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Piezoelectric Smart Walkway (IOT Based)

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Abstract: *In recent years, the demand for sustainable and renewable energy sources has increased significantly due to rapid urbanization and depletion of conventional resources. Piezoelectric energy harvesting has emerged as an effective technique for converting mechanical energy into electrical energy. This paper presents the design and implementation of a Piezoelectric Smart Walkway system that utilizes human footsteps as a source of energy generation.*

The system employs piezoelectric sensors embedded beneath a walking surface to generate electrical energy from applied pressure. The generated energy is stored and utilized for low-power applications such as LED lighting. Furthermore, the integration of Internet of Things (IoT) technology enables real-time monitoring and analysis of energy generation and pedestrian activity. The proposed system provides an eco-friendly and cost-effective solution for smart city infrastructure development..

Keywords: Piezoelectric Sensors, Energy Harvesting, IoT, Smart Walkway, Renewable Energy

I. INTRODUCTION

With the continuous growth of urban populations, the need for alternative energy sources has become increasingly important. Conventional energy generation methods are not only limited but also contribute to environmental pollution. Therefore, researchers are focusing on innovative techniques to utilize renewable and non-conventional energy sources.

Piezoelectric materials have the ability to generate electrical energy when subjected to mechanical stress. This property can be effectively used in public areas where a large number of pedestrians generate continuous pressure through footsteps. The concept of a piezoelectric smart walkway is based on capturing this mechanical energy and converting it into electrical power [1].

Additionally, IoT integration enhances system functionality by enabling data collection, monitoring, and remote control. This makes the system suitable for smart city applications, where efficient energy utilization and data-driven decisions are essential [2].

BACKGROUND

Traditional energy harvesting systems primarily rely on solar and wind energy. Although effective, these systems are dependent on environmental conditions and may not provide continuous energy output.

Piezoelectric energy harvesting provides an alternative approach by utilizing mechanical vibrations and pressure. Previous studies have demonstrated the feasibility of generating power from road traffic and pedestrian movement using piezoelectric materials [3], [4]. However, large-scale implementation in public infrastructure is still limited.

The increasing demand for smart and sustainable solutions has led to the exploration of piezoelectric systems in walkways, pavements, and transportation hubs. These systems not only generate energy but also provide valuable data for urban planning and management [5].

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PROBLEMSTATEMENT

In modern urban environments, a significant amount of kinetic energy generated by pedestrian movement is wasted. Public places such as railway stations, shopping malls, and sidewalks experience heavy foot traffic, yet no mechanism exists to harness this energy.

Conventional energy sources are expensive and contribute to environmental degradation. Moreover, there is a lack of integrated systems that combine energy harvesting with real-time monitoring capabilities.

Therefore, there is a need for a system that can efficiently capture and utilize this unused energy while also supporting smart monitoring and control mechanisms.

PROPOSED SOLUTION

To overcome the identified challenges, a Piezoelectric Smart Walkway system is proposed. The system consists of piezoelectric sensors installed beneath the walking surface. When pressure is applied due to footsteps, the sensors generate electrical energy.

The generated energy is converted from AC to DC using a bridge rectifier and then regulated using a voltage regulator. The stored energy is used to power LED lights and other low-power devices.

An IoT-based monitoring system is integrated to collect real-time data such as voltage output, energy generation, and pedestrian count. This data is transmitted to a cloud platform for analysis and visualization.

The proposed system ensures efficient energy utilization, reduces dependency on conventional power sources, and supports smart city development.

METHODOLOGY

The system is developed using a structured approach consisting of the following steps:

Energy Generation:

Piezoelectric sensors generate electrical energy when mechanical pressure is applied.

Energy Conversion:

The generated AC signal is converted into DC using a rectifier circuit.

Energy Storage:

The DC output is stored in rechargeable batteries for later use.

Control System:

A microcontroller (Arduino/ESP32) is used to monitor and control the system.

IoT Integration:

Data is transmitted to cloud platforms for real-time monitoring and analysis.

Output Application:

Stored energy is used to power LEDs and other devices.

RESOURCES USED

Software

Arduino IDE / PlatformIO
Python
AWS IoT / Google Cloud IoT
Grafana

Hardware

Piezoelectric Sensors
Arduino Nano / ESP32
Bridge Rectifier

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Voltage Regulator (LM7805)
Capacitors
Rechargeable Battery
LEDs
Wi-Fi Module

II. CONCLUSION

The Piezoelectric Smart Walkway system provides an innovative approach to energy harvesting by utilizing human footsteps as a source of power generation. The integration of IoT technology enables efficient monitoring and control, making the system suitable for modern smart city applications.

The proposed solution is eco-friendly, scalable, and cost-effective. It demonstrates the potential of converting everyday human activity into a valuable energy resource, thereby contributing to sustainable development

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