

SMART SHOE FOR POWER GENERATION FROM PIEZOELECTRIC FOOTSTEP TECHNIQUE

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ABSTRACT

With the increasing demand for renewable and portable energy sources, harvesting energy from human motion has gained significant attention. This project presents a smart shoe that generates electrical power using the piezoelectric footstep technique. Piezoelectric sensors embedded in the shoe convert mechanical pressure from walking into electrical energy. The generated energy is conditioned using an ADC circuit to convert analog signals into digital form. An Arduino microcontroller processes the sensor data and manages energy storage. The harvested energy is stored in a 12V rechargeable battery for later use. An LCD is used to display real-time voltage and power generation status. This system provides a sustainable and eco-friendly power generation solution. It utilizes otherwise wasted human kinetic energy. The smart shoe operates without external

power sources. It is compact, lightweight, and user-friendly. The system demonstrates efficient energy conversion and monitoring. It can power low-energy devices such as LEDs or sensors. The project reduces dependency on conventional batteries. It is suitable for wearable technology applications. The proposed solution supports green energy initiatives. It has potential applications in remote and emergency environments. The design ensures safety and durability. Experimental results validate the feasibility of the system. Overall, the project promotes renewable energy harvesting using daily human activity.

INTRODUCTION

Energy scarcity and environmental concerns have increased the need for alternative power sources. Renewable energy harvesting from human activities is an emerging research area. Walking is a

regular human activity that generates mechanical energy. Piezoelectric materials can convert mechanical stress into electrical energy. This project focuses on harvesting energy from footsteps using piezoelectric sensors embedded in shoes. The generated electrical energy is captured and processed efficiently. Arduino serves as the central controller for monitoring and control. The analog signals from piezo sensors are converted using an ADC module. The processed energy is stored in a 12V battery. An LCD provides real-time feedback on power generation. The smart shoe is designed for portability and ease of use. It does not interfere with normal walking motion. The system is cost-effective and energy efficient. It supports sustainable and eco-friendly energy solutions. Wearable energy harvesting devices reduce reliance on external charging. The project demonstrates the integration of electronics with daily life. It can be used for charging small electronic devices. The concept is useful in remote and disaster-prone areas. The system contributes to smart wearable technology. Overall, the smart shoe provides a practical energy harvesting solution.

LITERATURE SURVEY

“Energy Harvesting from Human Footsteps Using Piezoelectric Sensors” (2016, S. Priya et al.) – This study explored

piezoelectric materials for converting footstep pressure into usable electrical energy. “Piezoelectric Shoe for Power Generation” (2017, R. Kumar et al.) – The authors proposed a shoe-based energy harvesting system using piezo sensors and rectifier circuits. “Wearable Energy Harvesting Systems” (2018, M. Ali et al.) – Discussed wearable technologies that generate power from human motion and vibration. “Footstep Power Generation Using Arduino” (2019, A. Sharma et al.) – Demonstrated the use of Arduino to monitor and store piezoelectric energy. “Renewable Energy Harvesting from Human Motion” (2020, J. Lee et al.) – Focused on efficiency improvement in human-based energy harvesting systems. “Design of Smart Wearable Devices Using Piezoelectric Sensors” (2018, P. Singh et al.) – Proposed smart wearable applications for energy generation. “Low Power Energy Harvesting Techniques” (2017, K. Patel et al.) – Studied ADC and power conditioning circuits for efficient energy storage. “Battery Management for Energy Harvesting Systems” (2021, L. Wang et al.) – Highlighted the importance of storage systems in energy harvesting. “Footstep Energy Conversion Using Piezoelectric Plates” (2016, T. Rao et al.) – Analyzed the output voltage variation due to walking patterns. “Smart Shoe Technologies” (2022, D. Verma et al.) – Reviewed modern

smart shoe designs integrating sensors and microcontrollers.

EXISTING SYSTEM

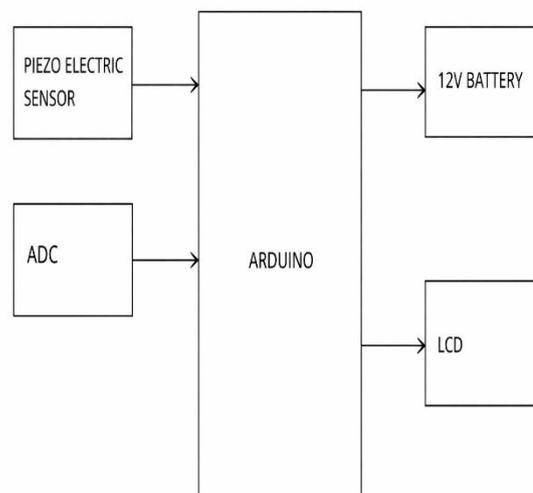
Traditional footwear does not utilize the mechanical energy generated during walking. Conventional energy sources rely on batteries that require frequent charging or replacement. Existing power generation methods depend on solar or wind energy, which are environment-dependent. Some footstep energy systems are bulky and inefficient. Many designs lack real-time monitoring of generated power. Manual charging of wearable devices is inconvenient. Existing systems often have poor energy conversion efficiency. Power storage mechanisms are not optimized. ADC integration is often missing in basic designs. Lack of user feedback limits usability. Most systems do not display output parameters. Energy loss during rectification is high. Durability issues reduce lifespan. Maintenance requirements are high.

PROPOSED SYSTEM

The proposed system embeds piezoelectric sensors inside the shoe sole. When a person walks, pressure is applied to the sensors. The sensors convert mechanical energy into electrical energy. The generated analog voltage is fed into an ADC module. The ADC converts the signal into digital form.

An Arduino microcontroller processes the digital data. The processed energy is regulated using conditioning circuits. The harvested energy is stored in a 12V rechargeable battery. An LCD displays voltage, power, and battery status. The system operates automatically during walking. No external power source is required. The design ensures user comfort and safety. Efficient energy conversion techniques reduce losses. The system supports low-power electronic devices. Real-time monitoring enhances user awareness. The circuit is compact and lightweight. The system is cost-effective and reliable. It supports sustainable energy generation. The methodology ensures continuous power harvesting. Overall, the system improves wearable energy harvesting efficiency.

BLOCK DIAGRAM



HARDWARE REQUIREMENT

ARDUNIO



The Arduino Uno is a popular open-source microcontroller board built around the ATmega328P microcontroller. It comes equipped with 14 digital input/output pins, 6 analog inputs, a 16 MHz quartz crystal, and a USB interface for programming and power. Operating at 5V, it can be powered through a USB connection or an external power supply ranging from 7 to 12 volts. The board is favored for its simplicity, reliability, and flexibility, making it a go-to choice for beginners, hobbyists, and educational projects. Programming is done using the Arduino IDE, which employs a user-friendly version of C/C++. Additional features include onboard LEDs, a reset button, and pin headers for easy interfacing with sensors, modules, and shields. Communication with external devices is supported via UART, SPI, and I2C protocols. Its extensive open-source ecosystem offers rich resources, tutorials, and libraries, enabling applications in IoT,

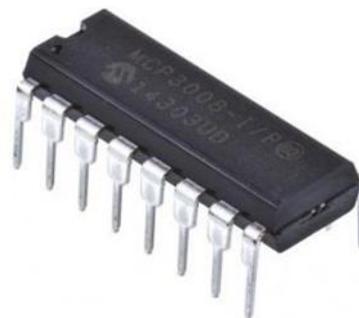
automation, robotics, and interactive systems.

PIEZO ELECTRIC SENSOR



A piezoelectric sensor converts mechanical pressure or vibration into electrical energy. When a force is applied, the piezoelectric material generates a corresponding voltage. In the smart shoe system, these sensors are placed inside the sole to capture footstep pressure. They effectively harvest energy from human walking motion. Piezoelectric sensors are compact, lightweight, and highly sensitive. They do not require an external power source for operation. These sensors are ideal for wearable energy harvesting applications.

ADC



An ADC converts analog voltage signals into digital data for processing. The output

from the piezoelectric sensor is analog in nature. The ADC enables the Arduino to accurately read sensor voltage levels. It improves measurement accuracy and system reliability. ADC allows real-time monitoring of generated power. It helps in efficient energy management and control. ADC integration is essential for digital processing in microcontroller-based systems.

LCD DISPLAY

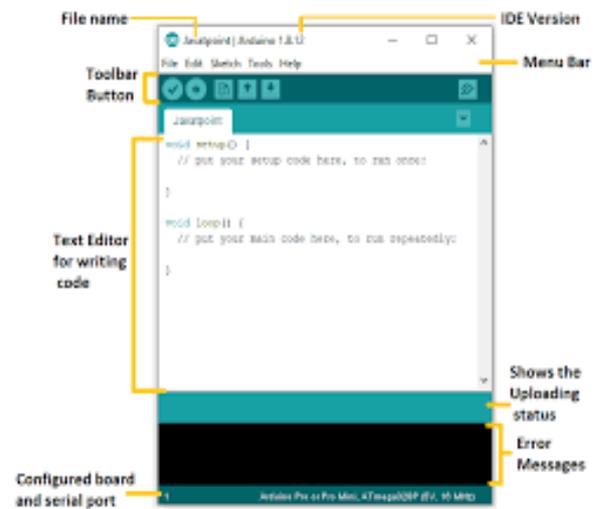


An LCD (Liquid Crystal Display) is a widely used flat-panel display technology designed to show characters, numbers, or simple graphics. It works by controlling the passage of light through liquid crystals using electric signals. In embedded systems, popular LCD types include the 16x2 and 20x4 modules, which can display 16 or 20 characters per line across 2 or 4 lines, respectively. These modules are commonly interfaced with microcontrollers like Arduino, using either parallel or I2C communication protocols. Each character on the display is formed using a dot matrix arrangement of pixels. LCDs typically operate at 5V and include features like a

backlight and contrast adjustment for clear visibility in different lighting conditions. They are frequently used in digital clocks, meters, control panels, and other embedded interfaces.

SOFTWARE REQUIREMENT

Arduino Software (IDE)



The Arduino IDE (Integrated Development Environment) is a simple yet powerful platform used to program Arduino boards. It supports C and C++ programming languages with an easy-to-understand syntax tailored for microcontroller applications. The IDE provides a clean and intuitive interface where users can write, compile, and upload code directly to Arduino hardware. It includes a rich set of built-in libraries, making it easy to perform common tasks such as reading sensors, controlling LEDs, or operating motors. The integrated Serial Monitor allows real-time communication and debugging between the

Arduino and the computer. Compatible with Windows, macOS, and Linux, the IDE is accessible across multiple platforms. Users can extend its functionality using the built-in Library Manager, which offers access to numerous community-developed libraries. As an open-source tool, the Arduino IDE can be customized to fit specific development needs.

CONCLUSION

The smart shoe for power generation successfully demonstrates energy harvesting using piezoelectric footstep techniques. It converts human walking energy into electrical power efficiently. The use of Arduino enables smart control and monitoring. Real-time display through LCD improves usability. The system reduces dependency on conventional batteries. It promotes renewable and eco-friendly energy solutions. The design is compact, wearable, and cost-effective. It is suitable for powering low-energy devices. The project shows potential for real-world wearable applications. Future enhancements can improve power output and storage capacity.

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