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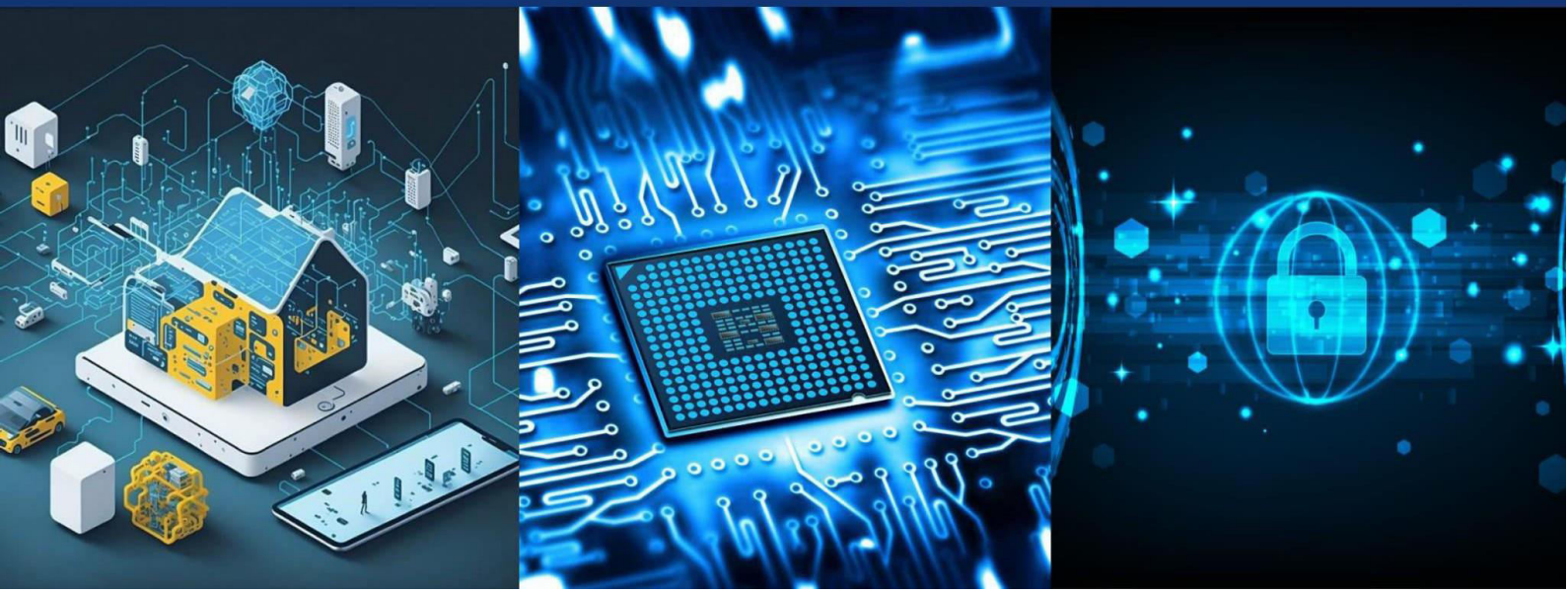

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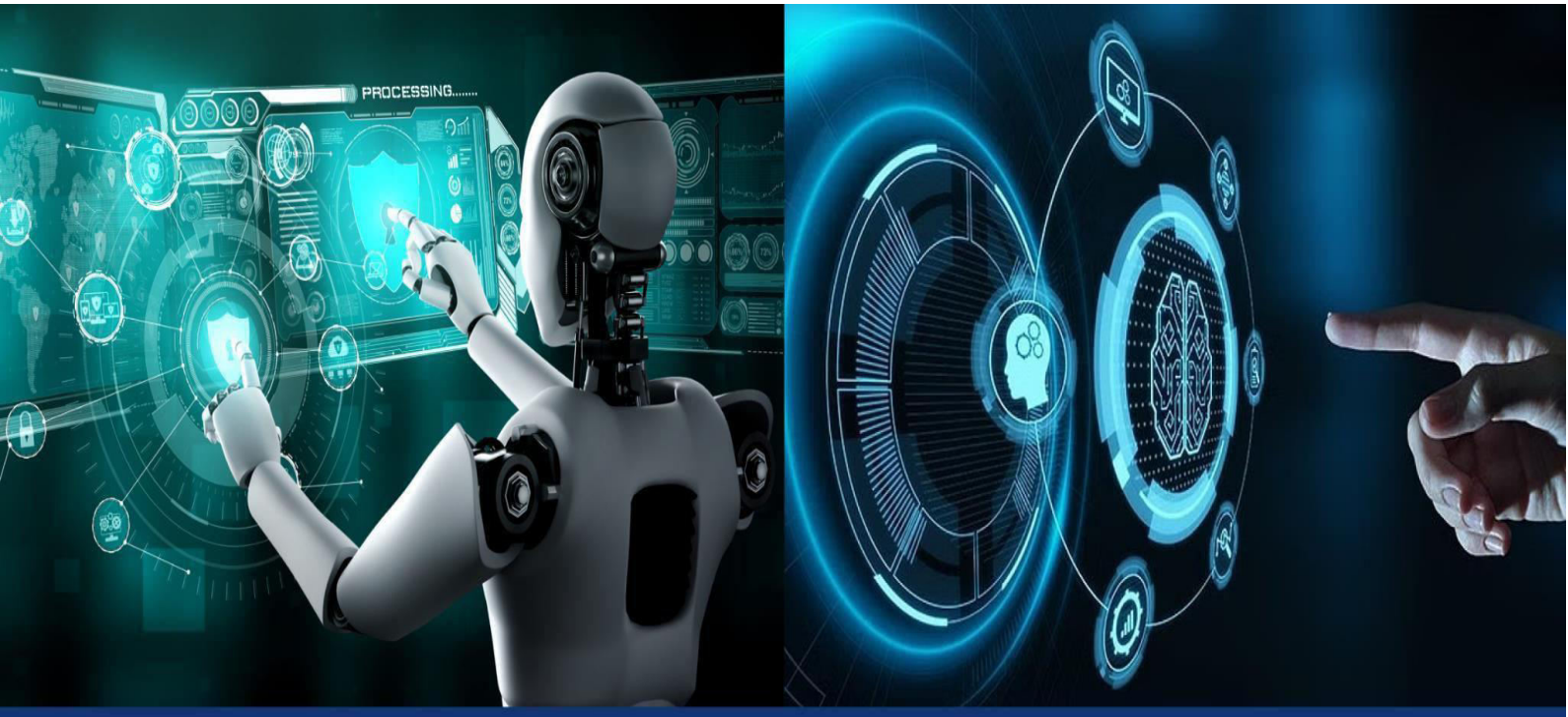

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Footstep Electricity Generation Using Piezoelectric Sensor

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ABSTRACT: The rapid growth in population and industrialization has resulted in increased energy demand and depletion of conventional energy resources. Hence, there is a strong need for renewable and sustainable energy solutions. Footstep electricity generation using piezoelectric sensors is an emerging technology that converts mechanical energy from human footsteps into electrical energy. Piezoelectric materials generate electric charge when mechanical stress is applied to them. In this work, a footstep power generation system is designed using piezoelectric sensors, rectifier circuits, voltage regulation, and energy storage units. The generated energy is stored and utilized for low-power applications such as LED lighting and sensor-based systems. Experimental observations show that the proposed system is efficient, economical, and suitable for implementation in high-footfall public areas.

KEYWORDS: Piezoelectric Sensor, Footstep Energy, Energy Harvesting, Renewable Energy, Sustainable Power.

I. INTRODUCTION

Energy is an essential requirement for the development of modern society. Conventional energy sources such as coal, petroleum, and natural gas are non-renewable and contribute significantly to environmental pollution. To overcome these issues, renewable energy sources such as solar, wind, and vibration-based energy harvesting are being explored. Footstep electricity generation using piezoelectric sensors is a novel method of harvesting energy from human motion. In crowded areas such as railway stations, shopping malls, colleges, and footpaths, a large amount of mechanical energy is wasted during walking. This mechanical energy can be effectively converted into electrical energy using the piezoelectric effect. Piezoelectric sensors produce electrical voltage when pressure is applied, making them suitable for footstep-based energy harvesting systems. This paper presents the design, working, and experimental analysis of a footstep electricity generation system using piezoelectric sensors. The proposed system is simple, cost-effective, and environmentally friendly. The motivation behind this work is to utilize otherwise wasted human mechanical energy and convert it into useful electrical power. Unlike conventional renewable sources such as solar and wind, footstep energy generation is independent of weather conditions and can continuously generate power in high-footfall areas. With the advancement of smart infrastructure and smart city concepts, energy harvesting technologies are gaining importance. Integrating piezoelectric-based energy generation systems into floors and pavements can contribute to decentralized power generation and reduce load on conventional power grids. Although the amount of energy generated per step is small, the cumulative effect in crowded locations makes this approach practically viable. This research emphasizes the feasibility, working efficiency, and real-time applicability of footstep electricity generation systems for low-power application

II. RELATED WORK

Several studies have been conducted on energy harvesting systems utilizing renewable resources such as solar and wind energy. However, in recent years, researchers have focused on vibration and motion-based harvesting techniques, particularly using piezoelectric materials. S. Priya and D. J. Inman (2009) discussed various energy harvesting technologies, emphasizing the efficiency and practicality of piezoelectric materials for micro-energy applications. Similarly, A. Erturk and D. J. Inman (2011) presented theoretical and experimental analyses demonstrating that piezoelectric systems can effectively convert mechanical vibrations into electrical power. Further, R. V. Kulkarni et al. (2016) explored footstep-based electricity generation using piezoelectric sensors, proving that human motion can be

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utilized as a renewable energy source. These studies collectively indicate that piezoelectric-based energy harvesting is an efficient, eco-friendly, and promising technology for small-scale energy generation in smart infrastructure applications.

III. PROPOSED ALGORITHM

The proposed algorithm focuses on converting mechanical energy from human footsteps into usable electrical energy through piezoelectric sensors. When a person steps on the footplate, pressure is exerted on the sensors, which convert this mechanical stress into alternating current (AC) voltage using the piezoelectric effect. This generated AC voltage is then passed through a bridge rectifier circuit to obtain direct current (DC) voltage. A voltage regulator ensures that the output remains stable and suitable for powering electronic components. The regulated energy is stored in a rechargeable battery or capacitor for future use. The system employs an Arduino microcontroller to monitor sensor activity, control power distribution, and display the voltage level on an LCD module. The stored energy can be used to operate low-power applications such as LED lights, sensors, and microcontroller-based systems, making the design both efficient and practical for high-footfall public areas.

IV. PSEUDO CODE

```
START
INITIALIZE piezoelectric sensors, rectifier, voltage regulator, battery, Arduino, and display module

WHILE system is ON:
  IF footstep detected THEN
    READ pressure value from piezo sensor
    GENERATE AC voltage
    CONVERT AC to DC using bridge rectifier
    REGULATE voltage using voltage regulator
    STORE energy in battery
    UPDATE LCD display with current voltage level
    TURN ON LED indicator
  ELSE
    DISPLAY “No Footstep Detected”
  ENDIF
ENDWHILE

STOP
```

V. SIMULATION RESULTS

The proposed footstep electricity generation system was simulated and tested under normal walking conditions to evaluate its performance. The output voltage generated by the piezoelectric sensors was recorded for varying numbers of footsteps. It was observed that as the number of steps increased, the voltage output also increased proportionally, demonstrating the effectiveness of the piezoelectric energy conversion process. The generated electrical energy was sufficient to power low-energy devices such as LEDs and to charge small capacitors. During experimentation, 10 footsteps produced approximately 3.2 volts, while 20, 30, and 40 footsteps generated around 5.6 V, 7.8 V, and 9.4 V respectively. These results confirm that the system efficiently converts mechanical pressure into electrical energy. Furthermore, the inclusion of multiple sensors enhanced the overall output, making the system more suitable for practical applications in crowded areas. The simulation and testing results validate that the proposed design is cost-effective, reliable, and capable of providing a sustainable energy source for low-power electronic systems in smart environments.

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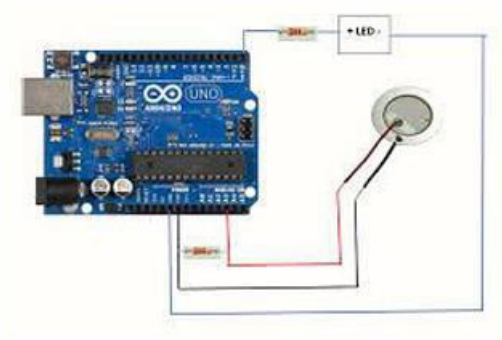

VI. CONCLUSION AND FUTURE WORK

The footstep electricity generation system using piezoelectric sensors successfully demonstrates the conversion of mechanical energy into electrical energy. The system is economical, sustainable, and suitable for implementation in public areas. Experimental results confirm that the generated power can be utilized for low-power applications. Future work can focus on large-scale implementation and integration with IoT systems.

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