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FOOTSTEP POWER GENERATION USING PIEZO SENSORS

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Abstract - *With an increasing demand for energy in our society today, it is becoming important to look for alternative/renewable forms of energy. One innovative idea to achieve this is called "footstep energy generation" using piezoelectric sensors converting mechanical energy created from walking into electrical energy. The footstep energy generation system consists of piezoelectric sensors placed under floors where you walk. Every time someone walks across these floors and exerts pressure on the floor, it will generate an electrical charge through the piezoelectric effect (due to force applied). An energy collection circuit will collect, rectify, and store any generated energy for use later. This stored power can be used for low power applications such as powering an LED light bulb, charging small electronic devices, or powering sensors in public areas. Footstep energy generation is particularly beneficial in high traffic/public places such as train stations, shopping malls, and pavements where large crowds of people continuously walk over the same location. The footstep energy generation system is cheap, environmentally friendly, and simple to set up.*

Keywords: **Piezoelectric Sensors, Footstep Power Generation, Energy Harvesting, Renewable Energy, Sustainable Technology, Mechanical to Electrical Energy Conversion**

1. INTRODUCTION

We rely heavily on electricity every day and as the world's population continues to grow, so too will the need for electricity. Currently, most of the energy sources we use today are referred to as non-renewable energy sources., Non-renewable sources tend to harm the environment in some way or another. Therefore, there is a growing need for alternative sources of energy to continuously create energy in practical, easy, and environmentally friendly ways. One way to accomplish this is to generate electricity from foot traffic (people walking) with the use of piezoelectric sensors, which produce electrical energy from mechanical pressure.

When there are lots of people walking in an area like a shopping mall, train station, or college campus, a tremendous amount of energy is wasted through foot power. Each time you take a step, you create a small amount of electricity through the use of piezoelectric sensors, but when you have continuous foot traffic, you can create enough energy over time that can be used meaningfully.

2.Problem Statement

As demand for electric power increases, most energy sources are harmful to the environment and do not qualify as renewable. Additionally, there is a waste of energy generated by human footsteps each day because a significant amount of mechanical energy is wasted in crowded areas. Existing sources of renewable energy rely upon environmental conditions that may not be available at all times making them impractical for use in the future. A need exists for an effective way to harness footprints to generate useful electricity through an easy to use system.

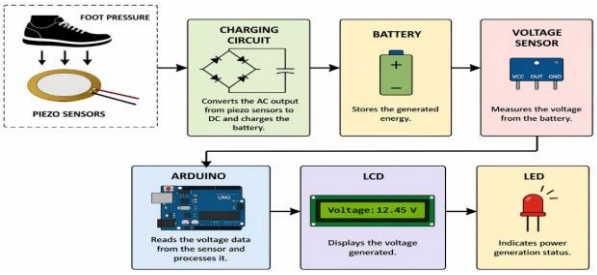

Figure 1: Outline Diagram of Proposed Smart Hybrid Attendance System

Figure 1: Illustrates the functionality of the power generation system by making use of piezoelectric sensors. Electrical energy is produced by applying pressure to the surface. This energy is transformed and stored in the battery via a charging circuit. Voltage is sensed using a sensing technique, and it is processed using the Arduino board. The output is displayed on the LCD and shown using LEDs.

3.Proposed system

The suggested design harnesses electricity from footsteps by making use of piezoelectric transducers. On application of force, the transducer creates an electric potential that is rectified and saved into the battery using a charging circuit. The amount of voltage produced is measured using a voltage sensor, which relays the information to the microcontroller, which in turn displays the data on the LCD monitor. Power generation is indicated by the LED light. The system has been developed to ensure simplicity and ease of installation. This can be done by installing it in highly populated places for increased power production.

4.System Architecture

The system includes the following elements:

- **Piezoelectric Sensors**: Convert mechanical pressure from footsteps into electrical energy.
- **Charging Circuit**: Converts and regulates the generated voltage into usable DC power.
- **Battery**: Stores the generated electrical energy for later use.
- **Voltage Sensor**: Measures the amount of voltage generated and stored in the system.
- **Arduino**: Acts as the main controller, processes sensor data, and manages output.
- **LCD Display**: Shows the generated voltage and system status.
- **LED Indicator**: Indicates when power is being generated.

5.Methodology

5.1System Overview

The Footstep Power Generation System makes use of the Piezo effect that allows converting mechanical energy from footsteps into electrical energy. These are installed in the bottom part of a surface where pressure is exerted while walking. Pressure creates an electrical voltage because of the piezo effect. The voltage is sent to the charger to provide a constant DC power output and is stored in a battery for future use. A voltage sensor captures the produced electrical energy and relays the information to the Arduino, which then controls the display of the data on the LCD and turns the LED ON/OFF.

5.2 Energy Generation using Piezo Sensors

The function of piezoelectric sensors is to harness the mechanical energy from walking motions and transform it into electrical energy. As soon as the person walks on the floor, pressure is exerted on the piezoelectric sensors, which results in the production of electricity. This is made possible through the process of piezoelectricity, whereby specific materials create an electric charge when force is exerted on them.

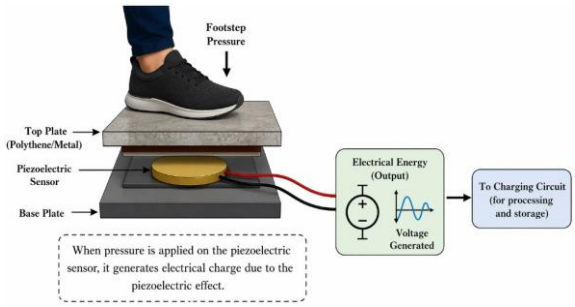

Figure 2: Working of Energy Generation Using Piezoelectric Sensors

Figure 2: The figure shows how piezoelectric sensors generate electrical energy when pressure is applied through footsteps. The produced voltage is then sent to the charging circuit for processing and storage.

5.3 Energy Storage and Voltage Measurement

The electrical energy generated by the piezo sensors is stored in a rechargeable battery for later use. A charging circuit is used to convert and regulate the voltage before storing it. This ensures that the battery receives stable and usable power. A voltage sensor is connected to measure the amount of energy stored in the battery. The measured voltage is then sent to the Arduino for monitoring and display.

Table 1: Experimental Readings of Footstep Power Generation System

Step Count	Voltage (V)	Current (A)	Power (W)	Observation
1 Step	2.5 V	0.001 A	0.0025 W	Low output
5 Steps	3.8 V	0.0015 A	0.0057 W	Moderate increase
10 Steps	5.0 V	0.002 A	0.010 W	Stable output
20 Steps	6.2 V	0.0025 A	0.0155 W	Good output
50 Steps	8.0 V	0.003 A	0.024 W	High output
100 Steps	10.5 V	0.004 A	0.042 W	Maximum observed

5.4 Output Display and Indication

This part represents the way the generated power is presented and used. LED acts as an indicator showing that power is being generated by pressing the button. Voltage data received from the generator is processed by the Arduino board and presented on the LCD screen. The USB charging module is attached to utilize the power generated by the system to charge other gadgets. Power supplied by the battery powers the charging circuitry to produce steady output

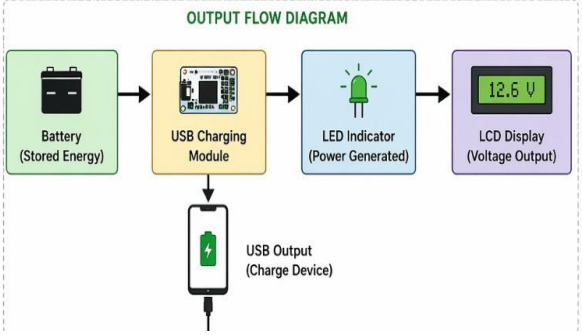

Figure 3: Output Display and Indication System

Figure 3: The figure shows how the generated energy is displayed using an LCD and indicated through an LED. It also illustrates the use of a USB charging module to charge devices using the stored energy.

6. Implementation

Implementation of the system design entails the incorporation of piezo sensors, charging circuit, battery, voltage sensor, Arduino, LCD, and LED. Piezo sensors are installed below the surface where it can sense any pressure caused by walking. As soon as there is pressure, the energy in form of electricity is produced due to piezoelectric phenomenon.

. The produced energy voltage is fed to the charging circuit in order to produce stable DC voltage output. The produced energy is stored in a rechargeable battery. The voltage is measured using a voltage sensor, which sends information to Arduino. Arduino interprets the input data and produces an output on the LCD display. LED indicators used to show production of power. USB module can be attached to make use of stored energy for charging electronic gadgets.

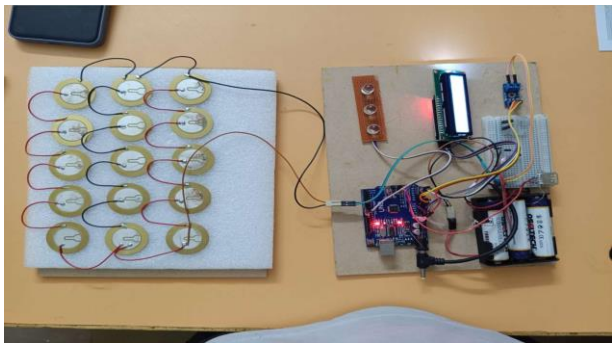

Figure : 4.1

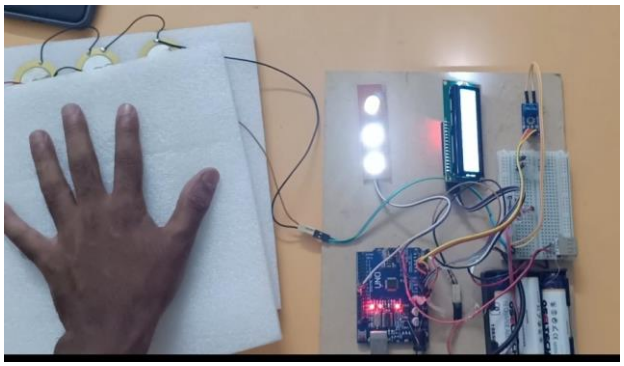

Figure : 4.2

Figure 4: Working of Footstep Power Generation using piezo

Figure 4: The system works by converting mechanical energy from footsteps into electrical energy using piezoelectric sensors. When pressure is applied, the sensors generate voltage, which is then stored and used for low-power applications.

7. Result and discussions

The developed system was then tested for its effectiveness by using various types of footsteps. It can be observed that the piezo sensors produced voltage upon application of pressure. Energy harvested was stored in the battery and detected through a voltage detector. Voltage values were then shown on the LCD, and an LED signified power production. The system was successful in charging portable gadgets with the aid of the USB module.

8.Advantage and Limitation Advantages

- The system generates renewable energy from human footsteps.
- It is simple, cost-effective, and easy to implement.
- It Works in both indoor and outdoor environments without depending on weather.
- Requires low maintenance and is suitable for high footfall areas.

Limitations

The energy generated per step is very small.

- Efficiency depends on the number of people and applied pressure.
- Not suitable for large-scale power generation.
- Output may vary under different conditions.

9. Future Scope

The system can be improved by increasing the number of piezoelectric sensors to generate more energy. Advanced energy storage techniques can be used to enhance efficiency. It can be implemented in crowded places like malls, stations, and public walkways. Improved materials can increase durability and performance. This concept can be combined with other renewable sources for better energy generation.

10. Conclusion

The piezoelectric footstep generator serves as a basic example of converting mechanical energy to electrical energy through piezoelectric sensing. This design effectively harvests and stores energy generated by the mechanical force exerted during human foot movements. This technique is efficient, easy to adopt, and applicable to small-scale projects. Despite producing small amounts of energy, it proves useful in places with a high volume of foot traffic.

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