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Power Generation Using Footsteps With Charging Station And Iot-Based Monitoring System

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Abstract:

This study suggests the design and development of a Piezoelectric Footstep Power Generation System with an integrated charging dock and IoT monitoring features. This system captures the mechanical energy of human footsteps using piezoelectric sensors and transforms it into electrical energy. The collected energy is rectified, stored in rechargeable batteries, and used to charge small electronic devices. A microcontroller monitors the system's parameters, which are displayed in real-time on an LCD screen and sent to the ThingSpeak IoT platform for remote monitoring and analysis. This approach provides an eco-friendly solution for energy harvesting in congested public areas while aiding the development of clean energy technological advancements alongside efficient energy management solutions.

I. INTRODUCTION

The ever-growing world demand for energy, together with the finite supply of fossil fuel resources and the negative environmental consequences of their use, has driven the search for alternative and sustainable sources of energy. Harvesting ambient energy from mechanical sources like human motion has been one of the areas that have shown great promise for meeting part of this demand. Footstep-generated mechanical energy, which is abundant where there is high pedestrian flow, is an underexploited source of renewable energy. The piezoelectric effect, where some materials produce an electric charge in response to applied mechanical stress, provides a very effective means of harvesting such energy.

This paper details the design and implementation of a Piezoelectric Footstep Power Generation System that efficiently generates electrical energy from mechanical energy. The system involves an array of piezoelectric sensors that are integrated in a walking surface, placed such that they could capture maximum pedestrian movement energy to be harvested. The electrical energy generated is subjected to rectification to yield a stable direct current (DC) output, which is then stored in rechargeable batteries. This retained energy is further used to energize low-power electronic equipment, showing its pragmatic uses in everyday settings.

For enabling effective monitoring and system control, a microcontroller unit (MCU) is incorporated in the design to deliver real-time measurement and display of critical electrical parameters, such as output voltage and battery state of charge, through an LCD interface. Moreover, to increase the accessibility and analysis of system performance data, an Internet of Things (IoT) communication module is utilized. Data are streamed to the ThingSpeak platform to support remote monitoring, data logging, and advanced performance analytics.

The incorporation of IoT capability turns the suggested system into a smart energy harvesting solution in line with the emerging paradigms of smart cities and intelligent infrastructure. Target deployment locations are areas of high and consistent public usage such as transportation terminals, university campuses, shopping centers, and leisure parks. Through the use of human motion as a sustainable energy source, the system is aimed at driving the development of decentralized energy systems, green urbanization, and the overall ideals of clean energy utilization and greenery.

II. RELATED WORKS

Past work in piezoelectric energy harvesting has centered on very specific and niche applications like marine, biomedical implants, vehicle sensing, or structural vibrations, which, though pioneering, are not very easily translatable to mass consumer application. Most such studies are not scalable, not real-time monitored, and do not perform intelligent data analysis, and hence are not well-suited for dynamic high-traffic city environments. Conversely, the current research is particularly aimed at human-focused energy harvesting by harvesting mechanical energy from footfalls in public areas. The use of microcontroller-based monitoring with cloud-connected analytics platforms enables real-time tracking of data, effective energy storage, and intelligent energy management. This renders the system not only viable for instant implementation in smart city infrastructure but also scalable and flexible for integration with other renewable energy sources. The fundamental distinction is its holistic, IoT-based design, which fills the gap between experimental energy harvesting and practical application in sustainable urban development.

III. CONCLUSION

The Piezoelectric Footstep Power Generation System presented is a proof of concept that highlights the feasibility of harnessing human mechanical energy as a renewable source of electrical power. By combining piezoelectric energy harvesting with real-time monitoring and IoT-based data analytics, the system provides an intelligent and pragmatic solution for localized power generation in high-traffic settings. The integration of microcontroller-based monitoring and cloud connectivity through the ThingSpeak platform allows real-time monitoring, which increases the reliability and effectiveness of the system. In addition, the capability to store the harvested energy for charging small electronics makes it useful in public infrastructure environments towards the overall objective of sustainable urban development and smart city projects. Enhancements in the future could involve piezoelectric material configuration optimization, scaling up to larger deployment fields, and combining with other renewable energy systems in order to maximize overall energy yield and system scalability.

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