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Foot Step Power Genration

Aniket Dhumbre, Atharv Kanjane, Priyanka Nila, Mansi Khedekar, Dr. Vaijayanti Deshpande
Zeal College of Engineering and Research, Narhe, Pune, Maharashtra, India

Abstract: *The project explores the use of piezoelectric sensors to generate electrical energy from human footsteps. These sensors convert mechanical stress into electrical energy, which can be harnessed and used in urban environments, public spaces, and smart cities. The technology promotes green energy and reduces dependence on conventional power sources. The sensors are strategically placed beneath walking platforms to maximize energy capture. The generated AC voltage is rectified and stored for low-power applications. This scalable and eco-friendly method can be integrated into future smart city infrastructure, supplementing traditional power supplies and reducing non-renewable resource dependency.*

Keywords: Piezoelectric Sensors, Two Power Generation Methods

I. INTRODUCTION

The "Footstep Power Generation Using Piezoelectric Sensors" project aims to harness the mechanical energy from human footsteps into usable electrical energy. Piezoelectric materials generate an electric charge when mechanical stress is applied, allowing them to be embedded in surfaces like footpaths, stairways, or corridors. This energy can be harnessed for low- energy devices like LED lights or digital displays, and stored in batteries for future use. The project raises awareness about energy harvesting and promotes the use of alternative energy sources in everyday life

OBJECTIVE

- To design and develop a system that harvests electrical energy from human footsteps using piezoelectric sensors.
- To efficiently convert mechanical stress into usable electrical energy.
- To store the generated energy for powering low-energy devices like LEDs, sensors, or small batteries.
- To promote an eco-friendly and sustainable method of energy generation in crowded public areas.
- To analyse the efficiency and scalability of footstep-based energy harvesting systems for real-world applications.

II. COMPONENTS USED

Arduino Uno board

FIG.NO.1 Arduino Uno board

The **Arduino Uno** is one of the most popular microcontroller boards, based on the **ATmega328P**. Here are its key specifications:

Microcontroller: ATmega328P (8-bit AVR)

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Operating Voltage: 5V
Recommended Input Voltage: 7-12V
Input Voltage Limits: 6-20V
Digital I/O Pins: 14 (6 provide PWM output)
Analog Input Pins: 6 (A0 – A5)
DC Current on I/O Pins: 40 mA
DC Current on 3.3V Pin: 50 mA
Flash Memory: 32 KB (0.5 KB used for Bootloader)
SRAM: 2 KB
EEPROM: 1 KB
Clock Speed: 16 MHz

PIEZOELECTRIC SENSOR

FIG.NO.2.Piezoelectric sensor

A piezoelectric sensor is a device that converts mechanical stress into electrical charge using the piezoelectric effect. These sensors are widely used to measure pressure, acceleration, strain, and force in various applications

Working Principle: When mechanical stress is applied to a piezoelectric material, it generates an electrical charge proportional to the force.

Materials Used: Common materials include quartz, tourmaline, and piezo ceramics.

RESISITOR

FIG.NO.3. RESISTOR

A resistor is a passive two-terminal electronic component that implements electrical resistance as a circuit element. In electronic circuits, resistors are used to reduce current flow, adjust signal levels, to divide voltages, bias active elements, and terminate transmission lines, among other uses. A package of material which exhibits a certain resistance made up into a single unit is called a resistor.

VALUE AND TOLERANCE OF RESISTANCE:

Unit of resistance is ohms; the symbol for ohm is an omega. Res. values are normally shown using colored bands. Each color represents a number as shown in the table below.

DIODE

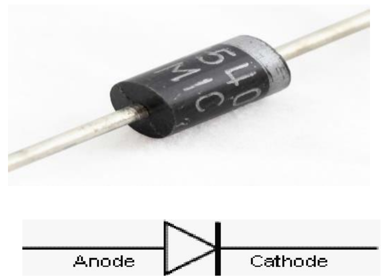

FIG.NO.5. DIODE

A diode is a two-terminal electronic component that allows current to flow primarily in one direction. It acts as a one-way switch, blocking current in the opposite direction.

Diodes are commonly made from semiconductor materials like silicon or germanium.

There are many types of semiconductor diodes namely Selenium, Germanium and Silicon types. Selenium type is commonly used in the early days in ac power suppliers but in recent years it has been replaced by silicon type as it sometimes emits toxic fumes when it burnt out. The characteristic is that it allows current to flow in one direction as shown in the symbol above. It has a cathode and an anode which determine the flow of the current. Current can only flow from anode to cathode. Silicon V-I characteristics are shown in the figure below. The junction barrier for silicon is about 0.7V and for Germanium is about 0.3V. It is also called forward voltage drop. Most of the diode used today is of silicon type as they are robust and reliable from DC to RF small signal applications.

LCD DISPLAY

FIG.NO.6. LCD DISPLAY

Liquid crystal display (LCD), electronic display device that operates by applying a varying electric voltage to a layer of liquid crystal.

LCD is a type of flat panel display technology used in various electronic devices like televisions, computer monitors, smartphones, and calculators.

LCD stands for liquid crystal display.

They come in many sizes 8x1,8x2 , 10x2 , 16x1 , 16x2 , 16x4 , 20x2 ,20x4 24x2 , 30x2 , 32x2 , 40x2 etc. Many multinational companies like Philips Hitachi Panasonic make their own special kind of lcd's to be used in their products. All the lcd's performs the same functions (display characters' numbers special characters ASCII characters etc.) Their programming is also same and they all have same 14 pins (0- 13) or 16 pins (0 to 15).

Capacitor

FIG.NO.7. CAPACITOR

A capacitor is a device that stores electrical energy by accumulating electric charges on two closely spaced surfaces that are insulated from each other. Capacitors are simple passive device that can store an electrical charge on their plates

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when connected to a voltage source. Compact but glossy, these are available in the range of <1 μF to 1 F with working voltages up to several hundred volts DC. The dielectric is a thin layer of aluminum oxide. They contain corrosive liquid and can burst if the device is connected backwards. The oxide insulating layer will tend to deteriorate in the absence of a sufficient rejuvenating voltage, and eventually the capacitor will lose its ability to withstand voltage if voltage is not applied. A capacitor to which this has happened can often be "reformed" by connecting it to a voltage source through a resistor and allowing the resulting current too slowly restore the oxide layer. Bipolar electrolytic (also called Non-Polarized or NP capacitors) contain two capacitors connected in series opposition and are used when the DC bias voltage must occasionally reverse. Bad frequency and temperature characteristics make them unsuited for high-frequency applications

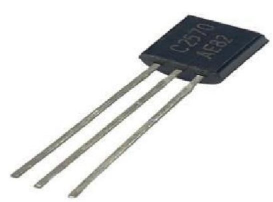
A capacitor or condenser is a passive electronic component consisting of a pair of condenser separated by a dielectric. When a voltage potential difference exists between the conductors, an electric field is present in the dielectric. This field stores energy and produces a mechanical force between the plates. The effect is greatest between wide, flat, parallel, narrowly separated conductors.

Cell Holder

FIG NO.8.CELL HOLDER

The cell-holding device is made of low-melting agarose gel, a material commonly used in biological research. A battery holder is one or more compartments or chambers for holding a battery.

TRANSISTOR



A transistor is a semiconductor device that can amplify or switch electronic signals and power. It is one of the fundamental building blocks of modern electronics.

Key Features of a Transistor:

Amplification: It can take a small electrical signal and make it stronger.

Switching: It can turn electrical signals on and off, acting as a digital switch.

Three-Terminal Structure: It consists of a base, collector, and emitter.

Types: The two main types are Bipolar Junction Transistors (BJT) and Field-Effect Transistors (FET)

BREAD BOARD

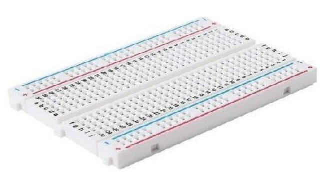


FIG.NO.10. BREAD BOARD

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A breadboard is a tool used for building and testing electronic circuits without soldering. It allows components to be easily connected and rearranged, making it ideal for prototyping.

Key Features:
Solderless Connections: Components are inserted into holes, making it reusable.
Power Rails: Side columns provide power distribution.
Interconnected Rows: Central rows allow easy component placement.

JUMPER WIRES

FIG.NO.11.JUMPER WIRES

Jumper wires are essential components in electronics, used to connect different parts of a circuit without soldering. They are commonly used with breadboards, microcontrollers (like Arduino and Raspberry Pi), and other prototyping tools.

Types of Jumper Wires:
Male-to-Male: Pins on both ends, used to connect two female headers.
Male-to-Female: One pin and one socket, used to connect a male header to a female header.
Female-to-Female: Sockets on both ends, used to connect two male headers.

III. WORKING

Piezoelectric Energy Generation
When mechanical pressure is applied to the piezoelectric sensors**,** such as from foot traffic, vehicle movement, or mechanical vibrations, these sensors generate electrical energy due to the piezoelectric effect**.** This phenomenon enables certain materials to generate a voltage when subjected to mechanical stress.

Output Characteristics:
The electrical energy produced is in the form of alternating current (AC)**.** This is because the pressure applied to the sensor is not constant—it varies with time and direction, leading to fluctuating voltages.

AC to DC Conversion
Since most electronic circuits and controllers operate **on** direct current (DC)**,** the AC output from the sensors must be converted.

Diode Bridge Rectifier:
A bridge rectifier circuit made of four diodes is used to convert AC into pulsating DC. This allows current to flow in only one direction, creating a unidirectional voltage.

Capacitor Filtering:
The rectified voltage still contains ripples. To smooth out these fluctuations, a capacitor is connected across the output of the bridge. The capacitor charges and discharges in response to the voltage changes, effectively filtering the ripples and providing a more stable DC output**.**

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Voltage Regulation and Sensing

The generated DC voltage may be too high for direct input into a microcontroller or sensing circuit, so it needs to be scaled down.

Voltage Divider Circuit:

A voltage divider (typically two resistors in series) is used to reduce the voltage to a level that is safe for the controller (**e**.g.**,** Arduino**,** PIC, ESP32, etc**.)** to read. The controller's analog input pins usually can read voltages up to 3.3V or 5V, so this step ensures compatibility and protect the input pin.

Signal Amplification and Power Indication

To provide a visual indication that energy is being generated:

Transistor Amplifier Circuit:

The rectified and filtered DC voltage can be weak or inconsistent depending on pressure strength. A **transistor** is used here to amplify the current to a level sufficient to drive an **LED**. When pressure is applied and power is generated, the LED lights up, indicating the system is actively producing electricity.

Energy Storage

Battery Charging:

To make the energy useful even when no pressure is applied (e.g., when the sensor is idle), the DC voltage is used to charge a rechargeable battery (such as a Li-ion cell or super capacitor). This stored energy ensures that the system can still operate (power a display or controller) when the piezo sensor is inactive.

Controller and Display System

The microcontroller plays a key role in monitoring and managing the system.

It reads the voltage level (via the scaled-down signal from the voltage divider)

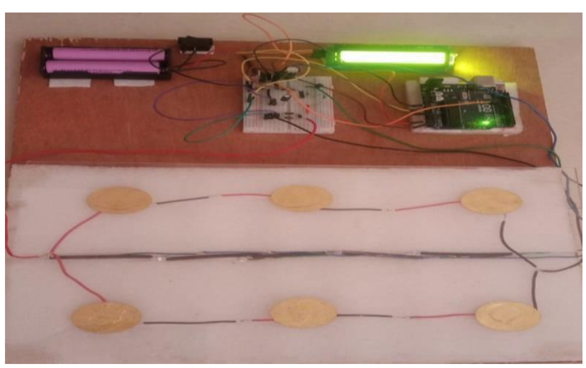
It can calculate and display real-time data such as:

Voltage generated

Step count

The processed data is then sent to a display module (such as an LCD display) to visually represent the system's output and status to users.

V. ACTUAL PROJECT VIEW



VI. LITERATURE REVIEW

The fly haggle wheel is likewise coupled to the littler sprocket shaft-The flywheel is utilized to expand the rpm of the littler sprocket shaft-The rigging wheel is coupled to the generator shaft with the assistance of another apparatus wheel-The generator is utilized here, is perpetual magnet D.C Stepper Motor-The created voltage is 12Volt D.C. This voltage is further intensified utilizing IC MC34063 DC-DC convertor and is put away to the Lead-corrosive 12 Volt battery. This technique produces the electric power without dirtying our surrounding. The waste energy supplied by human is used in this frame-work. This energy source is ceaseless & renewable. In addition, we are certain that this technique for power era will be utilized for rustic jolt & to satisfy our energy needs. (1)

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Piezoelectric material is seen as a potential candidate for energy generation since it has an outstanding property of converting kinetic energy into electricity. In this study, a prototype termed as Vibration Energy Harvester (VEnH) is developed to assess its performance in generating electricity from a vibration source. The prototype consists of a cantilever beam with a piezo ceramic attached at half-length of the cantilever beam, a DC motor for emulation of the vibration produced by human footsteps and a microcontroller, When a continuous force is applied to the VEnH, the cantilever beam experienced form actions and thus induces electricity Piezoelectric ceramics can be used for energy conversion , i.e. from kinetic energy into electricity (transducers) orinversely from electricity into kinetic energy (actuators). Piezoelectric materials can be electrically polarized or undergo a change in polarization when subjected to a stress. The efficiency of energy generation depends not only to the amplitude of input displacement but also excitation frequencies. It is achieved only when someone is in running mode and this frequency is the system threshold. (3)

The setup uses a spring action to pull a lever assembly, rotating a freewheel bearing and a shaft. The shaft rotates a large pulley connected to a smaller pulley via a V-belt. The smaller pulley, coupled with a dynamo, converts rotary motion
energy into electric current. The weight applied on the tile and voltage generated are linear, making it suitable for crowded areas and street lighting. (4)

This paper presents a novel paver that efficiently harvests energy from human walking, which can be used to power smart infrastructure sensors, monitor structural health, and provide environmental sensing data. The authors analyze the parameters of the energy harvesting paver using a rack and pinion mechanism, design concept, prototype, and modelling and simulation. They model the energy harvesting paver as a mass-spring damper system, and present the design,
modelling, analysis, simulations, and experimental tests. The theoretically available potential energy is transmitted into the paver, and 50% of it is converted into electricity, significantly higher than published values. The dynamic model, analytical , and optimization method can be used for designing similar vibration energy harvesting devices. (5)

VII. FURE SCOPE

The Foot Step Power Generation Project has promising future prospects: Potential Applications

Public Spaces: Installing footstep power generation systems in public areas like railway stations, airports, and shopping malls.

Smart Cities: Integrating footstep power generation into smart city infrastructure.

Sustainable Energy: Contributing to renewable energy sources and reducing carbon footprint.

VIII. CONCLUSION

This project proposes a non-conventional method for generating electrical power by walking or running on foot steps. This method converts mechanical energy into electrical energy, making it essential for highly populated countries like India and China. The energy conservation theorem and Piezo sensor are used to generate power, utilizing waste energy from foot power with human locomotion