An Electricity Generation Using Footstep Energy And Mobile Charging Through Rfid Technology

Dr.K.Durga Prasad[1], Chintabathini Vivek[2], Bandla Priyanka[3], Chintha Venkateswarlu[4], Depangi Paul Siddhartha[5],

[2,3,4,5]UG Student,ECE,Chalapathi Institute Of Engineering&Technology Guntur-Andhra Pradesh,India

[1]Associate Professor ECE,Chalapathi Institute Of Engineering&Technology Guntur-Andhra Pradesh,India

Abstract— **The increasing demand for energy and the rapid growth of portable electronic devices have encouraged the development of alternative and sustainable power generation methods. This project presents a system for electricity generation using footstep energy combined with mobile charging through RFID technology. The system harnesses mechanical energy produced by human footsteps using piezoelectric sensors embedded in a pressure-based floor tile. These sensors convert mechanical stress into electrical energy, which is then rectified, regulated, and stored in a rechargeable battery or supercapacitor.**

The stored energy is utilized to provide regulated DC output for charging mobile devices through USB ports. To enhance functionality and security, an RFID-based control system is integrated into the setup. Each user is provided with an RFID tag or card, which is authenticated by an RFID reader connected to a microcontroller. Upon successful authentication, the system enables the charging unit, allowing controlled access to the generated power. This also enables user identification and potential tracking of energy usage.

The proposed system promotes the concept of renewable energy utilization in high-footfall areas such as railway stations, malls, and educational institutions. Although the energy generated per step is limited, the system demonstrates an effective model for energy harvesting, smart energy distribution, and controlled access using RFID technology. This project contributes toward sustainable development by converting wasted mechanical energy into usable electrical power while incorporating smart control features.

introduction

I. INTRODUCTION

In recent years, the increasing consumption of electrical energy and the rapid expansion of portable electronic devices have created a strong need for alternative and renewable energy sources. Conventional energy sources such as fossil fuels are not only limited but also contribute to environmental pollution. As a result, there is growing interest in harvesting energy from naturally available and wasted sources. One such promising method is footstep energy generation, which converts mechanical energy produced by human walking into electrical energy.

This project focuses on the development of a system that generates electricity using piezoelectric sensors embedded in floor tiles, which capture the pressure of human footsteps and convert it into usable electrical energy. The generated energy is then stored in a battery or supercapacitor after proper rectification and voltage regulation. This stored energy can be effectively utilized for small-scale applications such as mobile charging.

To enhance the functionality and provide controlled access, the system integrates RFID (Radio Frequency Identification) technology. The RFID module is used to identify users through unique tags or cards and regulate the charging process. Only authenticated users are allowed to access the charging facility, making the system more secure and efficient.

II. REVIEW LITERATURE SURVEY

Khan et al. (2018) studied the application of piezoelectric materials for harvesting energy from human footsteps. Their research showed that piezoelectric sensors such as PZT embedded in floor tiles can effectively convert mechanical pressure into electrical energy, which can be used for low-power applications like LED lighting systems in public places.

Priya and Inman (2009) provided a comprehensive review of piezoelectric energy harvesting technologies. Their work highlighted the efficiency of piezoelectric transducers in converting ambient mechanical vibrations into electrical energy and

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emphasized design improvements to enhance power output and overall system performance.

Reddy et al. (2019) proposed a footstep power generation system using piezoelectric sensors along with energy storage units. Their system incorporated rectifier circuits and rechargeable batteries to store the generated energy. They concluded that areas with high pedestrian movement can significantly increase energy production.

Sharma and Gupta (2020) focused on integrating microcontroller-based systems with energy harvesting devices. Their study demonstrated the use of Arduino-based control systems to manage and regulate energy flow from piezoelectric sensors to storage devices, improving automation and efficiency in energy utilization.

Singh et al. (2021) introduced an RFID-based smart energy management system for controlled access applications. Their research showed that RFID technology can be effectively used for user authentication and monitoring in charging stations, ensuring secure and efficient energy distribution.

Wang et al. (2022) developed an integrated system combining piezoelectric energy harvesting with IoT and RFID technology. Their work enabled real-time monitoring of energy usage and user identification, making the system suitable for smart city infrastructure and intelligent energy management applications.

Overall, the literature indicates that footstep energy harvesting systems are effective for renewable energy generation at a small scale. However, their performance improves significantly when combined with energy storage systems and smart technologies such as RFID and microcontrollers, enabling efficient, secure, and practical real-world applications.

III. RESEARCH METHODOLOGY

The proposed system for electricity generation using footstep energy with mobile charging through RFID technology is designed to convert mechanical energy into electrical energy and manage its usage through a controlled smart system. The methodology of this project is divided into different stages, including energy generation, power conditioning, energy storage, and user authentication using RFID.

In the first stage, energy generation, piezoelectric sensors are embedded within a specially designed floor tile or platform. When a person steps on the tile, mechanical pressure is applied to the piezoelectric material, which generates an electrical charge. This conversion is based on the piezoelectric effect, where mechanical stress is directly converted into electrical energy.

In the second stage, the generated electrical output is typically in the form of alternating voltage with low magnitude. Therefore, a bridge rectifier circuit is used to convert AC voltage into DC voltage. After rectification, a voltage regulator is used to maintain a stable output suitable for charging and storage purposes.

In the third stage, the regulated DC power is stored in an energy storage unit such as a rechargeable battery or supercapacitor. This stored energy acts as a backup supply and is later used for mobile charging applications. A power management circuit is included to ensure efficient energy distribution and prevent overcharging.

In the fourth stage, an RFID-based control system is implemented to provide user authentication. Each user is assigned a unique RFID tag or card, which is scanned using an RFID reader connected to a microcontroller. The microcontroller verifies the user identity and enables or disables the charging output accordingly. This ensures controlled access and efficient utilization of stored energy.

IV. PROPOSED METHODOLOGY

The proposed methodology for the system titled Electricity Generation Using Footstep Energy with Mobile Charging Through RFID Technology is designed to efficiently convert human mechanical energy into electrical energy and manage its utilization through a smart control mechanism. The system integrates energy harvesting, power conditioning, energy storage, and RFID-based authentication in a structured manner.

The first step of the proposed system is footstep energy harvesting, where piezoelectric sensors are embedded inside specially designed floor tiles. When a person walks over the tile, mechanical pressure is applied to the sensors, which generates electrical energy based on the piezoelectric effect.

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This energy is initially in an unstable and low-voltage form.

In the second step, the generated electrical output is passed through a power conditioning unit, which includes a bridge rectifier to convert AC voltage into DC voltage. A filter circuit is used to reduce ripples, and a voltage regulator is employed to maintain a constant and usable DC output suitable for storage and charging applications.

The third step involves energy storage, where the regulated DC power is stored in a rechargeable battery or supercapacitor. This stored energy acts as a continuous power source and ensures availability even when footstep activity is low. A charge controller is included to protect the storage unit from overcharging and deep discharge.

The fourth step introduces RFID-based user authentication, where each user is provided with a unique RFID tag or card. When the user scans the RFID tag, the RFID reader sends the data to a microcontroller. The microcontroller verifies the identity and grants access to the charging system only if the user is authorized.

In the final step, the microcontroller-based control system manages the entire operation of the setup. It controls energy flow from storage to the mobile charging unit and ensures that power is delivered only after successful RFID authentication. The output is provided through a regulated USB charging port for charging mobile devices.

V. WORKING PRINCIPLE

The working principle of the proposed system is based on the conversion of mechanical energy into electrical energy using the piezoelectric effect, followed by controlled storage and utilization of the generated power through an RFID-based smart system.

When a person walks on the specially designed floor tile, mechanical pressure is applied to the embedded piezoelectric sensors. Due to the piezoelectric effect, these sensors generate an electrical charge proportional to the applied force. This electrical output is initially in the form of low-level alternating voltage.

The generated AC voltage is then passed through a bridge rectifier circuit, which converts it into direct current (DC). Since the output voltage may still be unstable, a voltage regulator circuit is used to maintain a constant and usable DC voltage suitable for electronic devices.

The regulated electrical energy is stored in an energy storage unit, such as a rechargeable battery or supercapacitor. This stored energy can be utilized whenever required, especially for mobile charging applications. A charge control mechanism ensures safe and efficient storage without overcharging or damage to the battery.

For controlled access, an RFID system is integrated into the setup. Each user is assigned a unique RFID tag or card. When the user scans the RFID card on the RFID reader, the information is sent to a microcontroller. The microcontroller verifies the user identity and activates the charging system only for authorized users.

Once authentication is successful, the stored energy is supplied to a USB charging module, allowing users to charge their mobile devices. If authentication fails, the system remains inactive and no power is supplied.

Thus, the system operates by continuously harvesting footstep energy, storing it efficiently, and distributing it in a controlled manner using RFID-based authentication, making it both a renewable and smart energy solution.

VI. BLOCK DIAGRAM

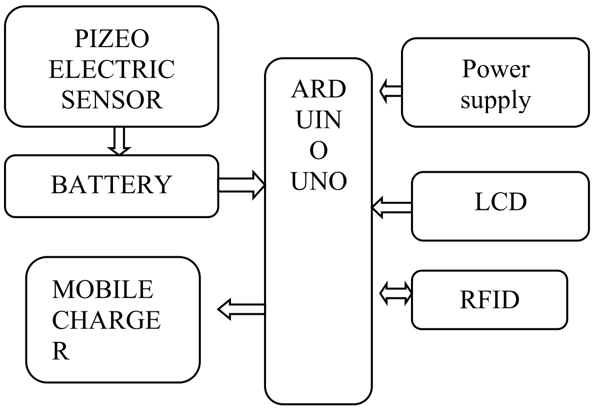

Fig. 6.2. Block Diagram

VII. RESULTS AND OUTCOMES

Fig. 1. The proposed system for electricity generation using footstep energy with mobile charging through RFID technology successfully demonstrates the practical conversion of mechanical energy into usable electrical energy. The piezoelectric sensors embedded in the floor tiles were able to generate electrical output whenever pressure was applied through human footsteps. This

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confirms the effective working of the piezoelectric energy harvesting principle.

Fig. 2. The generated electrical energy was successfully converted from AC to DC using a rectifier circuit and stabilized using a voltage regulator. The regulated output was efficiently stored in a rechargeable battery/supercapacitor, ensuring continuous availability of power for later use. This stored energy was found to be sufficient for low-power applications such as mobile charging. The integration of the RFID system provided a reliable method for user authentication. Only authorized users with valid RFID tags were allowed to access the charging system. This improved the security and controlled usage of the generated energy. The microcontroller successfully coordinated the RFID verification process and power distribution system.

Fig. 7.1. Output1 CHARING

Fig. 7.2. Output2 RFID VERIFIED

The overall performance of the system was found to be stable, accurate, and efficient. It reduced the need for manual checking and minimized human errors. The system demonstrated reliability in continuous operation and proved to be a cost-effective solution for small and medium-scale retail stores. The outcomes of this project show that the proposed system can significantly improve inventory management by providing real-time monitoring, automatic alerts, and reduced operational effort

VIII.CONCLUSION

The integration of a rectifier and voltage regulator ensures stable and usable DC output, which can be efficiently utilized for mobile charging applications. Additionally, the inclusion of RFID technology enhances the system by providing user authentication and controlled access, making the system secure and efficient.

From the study and implementation, it is observed that the system performs best in high footfall areas such as railway stations, shopping malls, and educational institutions, where continuous human movement can generate significant cumulative energy. Although the energy generated per step is limited, the concept proves to be a sustainable solution for small-scale power needs.

In conclusion, this project demonstrates a smart combination of renewable energy harvesting and modern control technology. It contributes towards energy conservation and supports the development of eco-friendly and intelligent infrastructure systems. With further improvements in piezoelectric materials and energy storage efficiency, this system can become more practical for large-scale applications in the future.

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