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Footstep Power Generation System Using Piezoelectric Sensor and Arduino UNO

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Abstract

This project focuses on converting mechanical energy into electrical energy using piezoelectric sensors. When pressure or mechanical weight is applied to a piezoelectric sensor, it detects and generates voltage or current. As global energy resources become increasingly exhausted and renewable energy sources remain insufficient to meet electricity demands, alternative solutions are essential. Walking on floors and stairs generates clean, noiseless and pollution-free energy.The human population represents an abundant and renewable energy sources.

This project generates electrical energy from the movement of pedestrian, such as walking or jogging. This method is ideal for densely populated areas such as schools, colleges, temple or movie theatre where people are constantly in motion. When people walk on piezoelectric steps or platforms, the generated energy is harvested and stored in batteries for later use. This technology can charge mobile phone, laptops, computers, and other electronic devices.

Keywords

Piezoelectric Sensor, Arduino UNO, Battery, Bridge Rectifier, Footstep Power Generation.

Introduction

In Footstep Power Generation System, we have used a piezoelectric sensor and Arduino UNO microcontroller to mechanical energy into electric energy. This electric energy will be stored in a battery, and we can use it we need the electricity. When we press or apply pressure the piezoelectric sensor then it will count the step, and this counted step will convert into electric energy.

It will comprise several key components: bridge rectifier, battery, breadboard, piezoelectric sensor, Arduino UNO and LED strip light. When piezoelectric sensor detects the weight or the pressure then the strip light will activate or deactivate accordingly. Non-conventional energy system is very essential currently to modern nation.A Piezoelectric material is a type of transducer that convert one form of energy into another. This technology is particularly valuable in crowded locations such as railway station, temple, highway and bus stand. Footstep power generation system is mainly used in densely populated countries like India and China. By utilizing this principle, the system can be implemented in areas where mechanical energy is continuously converted into electrical energy. The electric voltage which was produced by the piezoelectric

transducer can easily measure using voltage measuring instruments, which will be measured by the force, and the output will be shown in the LCD Display.

When human will be appliedto the piezoelectric sensor,the minimum voltage for per footstep rangefrom 10V to 15V. This energyis stored in a rechargeable battery. The non-conventional energy generated form footstep converts mechanical energy into electric energy. Rather than wasting human energy produced while walking on roads or streets, this technology harnesses it to generate usable electricity.

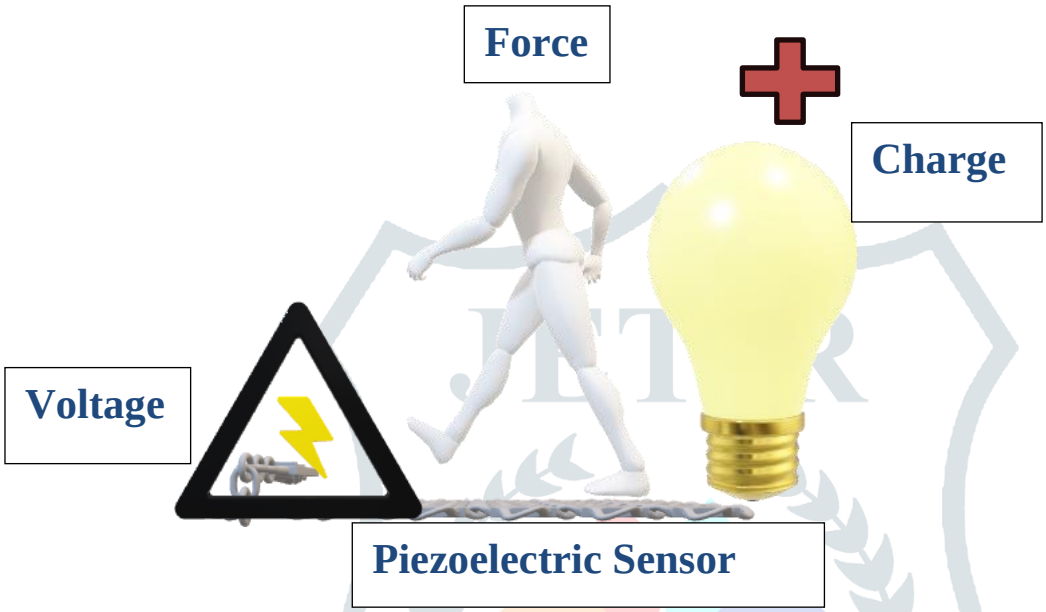

Fig.1 Footstep Power Generation System

Literature Review

Piezoelectric energy harvesting is a simple method of converting mechanical energy into electrical energy. Human footstep can be used as a source of mechanical energy because pressure is produced whenever a person walks. Several researchers have studied piezoelectric material for converting vibration and human motion into electrical energy.

Fakhzan and Muthalif studied vibration-based energy harvesting and showed that piezoelectric materials can convert mechanical vibration into electrical energy. Mitcheson et al. studied energy harvesting from human and machine motion and reported its usefulness for low-power electronic devices.

From these studies, it is clear that footstep energy harvesting is useful for low-power applications. The present work used piezoelectric sensors, a bridge rectifier, rechargeable battery and Arduino UNO to generate, store and monitor electrical energy produced from footsteps.

Proposed Methodology

The proposed footstep power generation system uses a piezoelectric sensor and Arduino UNO microcontroller. The piezoelectric materialconverts mechanical energy into electric energy. When a person walks or the vehicle is moving on the piezoelectric sensor then the electric energy is generated and stored in a rechargeable battery. Since the output of piezoelectric material is not stable, a bridge rectifier is used convert this variable voltage into steady, linear DC voltage. The resulting DC Voltage is stored in rechargeable battery. In this project we have tested both series and parallel connection. As the voltage is generated, the display shows the amount of voltage produced in real time.

The block diagram of the footstep power generation system as follow:

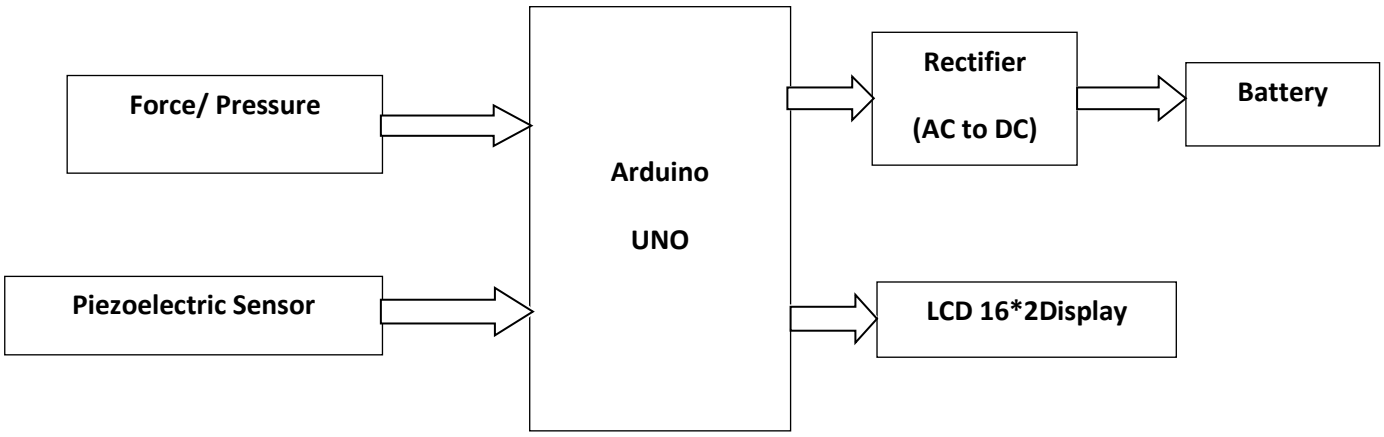

Fig.2 Block Diagram of Footstep Power Generation System

Description of Block Diagram

1. Force/ Pressure Input

When the person stands on or applies pressure to the piezoelectric sensor, mechanical force and pressure are applied to the piezoelectric material. This generates electrical energy, which is subsequently stored in the rechargeable battery.

2. Piezoelectric Sensor

Piezoelectric sensor is a transducer materialthat converts mechanical energy into electrical energy. Whenpressure or force will be applied to the material, it will producea DC Voltage. Generally, this project will be utilised in the road, railway station, temple, school or college, etc.

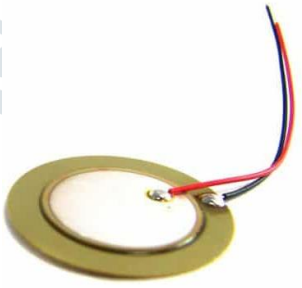

Fig.3 Piezoelectric Sensor

The piezoelectric sensor operates on the piezoelectric effect to measure the displacement, force, pressure, etc and it will convert into electric energy.

3. Rectifier

Rectifier is consisting of Four Diodes and this device is used to change or convert AC into DC output. Rectifier is classified into two types where as follows

a. Full Wave Rectification
b. Half Wave Rectification

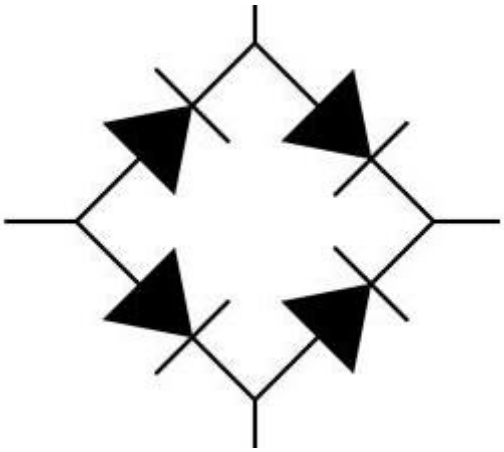

Fig. 4 Rectifier

In this project, piezoelectric sensor will produce the variable DC output while we apply the pressure on it, the variable DC output will convert the pure DC by using the rectifier and it will store the energy in the battery.

4. Arduino UNO

Arduino UNO is a popular open-source microcontroller board based on the ATmega328p chip. It features 14 digital input/output pins, 6 analog inputs and 16 MHz Clock. We can connect it to a computer via USB to write and upload the code using Arduino IDE software for simple hardware project.

It will operate 5V and it flash memory will be 32 KB and also clock speed is 16MHz.There is a present of reset button which is present by physically it is used to restart the uploaded program by physically.

Fig.5 Arduino UNO

5. Battery

Battery is used to store the electric energy which was created by piezoelectric pressure / force. It is a rechargeable battery.

6. LCD 16*2 Display

It is device which will show the output of the voltage. An LCD 16*2 display is a basic electronic display screen. LCD means Liquid Crystal Display and 16*2 means 16 columns and 2 rows, for a total 32 characters.

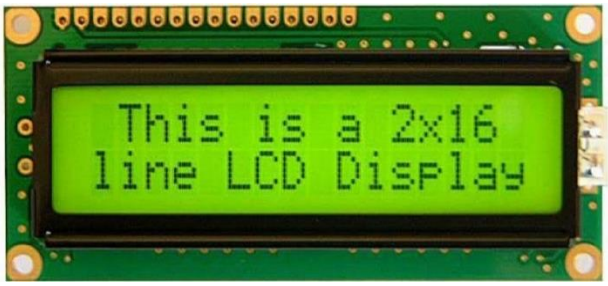

Fig.6 LCD 16*2 Display

Simulation Result

This simulation results demonstrate the functionality of the footstep power generation system. The LCD display shows the step count and voltage output in real time. The test setup successfully counts footsteps and measures the generated voltage, confirming the system ability to convert mechanical energy into electrical energy.

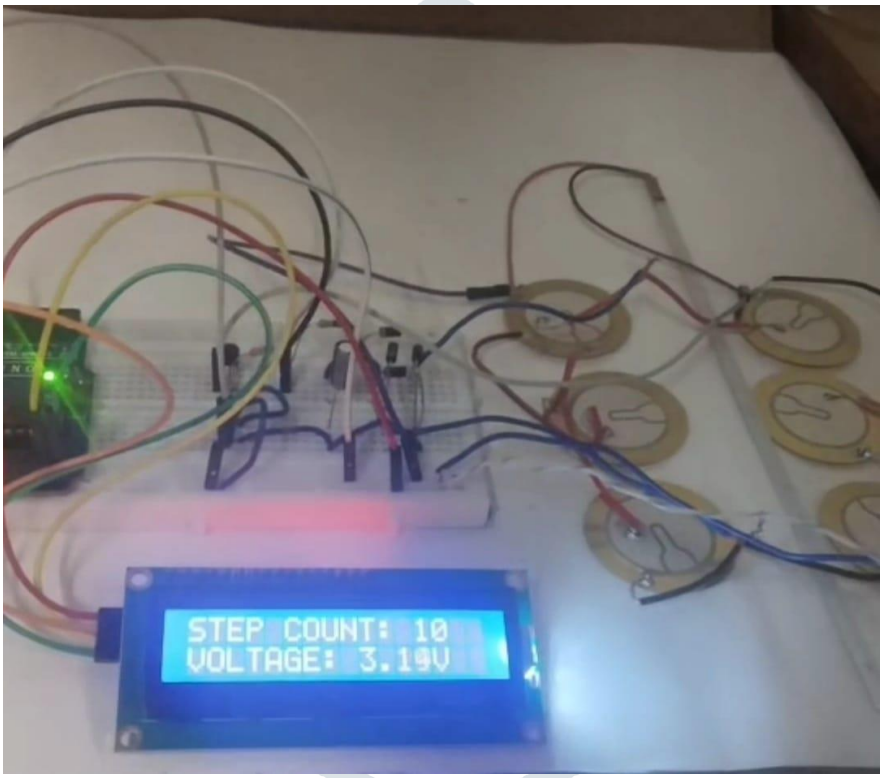

Fig.7 Simulation Result

Conclusion

The Footstep Power Generation System Using Piezoelectric Sensor and Arduino UNO can be effectively implemented in rural and urban areas where the power is available in less, limited or unavailable. This system offers an efficient power generation in highly populated countries. Hence, footstep is the main source of power generation and it is zero percent pollution project.

By implementing this project, we can use both AC and DC drives based on their forces we were apply. To get more electricity we can also increase the piezoelectric sensor. Hence, this project is useful in many areas where was a problem an electricity.

Future Scope

As India is a developing country where the energy management is a big challenge for huge population. After all, human power is readily available in much area with the heavy root of traffic, such as tourism, dancing, etc. This generated energy is simultaneously stored it into the battery. Energy is generated by step of human being is too less but if number of steps increases or a vehicle goes on sensor ultimately energy is produced and also it will be increases.

They implement piezoelectric effect on the stairs of the bus. Japan has already started experiment on this project for energy generation. This is a technology with a wide range of application that is slowly being adopted in the race to develop alternative energy sources.

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