IJARSCT

International Journal of Advanced Research in Science, Communication and Technology

International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal

ISSN: 2581-9429

Volume 5, Issue 10, June 2025

Impact Factor: 7.67

Footstep Power Generation Using Piezoelectric Sensors

Mithuna K[1], Poornima K[2], Venu Gopal M R[3], Monish S[4], Mrs. S Savitha[5]

[1,2,3,4]UG Scholar, Department of Electronics and Communication

[5]Assisstant Professor, Department of Electronics and Communication

East Point College of Engineering and Technology, Bangalore, Karnataka, India

Abstract: *The increasing demand for energy, essential for human sustenance and development, has led to the rapid depletion and wastage of conventional energy resources. In this context, the utilization of waste energy from human locomotion presents a promising and innovative solution, particularly in densely populated countries like India, where public spaces such as railway stations and temples remain crowded throughout the day. This research explores the concept of power-generating floors using piezoelectric technology, where mechanical pressure exerted by footsteps is harnessed through piezoelectric transducers embedded in flooring. These transducers convert kinetic energy into electrical energy, which can then be stored and utilized for various applications including agriculture, household needs, street lighting, and powering sensors in remote areas. Human movement exerts a considerable amount of force that typically goes to waste; this study aims to capture and convert that force into a usable power source. While it may not completely solve the global energy crisis, the development of such a system is a step forward. For instance, if 12 footsteps can generate 100W of power, then 120 footsteps could yield 1,000W, and installing this system across 100 such floors could potentially generate up to 1 megawatt of power. This approach offers a scalable, renewable, and sustainable energy solution, contributing meaningfully to energy conservation efforts.*

This Research investigates the feasibility of piezoelectric flooring for harnessing energy from human locomotion as a sustainable solution to the growing energy crisis. In densely populated areas, the kinetic energy wasted during walking can be converted into usable electrical power using piezoelectric transducers integrated into floor surfaces. This paper examines the potential applications of this technology, including powering remote sensors, street lighting, and agricultural systems. Furthermore, it outlines crucial areas for future research, such as hybrid energy harvesting techniques, smart power management strategies, material optimization, long-term durability assessments, wireless data monitoring, and comprehensive cost-benefit analyses. The goal is to demonstrate the viability of piezoelectric flooring as a significant contributor to energy generation, particularly in high-traffic environments, and to pave the way for its large-scale implementation

Keywords: piezoelectric

I. INTRODUCTION

With the increasing global demand for renewable energy, researchers are turning to novel and sustainable power generation methods. One promising innovation involves harvesting energy from human footsteps using piezoelectric sensors. This project investigates the conversion of mechanical pressure from walking into electrical energy, which can be stored and utilized for low-power electronic applications.

Piezoelectric materials produce an electric charge when subjected to mechanical deformation. By integrating these sensors into floors or walkways, kinetic energy from footsteps can be effectively transformed into usable electricity. In this study, the harvested energy is stored in a 3.7V lithium-ion battery, with an Arduino Uno microcontroller overseeing the system. A voltage sensor is employed to monitor the electrical output from the piezoelectric modules and battery,

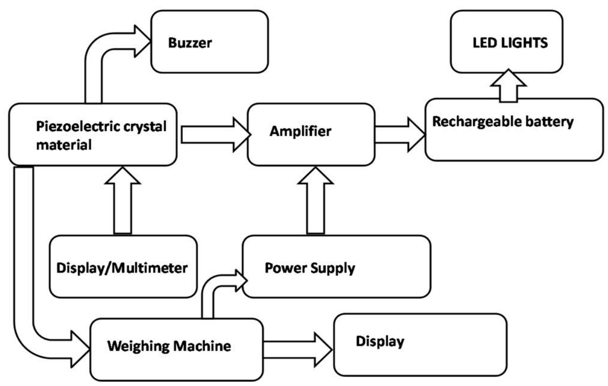
DOI: 10.48175/IJARSCT-28828

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 5, Issue 10, June 2025
Impact Factor: 7.67

while an I2C LCD display offers real-time updates on voltage readings. The setup also includes a charging circuit that regulates power flow and ensures safe and efficient battery charging.

This technology holds significant potential for implementation in high-traffic areas such as public spaces, smart urban environments, and transportation terminals, where consistent pedestrian movement can generate substantial energy. The objective of this research is to assess the viability of footstep-powered energy systems and their contribution to environmentally sustainable energy solutions. By advancing this technology, the study aims to reduce dependence on traditional energy sources and capitalize on otherwise wasted mechanical energy.

BLOCK REPRESENTATION



II. METHODOLOGY

The methodology involves the following key steps:

01. The mechanical energy from footsteps is converted into electrical energy using piezoelectric sensors.
02. The generated energy is stored in a 3.7V lithium-ion battery
03. The energy is continuously monitored using an Arduino Uno.
04. A voltage sensor is used to measure the output from the piezoelectric sensor and battery.
05. The real-time voltage readings are displayed on an I2C LCD screen.
06. A charging circuit is integrated to regulate the battery charging process and prevent overcharging or deep discharge.

The project successfully demonstrates the feasibility of energy harvesting from human footsteps using piezoelectric sensors. The system efficiently converts mechanical energy into electrical energy, stores it in a battery, and continuously monitors the energy output. The use of an Arduino Uno, voltage sensor, and I2C LCD screen enables real-time monitoring and analysis of the generated power. The charging circuit ensures safe and efficient battery charging, making the system practical for various low-power applications.

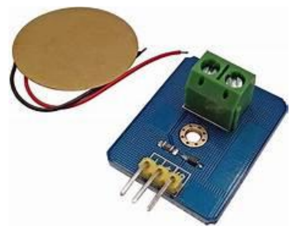
III. HARDWARE REQUIREMENTS

01.Arduino UNO: The microcontroller board responsible for processing sensor data and controlling other components.

DOI: 10.48175/IJARSCT-28828

ISSN: 2581-9429
Volume 5, Issue 10, June 2025
Impact Factor: 7.67

02.Piezoelectric Sensors:Captures mechanical energy from footsteps using piezoelectric sensors.Converts that energy into electrical energy.Stores the energy in a rechargeable battery.Uses an Arduino microcontroller and voltage sensors to monitor and control the energy flow. Displays the energy data on an LCD screen.Uses a charging circuit to protect the battery.



03.Voltage Sensor :The DC 0-25V sensor is a device engineered to measure DC voltage levels up to 25V. It is commonly used in electronics and microcontroller projects to monitor and analyze voltage in low-voltage DC systems, including batteries, power supplies, and solar panels.

04. I2C LCD Display (16x2) :I2C (Inter-Integrated Circuit) is a communication protocol widely used in various electronic devices. It's a serial communication protocol, meaning data is transferred bit by bit over a single wire, reducing the number of pins required for communication. In the context of LCDs, an I2C LCD display incorporates an I2C module directly on the LCD, simplifying the wiring and control process.

05.3.7V Lithium-Ion Battery :A 3.7V lithium-ion battery is a type of rechargeable battery commonly used in portable electronic devices. It is composed of lithium ions that move between the anode and cathode during charging and discharging. The battery has a nominal voltage of 3.7V, which means it can provide a steady voltage output of 3.7V under normal operating conditions.

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 5, Issue 10, June 2025
Impact Factor: 7.67

06. Diodes & Rectifier Circuit :The AC voltage generated by the piezoelectric sensors is converted into DC voltage using diodes and a rectifier circuit. This is necessary because most electronic devices, including the Arduino Uno and the lithium-ion battery, require DC voltage to operate.

07. Footpad/Platform :A sturdy surface to install piezoelectric sensors for footstep detection.

IV. SOFTWARE TOOL

The following software tools and libraries are required for the development and operation of the SafeDrive system:

1. ArduinoIDE:

Purpose: The primary software for programming the Arduino UNO. It provides an integrated development environment to write, compile, and upload the code to the microcontroller.

- Link: ArduinoIDE

2. Arduino Libraries:

Purpose: Libraries are used to interface with the hardware components like the eye blink sensor, relays, and buzzer. These libraries simplify the coding process by providing predefined functions for hardware control. Some commonly used libraries are:

- Servo Library: For controlling servo motors (if applicable in the project).
- Relay Module Library (if using a specialized relay module): To control relays easily.

3. Sensor Libraries:

Purpose: If the eye blink sensor is based on a specific type of sensor (e.g., infrared sensor, camera-based module,or any specialized blink sensor),corresponding sensor libraries will be needed to process the data and detect blink patterns. Examples include:

Adafruit Sensor Library (for certain sensors).

TCS3200 or similar library (if using a color sensor or optical sensor for detecting eye blinks).

4. Serial Monitor(Arduino IDE Tool):

Purpose: Used for debugging the system by displaying real-time sensor readings and system status messages during development.

V. ADVANTAGES

Renewable & Sustainable Energy:

Eco-Friendly: Uses human footsteps as an energy source, reducing reliance on non-renewable power.

Zero Carbon Emissions: Unlike fossil fuels, this system does not contribute to pollution.

Cost-Effective Solution:

Low-Cost Components: Uses affordable Arduino Uno, piezoelectric sensors, and a lithium-ion battery, making it an economical solution.

Minimal Maintenance: Requires less maintenance compared to complex mechanical or electromagnetic energy harvesting systems.

Energy Storage & Efficient Utilization:

Battery Storage: Unlike traditional piezoelectric systems, this project stores power in a lithium-ion battery.

Efficient Charging Circuit: Ensures safe charging and prevents power wastage.

Real-Time Monitoring & Data Analysis:

Live Voltage Display: The I2C LCD screen continuously shows real-time voltage output.

Voltage Sensor Integration: Helps track the efficiency and performance of the system.

Scalable & Customizable:

Expandable System: Additional piezoelectric sensorscan be added to increase energy generation.

Flexible Deployment:Can be installed in public places, walkways, shopping malls, metro stations, and stadiums.

Wide Range of Applications:

Smart Walkways:Can be used in train stations, airports, and parks to power lighting systems.

Wearable Technology: Future versions could be integrated into shoes for personal power generation.

Remote & Rural Areas: Useful in off-grid locations where conventional electricity is not available.

Promotes Green Technology & Awareness:

Encourages theadoption of renewable energy solutions.

Can be used for educational purposes in schools and universities to teach energy harvesting concepts.

Limitations of Existing Systems

High Cost: Piezoelectric tiles and electromagnetic systems are expensive to install and maintain.

Low Energy Output: The power generated per footstep is relatively small, requiring multiple units for practical use.

Efficiency Issues: Energy loss due to material inefficiency and lack of proper storage solutions.

How This Project Improves Existing Systems

Cost-Effective Approach: Uses low-cost piezoelectric sensors, Arduino Uno, and a lithium-ion battery instead of expensive tiles.

Real-Time Monitoring: Displays voltage output on an I2C LCD screen to analyze efficiency.

Energy Storage: Incorporates a charging circuit and battery to store and manage generated power efficiently.

Scalability: Can be expanded by adding multiple piezo sensors for higher power generation.

This project provides a low-cost, scalable, and efficient alternative for footstep-based energy harvesting, making it suitable for small-scale applications like LED lighting, sensor networks, and smart walkways.

VI. FUTURE SCOPE

- IoT-Based Monitoring: Integrate with wireless communication (WiFi/Bluetooth) to track power generation remotely.
- Battery Optimization: Use supercapacitors for better energy storage and utilization.
- Large-Scale Urban Deployment: Implement in public parks, stadiums, and city squares for large-scale renewable energy production.
- Advanced Materials: Investigate the use of advanced piezoelectric materials like nanocomposites for higher efficiency.
- Hybrid Systems: Combine with other energy harvesting methods like solar or thermal for continuous power generation.
- Smart Fabric Integration: Develop wearable systems by integrating piezoelectric sensors into clothing.

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429 Volume 5, Issue 10, June 2025 Impact Factor: 7.67

VII. CONCLUSION

The Footstep Power Generation System—comprising piezoelectric sensors, an Arduino Uno, voltage and LCD monitoring components, a lithium-ion battery, and a charging circuit—demonstrates a promising and innovative method for capturing renewable energy from human activity. By efficiently converting footstep-induced mechanical energy into electrical power, the system offers a clean, low-maintenance, and environmentally friendly alternative to conventional energy sources.

Its ability to store harvested energy and provide real-time monitoring makes it highly adaptable for diverse applications in smart urban infrastructure, educational campuses, healthcare facilities, and residential settings. Furthermore, with advancements such as IoT integration, wireless data transmission, and broader deployment, this technology has the potential to evolve into a practical and scalable solution for powering low-energy devices and systems. Ultimately, this approach supports the global shift toward sustainable energy practices by transforming everyday human motion into a valuable source of clean power.

With further enhancements such asIoT integration, wireless monitoring, and large-scale implementation, footstep power generation can become aviable alternative energy source for powering small electronic devices, lighting systems, and smart applications.

REFERENCES

[1]. M.Nitashree, et.al., "Foot Step Power Generation Using Piezoelectric Material," International Journal of Advanced Research in Electronics and Communication Engineering. vol. 4. pp. 2503-2506, Oct 2015.

[2]. D.Marshiana, et al., "Footstep Power production using Piezoelectric Sensors," Research Journal of Pharmacy and Technology, vol 9, pp. 831-834, Jul 2016.

[3]. V.Panneerselvam, et al., "Portable DC Regulated Power Supply from Footsteps," International Journal for Scientific Research & Development, vol 5, pp. 916-918, April 2017.

[4]. R.Prabaharan, et.al., "Power Harvesting By Using Human Foot Step, International Journal of Innovative Research in Science, Engineering and Technology, vol 2, pp 3001-3009, Jul 2013.

[5]. P.Madhu, et al., "Electrical Power Generation by Foot-steps using Piezo-electric Transducers," International Journal of Recent Trends in Engineering & Research (IJRTER) vol. 2 pp 108-115, June 2016.

[6]. C.Gautam, et.al., "Power Harvesting Through Human Locomotion," International Journal of Advanced Research in Electrical. Electronics and Instrumentation Engineering, vol 6, pp. 2277-2282, April 2017.

DOI: 10.48175/IJARSCT-28828