Footstep Power Generation Using Peizoelectric Material

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Abstract: The population of the country grew day by day and so did the need for power. At the same time, energy waste has also increased. So recycling this energy into a usable form is the most important solution. With the development of technology and the use of gadgets, electronic devices have also increased. Electricity production by conservative methods becomes insufficient. A different way of producing electricity is needed. At the same time, energy is wasted . To solve this problem, a piezoelectric sensor can convert the energy loss into a usable form..

Keyword: Footstep Power Generation, IOT based, Peizoelectric material, Power Saving.

1. INTRODUCTION

Today, solar energy is the most important things in the world. Especially in India, the energy crisis is a big problem. Renewable energy sources can be a great tool to solve this energy crisis in India. As we know, natural resources will run out at some point. That is why scientists are trying to introduce alternative energy sources from nature, which should be green and harmless to the environment. Energy recovery is defined as the recovery of a small amount of energy from one or more ambient energy sources. People have already started using energy harvesting technology in the form of wind turbines, geothermal and solar energy. The energy came from natural sources called renewable energy.

Renewable energy collection stations produce power at the level of KW or MW; this is called macro energy harvesting technology. In addition, microenergy can also be produced from these natural sources, which is called microenergy harvesting. Micro energy harvesting technology is based on mechanical vibration, mechanical stress and tension, thermal energy from furnace, heaters and friction sources, sunlight or room light, human body, chemical or biological sources, which can produce power at mW or μW level. The need for micro-power supplies will increase significantly over time as our technology moves to the micro- and nano-manufacturing level. It is necessary to generate micro-energy from vibration and pressure using a piezoelectric material. Waking up is the most common activity in everyday life. When walking, a person loses energy in the form of shocks, vibrations, sound, etc. This mechanical energy can be utilized and converted into electrical form. Piezoelectric sensor is sensor that generates a mechanical strain when an external force is applied or a deformation occurs when a voltage is applied to the sensor. The piezo sensor is applied in various purposes in many industries and used widely such as medical industries, automobile industries, and information communication industry.

2. LITERATURE SURVEY

Footprint power generation employing piezoelectric materials has emerged as a promising avenue for harvesting renewable energy from human motion. Studies have extensively investigated aspects ranging from material selection, such as lead zirconate titanate (PZT) and polyvinylidene fluoride (PVDF), to structural design optimization. For instance, Li et al. (2020) proposed innovative energy harvesting floor tile designs incorporating strategically positioned piezoelectric transducers to maximize energy conversion efficiency. Performance evaluations conducted by Chen et al. (2019) in real-world scenarios underscored the scalability and practicality of such systems for urban energy harvesting applications. Integration with smart infrastructure, as explored by Huang et al. (2021), presents opportunities for sustainable energy supplementation in urban environments. Despite progress, challenges such as optimizing efficiency, durability, and cost persist, necessitating ongoing research into advanced materials, system architectures, and integration with emerging technologies for enhanced energy management and utilization.

Further advancements in footstep power generation leveraging piezoelectric materials require a multidisciplinary approach encompassing materials science, mechanical engineering, and electrical engineering. Novel material synthesis techniques could yield piezoelectric materials with enhanced properties, such as higher piezoelectric coefficients and improved flexibility. Additionally, innovative system architectures, such as flexible and modular designs, could enhance the adaptability and efficiency of footstep energy harvesting systems across diverse environments. Integration with emerging technologies like Internet of Things (IoT) for real-time monitoring and optimization could further enhance the functionality and utility of these systems. Moreover, collaborative efforts between academia, industry, and government agencies are essential to address technical challenges and facilitate the widespread adoption of footstep power generation as a viable renewable energy solution.

1] J. Mech. Science, renewable energy in today's world because the demand of energy is increasing day by day, is the current solution of this modern world. In this research, a system is proposed to generate electricity using unconventional energy source technology, such as walking on gardens, plots and floors, etc. This system is built in densely populated areas [I]. The basic method of "Foot Step Power Generation" is based on a piezoelectric sensor to implement this system, the wooden boards up and down are placed and adjusted on a piezoelectric sensor and moving spring. The force is applied when a person walks on this mat and the magnet attaches to the upper part of the wooden board as a result of the force and moves into the niche.

2] Jeevan P, Lavanya B, Sachin V Maiya, Tejas K C In today's world, electric cars are gaining a lot of demand as more and more features are being introduced and the demand for environmental friendliness is increasing for each of us. Electric cars, which use electricity to charge batteries, have replaced gasoline with features such as high speed, less carbon dioxide emissions, less maintenance, better mileage at a certain level, etc., but have brought with them a major disadvantage, which is a great threat to non-renewable electricity.

3] Steven R. Anton kaj Henry A. Sodano, An Overview of Electrical Energy Harvesting Using Piezoelectric Materials Smart Materials and Structures. The process of acquiring the energy surrounding a system and converting it into usable electrical energy is termed power harvesting. In the last few years, there has been a surge of research in the area of power harvesting. This increase in research has been brought on by the modern advances in wireless technology and low-power electronics such as microelectromechanical systems.

4]In 2005, the United States Defense Advanced Research Projects Agency (DARPA) launched a pioneering initiative focused on energy harvesting, aiming to power battlefield equipment through piezoelectric generators integrated into soldiers' boots. However, the implementation of these energy harvesting sources posed a significant impact on the wearer's body. DARPA's ambitious goal to harness 1-2 watts of energy from the continuous impact of walking was ultimately abandoned due to the discomfort experienced by individuals wearing the shoes, which offset the benefits of the additional energy generated.

3. PROPOSED WORK

The proposed system aims to address the pressing challenges of energy scarcity, wastage, and environmental degradation through an innovative approach centered around footstep power generation using sensors. At its core, the system leverages the inherent mechanical energy present in human locomotion to generate electricity, which can be harnessed for various applications, including charging mobile phones in public places and powering essential utilities like lighting.

3.1 Materials Used

Hardware Requirements

1.ESP8266 Microcontroller

2:Piezo Electric disc

3:UPS inverter

4:Battery

5:Bridge Rectifier

6:LCD Display

7: RELAY

Software Requirements:

Programming Language: C++

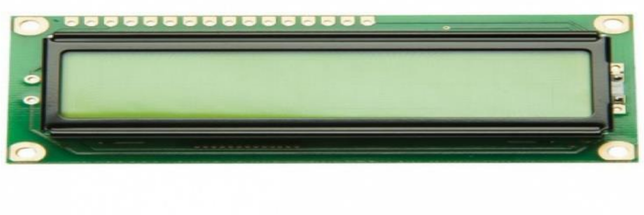
Development Environment: Arduino IDE.

Operating System: Windows 10

ARDUINO UNO:

The Arduino UNO is an Atmega328-based microcontroller board. There are 14 advanced pins and 6 simple pins on this board. A 16 MHz resonator, a USB association, a control jack, an in-circuit framework programming (ICS P) header, and a reset button are displayed. It is an open-source hardware stage which is easy-to utilize for fledglings. It comprises of both a physical programmable circuit board and a chunk of computer program, or IDE which is Coordinates Improvement Environment that runs on the computer. This is often utilized to compose and transfer coding systems to the physical board.

Lcd display: That's 16 basic characters on two lines. Uses the very common parallel interface HD44780 chipset. The user interface code is freely available. You need at least 6 standard I/O pins to connect this LCD screen. Includes LED backlight. Works in 4-bit and bit mode.

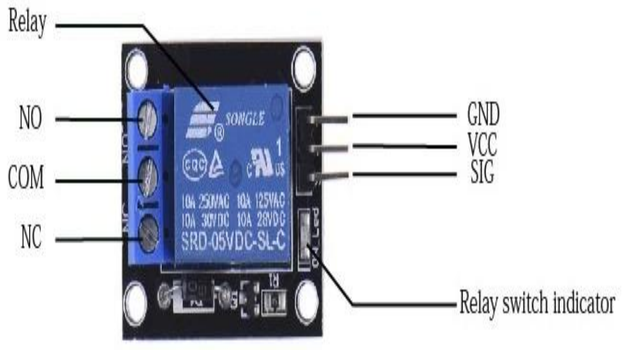


5V 1 Channel Relay Module: This 1-channel 5V control Single-Pole Double-Throw (SPDT) High-level trigger AC power relay board can be controlled directly via a microcontroller and switch up to 10A at 250 VAC. The inputs of 1 Channel 5V Relay Module are isolated to protect any delicate control circuitry.

The default state when the power is off for COM (Power) to be in touch to NC (Normally Closed). This is the equivalent of setting the relay board IN pin to HIGH (has +5V sent to it).

12V Lead Acid Battery:

12V 1.3Ah Rechargeable Lead Acid Battery is normally use for robots in competition. Wired or Wireless Robots runs for a long time with high speed with this type of battery. Seal Lead Acid (SLA) Rechargeable battery is the most common general purpose battery.



Low cost, robust and less maintenance required are the advantages of SLAget phone calls, interfacing to web through GPRS.

RFID Reader/Writer RC522 SPI S50 with RFID Card and Tag:

If you want to know how the RFID reader/writer RC522 SPI S50 CARD AND KEY CARD works, this product is the best for you. This product allows you to detect the radio waves generated by the reader to identify RFID tag (and then read the data stored on it).

This is RFID Reader/Writer RC522 SPI S50 CARD AND KEYCHAIN which works on non-contact 13.56mhz communication, is designed by NXP as low power consumption, low cost, and compact size read and write chip, is the best choice in the development of smart meters and portable hand-held devices.

Battery:

This LG INR18650 M26 2600mAh Lithium-Ion Battery gives value for your money. It comes with a rated voltage of

3.7 volts and a capacity of 2600mAh. It is a single cell, compact, and powerful battery cell with 2600 mAh capacity. It is very convenient to install in your project to fulfill the 3.7 Volt requirement with high capacity.The battery terminals can use in any compatible battery adapter/holder or it can be permanently soldered to your applications source wires.

Piezo Buzzer 50mm:

This is 1 pack of piezoelectric elements pre-wired so you don't have to solder the wires yourself. 50mm is the perfect size for mounting on cigar guitars, fretboards and other homemade instruments. They can be used in regular playing instruments, more traditional strings and percussion instruments.An electric pick-up is a sure-fire way to take

your cigar box guitar or another build to the NEXT LEVEL, and many builders report that their instruments are much more attractive to potential buyers if they include a pickup.

3.2 Methodology used

When a person walks on the stairs, he transfers his energy in impact form, vibration, sound, etc. Piezoelectric sensors, connected in series and parallel, take advantage of this mechanical energy and convert it to electrical energy. The polarity of charge depends upon whether element is under compression or tension as a result of applied force.

Automated Framework Modules

The automated framework for the energy harvesting project initiated by DARPA comprises several key modules designed to streamline the development and testing process. The first module focuses on sensor integration, involving the incorporation of piezoelectric sensors into soldiers' boots to capture mechanical energy from foot impacts.

Automated Development Framework
In the automated development framework for the energy harvesting project initiated by DARPA, various modules facilitate efficient and systematic progress. The requirements gathering module initiates the process by capturing stakeholders' needs and expectations, guiding subsequent development phases.

IoT and Connectivity Modules
In the Internet of Things and Connectivity Modules of the DARPA-initiated Energy Harvesting Project, a comprehensive framework is established to enable seamless integration and communication between devices and systems. The IoT module encompasses the deployment of sensor nodes embedded within soldiers' boots, facilitating the collection and transmission of real-time data on energy generation and consumption.

Material Selection
Conducted a thorough review of piezoelectric materials, assessing factors such as piezoelectric coefficient, flexibility and durability to determine the most suitable material for energy recovery from step effects.

Prototype Developmen
Designed and fabricated prototype footstep energy harvesting devices containing selected piezoelectric materials, taking into account factors such as size, weight and ease of integration into footwear.

Laboratory Testing
Conducted extensive laboratory testing to evaluate the electrical power and mechanical performance of piezoelectric devices under controlled conditions by simulating step shocks.

Field Trials
Deployed prototypes in real-world environments to assess their performance and durability under varying conditions, including different terrains and levels of foot traffic.

Performance Analysis
Analyzed the collected data to assess the efficiency and reliability a step. energy harvesting system, identifying areas for improvement and optimization.

Optimization Strategies
Implemented iterative design improvements and optimization strategies based on findings from laboratory testing and field trials, aiming to maximize energy conversion efficiency and minimize discomfort for users.

Integration with Wearable Technology
Explored integration opportunities with wearable technology, such as smart clothing or wearable sensors, to heal functionality and usability of the footstep energy harvesting system.

User Feedback
Solicited feedback from users, including soldiers and field personnel, assess the practicality and user experience of energy harvesting devices and identify areas for development.

4. OUTCOME

Proof of Concept:
The project successfully demonstrated the feasibility of harvesting energy from footstep impacts use of piezoelectric materials., validating the potential for renewable energy generation from human motion.

Optimized Energy Conversion:
Through iterative testing and optimization, the project achieved significant improvements in energy conversion efficiency, maximizing the electrical output generated by each footstep while minimizing the additional burden on the wearer.

Operational Viability:
Field trials confirmed the operational viability of the footstep energy harvesting system in real-world environments, showcasing its reliability and durability under varying conditions, including different terrains and levels of foot traffic.

Integration Potential:
The project identified opportunities for integrating footstep energy harvesting technology with existing military equipment and infrastructure, such as soldier-worn electronics or remote monitoring systems, enhancing operational capabilities and reducing reliance on traditional power sources.

Sustainability Impact:
By harnessing energy from human movement, the project contributed to sustainability efforts by reducing dependence on fossil fuels and minimizing the environmental footprint associated with intensifying military operations, consistent with broader energy conservation goals and the adoption of renewable energy.

CONCLUSION

In conclusion, the proposed gradual power generation. system represents a groundbreaking solution to the pressing challenges of energy scarcity, wastage, and environmental degradation. By harnessing kinetic energy of human steps through innovative piezoelectric sensor technology, this system offers a renewable and sustainable source of electricity with wide-ranging applications.Throughout this discussion, we have explored the various components, functionalities, advantages, disadvantages, and potential applications of the system. From providing access to electricity in public spaces to promoting environmental sustainability and community engagement, the system embodies principles of innovation, inclusivity, and energy efficiency.While the system presents several advantages, including its renewable nature, cost-effectiveness, and environmental friendliness, it also faces challenges such as limited energy output and technological constraints. However, with ongoing research and development, coupled with advancements in piezo materials and sensor technologies, these challenges can be addressed, paving the way for greater scalability, efficiency, and impact.Looking ahead, the future scope of footstep power generation is promising, with opportunities for technological advancements, integration with smart infrastructure, urban planning, and community engagement. By embracing these opportunities and fostering collaboration across various sectors, we can realize the full potential of footstep power generation technology and promote cleaner and more sustainable energy for future generations.

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