezoelectric power generation system. This project describes the use of piezoelectric material to use energy from people walking, moving vehicles and other mechanical pressures. This concept is also useful to some large vibrating sources which are found from nature. This concept is cost effective and easy to implement. Finally the actual operation results are analyzed and studied. This project has the advantages of energy saving, pollution-free which is good for development.

1. Introduction

Now a day's energy is one of the most important issues around the world specially in countries where energy crisis is a big problem. As we know natural resources will finish one day. That's why researchers are trying to find out energy sources from nature. That must be not harmful for the environment. Humans have already started to use energy harvesting technology in the form of windmill, geothermal, solar energy and piezoelectric material. They are known as renewable energy which is generated from natural resources. These Renewable energy harvesting plants generate MW level power; it is called macro energy harvesting technology. Micro energy can also be produced from these natural sources that are called micro energy harvesting plants. This Micro energy harvesting technology is based on mechanical vibration, mechanical stress and strain, which can generate mW or μW level power. Our aim is to generate electrical energy from vibration and pressure using piezoelectric material.

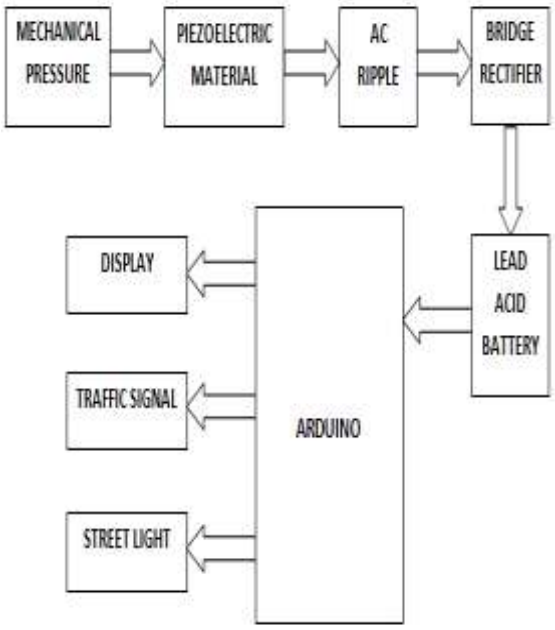
2. Literature survey

The capacity of piezoelectric effect in energy harvesting model has also been discussed by I. Patel, (2010) stating that a previous modelling study by Starner,(1996) in which he showed that 5 Watt of electrical power or energy can be generated by a 52 kg person at a walking path using a PVDF (polyvinylidene fluoride) energy harvesting device integrated in a shoe.

The searches of this experiment have covered the way energy can be stored using a bridge rectifier and a capacitor.

Energy generation by piezoelectric material through the impact of rain drops has also been proposed and proven in the principle (R.Guigon, 2008)

3. Block Diagram



a) Block Diagram Description

The Block diagram consists of Piezoelectric material where the applied mechanical pressure is from an external source and the corresponding vibrations are transferred to piezo material. The ability of certain materials to generate and withstand an electrical potential is referred as "PIEZO ELECTRICITY". An Alternating voltage is generated from this Piezoelectric material. This generated Alternating voltage has to be converted that is rectified using AC to DC converter. This rectified DC voltage should be stepped up using a boost up converter that is a type of DC to DC converter. The generated DC voltage is then stored in a storage element which is a battery.

4. Piezoelectric Sensor

Recently most of the research in the energy field is to develop sources of energy for future use. It is necessary to find renewable sources of energy for the future scope. Piezoelectric materials are more and more researched as they turn out to be very useful and unusual materials with very specific and interesting properties. These materials have the ability to produce

electrical energy from mechanical stress or pressure example they can convert mechanical stress like vibrations, tension etc into electricity. Such devices are referred to as energy harvesters and can be used in various applications where outside power is unavailable and batteries are not a better option. Recent experiments have shown that these materials can be used as power generators.

Piezoelectric materials have two properties that is direct and converse effect. Direct effect is the property of certain materials to develop electric change on their surface when mechanical stress is applied on them, while converse effect is the property of certain materials to develop mechanical stress when an electric charge is induced in them.

"PIEZOELECTICITY" also called as the piezoelectric effect, is the ability of certain materials to generate an AC (alternating current) voltage when subjected to mechanical stress or vibration.

"ENERGY HARVESTING" refers to the generation of energy from sources such as temperature, vibration or air flow. Piezo elements convert the kinetic energy from vibrations or shocks into electrical energy.

5. Full-wave Bridge Rectifier

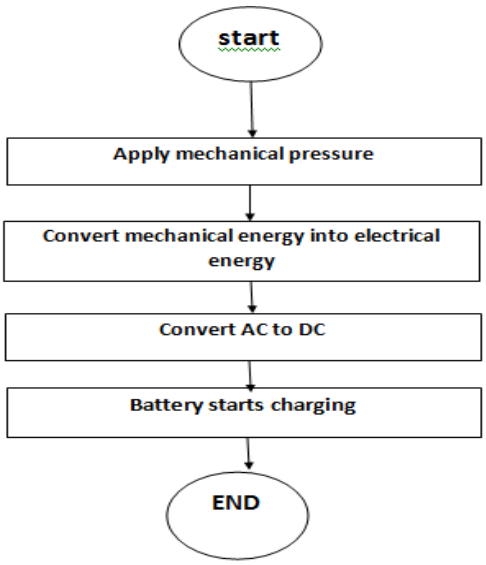
Full-bridge rectifier is used as rectifier circuits to convert the AC output of a piezoelectric material into a DC voltage. The rectifier circuit consist of 4 diodes. The voltage needs to be rectified due to the need of constant supply of voltage to light up the series of LED placed in parallel.

6. Lead-Acid Battery

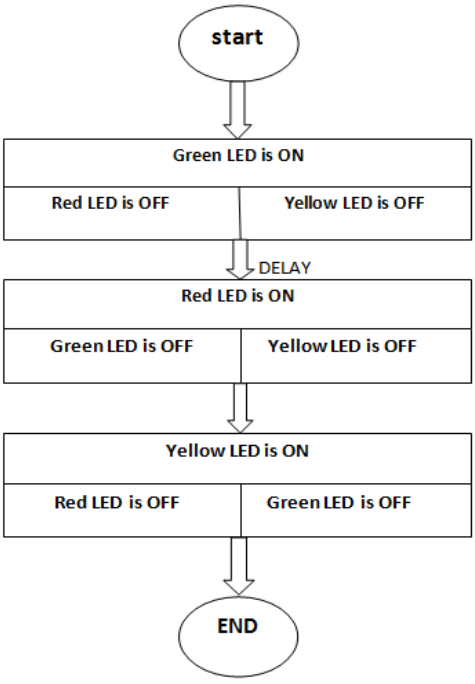
Battery is an array of electrochemical cells for storage of electricity, either linked individually or linked together and housed in a single unit. Electrical batteries are a combination of one or more electrochemical cells, used for the conversion of stored chemical energy into electrical energy. Also used for Battery standby power applications. Devices such as Hearing aids and wristwatches are powered by Miniature cells Standby power for telephone exchanges or computer data centres are provided by larger batteries.

7. Flowchart

a) Hardware



b) Software



8. ARDUINO

ARDUINO SPECIFICATIONS:-

PARAMETERS VALUE

1. Input voltage 7-12V

2. Temperature range

3. Input voltage limits 6-20V

4. Analog i/p pins 6 (A0-A5)

5. DC current on I/O pins 40mA

6. DC current on 3.3V pin 50mA

7. Operating Voltage Range (V) 5v

8. Digital I/O Pin Count 14(Out of which 6 provide PWM o/p)

9. Flash memory 32 KB

11. Data EEPROM (bytes) 1 KB

12. SRAM Bytes 2 KB

13. Frequency (clock speed) 16 MHz

Features:

- Microcontroller: ATmega328.
- Operating voltage: 5V.
- Input voltage: 7-12V.
- Analog input pins: 6
- DC current per I/O Pin: 40 Ma
- Flash memory: 32 kb

9. Comparison with existing technology

Sr.no	Authors	Paper /Mechanism	Advantage	Disadvantage
1.	Antaki 2001	Hydraulic system	Battery charging for artificial organs.	Very Heavy
2.	Shenck 2014	Curved patch and flexible stave	RF encoder	Low output power
3.	Leinonen 2012	Moonie	----	Low power

10. Conclusion

The main Aim of this design is to implement reliable and environmental friendly renewable energy sources using foot step power generation to reduce the electricity shortage. In the Recent research papers that relate to piezoelectric power generation concentrate in the fields of mechanical, material, microelectronic science, certain limited and special application areas, for e.g. piezoelectric micro-electro-mechanical (MEM) system, piezoelectric road signs, self-powered piezoelectric power generation shoes, passive safety-belt detecting device and wireless sensor network. This paper also presents right possible application of piezoelectric energy generation in electricity production field. Flexible piezoelectric materials are attractive for power generation applications because of their ability to retain large amount of stress. Piezoelectric materials can convert the vibrating energy into electrical energy. This converted Electrical energy can be used to power other devices or stored for later use.

11. References

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