Harvesting Energy from Human Footsteps: A Path to Sustainable Power

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***Abstract*—This Technical Teamwork presents a piezoelectric energy-harvesting system that generates electrical power from human footsteps. Mechanical pressure applied while walking is converted into usable electrical energy through piezoelectric plates embedded in a flooring platform. The generated voltage is rectified, regulated, and stored in a battery or capacitor to power small loads such as LEDs or sensors. The modular design allows multiple piezo discs to be arranged for higher output, making the system scalable and suitable for public places like footpaths and corridors. This eco-friendly approach demonstrates the potential of piezoelectric materials as a clean and sustainable energy source for low-power applications.**

***Index Terms*—Piezoelectric energy harvesting, Piezoelectric plates / piezo discs, Flooring platform, Voltage rectification, Voltage regulation, Battery / capacitor storage.**

I. INTRODUCTION

The Footstep Power Generation System is a simple and eco-friendly method of producing electrical energy from human footsteps using piezoelectric sensors. When people walk on the platform, the mechanical pressure applied on the piezoelectric plates is converted into electrical energy. This makes the system suitable for crowded public places like footpaths, malls, footbridges, and parks where continuous footsteps can generate small but useful electrical power. The project also helps in understanding renewable energy concepts, piezoelectric behavior, power conditioning, and smart flooring technologies. Human footsteps naturally contain kinetic and mechanical energy that usually goes unused. With the growing demand for clean and sustainable energy, collecting this wasted energy becomes important. This project solves the issue by using piezoelectric plates that convert pressure into electrical voltage. The generated energy is then passed through a rectifier to convert AC to DC, regulated properly, and stored in a battery. This stored energy power small loads such as LEDs and monitoring circuits. Thus, the system contributes to renewable micro-energy solutions by utilizing everyday human motion. The main aim of the project is to design a working footstep-based energy harvesting model that converts mechanical force into electrical output suitable for low-power applications. The objectives include generating power from footsteps, demonstrating piezoelectric energy harvesting, rectifying and storing the output, and powering small electronic devices. The methodology uses multiple piezo discs placed under the platform, connected in series–parallel combinations to increase energy output, followed by rectification and storage. The project shows how piezoelectric materials can be used to design smart and sustainable flooring systems. The system is modular, meaning more piezo plates can be added to increase the generated power. This makes it suitable for future smart city projects and public infrastructures. While the power output is low and dependent on the number of footsteps, it still provides a promising way to convert wasted mechanical energy into useful electrical energy.

II. LITERATURE SURVEY

Article 1: Paper 1 focuses on generating electrical energy from human footsteps using piezoelectric discs. The study shows that when pressure is applied on the piezo elements, they produce 4–7V of usable DC power after rectification. By arranging multiple discs in series–parallel, the output improves and can be used to power small loads like LEDs. The system works well in high-footfall areas such as malls and walkways, and is highlighted as a low-cost, eco-friendly method of small-scale energy harvesting. The paper concludes that footstep power generation is practical and scalable for renewable micro-energy applications.

Article 2: This study focuses on converting human walking pressure into electrical energy using the piezoelectric effect. When mechanical stress is applied on the sensors, they generate AC voltage, which is then rectified to DC and stored in a battery. The system commonly uses quartz-based piezo discs arranged in series or parallel to increase voltage output and maintain uniform stress distribution. Findings show that a series combination of four sensors can produce around 48V under repeated footsteps. The paper concludes that this technology is clean, silent, low-maintenance, and suitable for public places. Future improvements suggested include optimizing materials and design to increase output without increasing the number of sensors.

Article 3: This paper presents a shoe-based energy harvesting system using piezoelectric sensors to convert footstep vibrations into electrical power. The methodology involves using multiple piezo discs connected in parallel to maximize current output, which is then rectified and stored in a capacitor or rechargeable battery. Reviewed research highlights the use of rectifier-based systems for powering small electronic devices, especially in mobile charging applications. Experimental results show each footstep can generate approximately 0.3–0.5V, making the system suitable for low-power applications such as USB charging. The paper emphasizes scalability and suggests expanding the design for larger pedestrian areas to achieve higher energy output.

Article 4: This paper presents a shoe-based energy harvesting system using piezoelectric sensors to convert footstep vibrations into electrical power. The methodology involves using multiple piezo discs connected in parallel to maximize current output, which is then rectified and stored in a capacitor or rechargeable battery. Reviewed research highlights the use of rectifier-based systems for powering small electronic devices, especially in mobile charging applications. Experimental results show each footstep can generate approximately 0.3–0.5V, making the system suitable for low-power applications such as USB charging. The paper emphasizes scalability and suggests expanding the design for larger pedestrian areas to achieve higher energy output.

Article 5: This study demonstrates a practical footstep power generation system that converts mechanical pressure from walking into electricity using PZT-based piezoelectric sensors. The design uses a series-parallel configuration—three sensors in series and ten such sets in parallel—to achieve an efficient balance of voltage and current, producing around 39 V per tile. The AC output is rectified, filtered, and stored in a 12 V battery, with a microcontroller monitoring system status. Results show that energy output increases with weight and number of steps, averaging 2.4 J per step, and the system can briefly power loads such as a 100 W bulb. With potential large-scale output up to 2000 W, the technology is suitable for crowded areas like campuses, stations, and malls. Overall, the project proves that piezoelectric materials can effectively harvest renewable energy from human movement in a cost-effective and eco-friendly way.

III. METHODOLOGY

Platform Construction:
A footstep platform is built with multiple piezoelectric discs sandwiched below it to receive pressure walking steps.

Sensor Arrangement:
Eight piezoelectric discs are arranged in two series chains, and both chains are connected in parallel to improve overall voltage and current output. (As described in the PDF: chain of 4 + chain of 4)

Energy Generation:
When pressure is applied on the platform, the piezo discs generate AC voltage due to the piezoelectric effect.

Rectification Circuit:
A bridge rectifier using 1N4007 diodes converts the AC voltage to DC.A 10µF capacitor filters and stabilizes the voltage

IV. BLOCK DIAGRAM

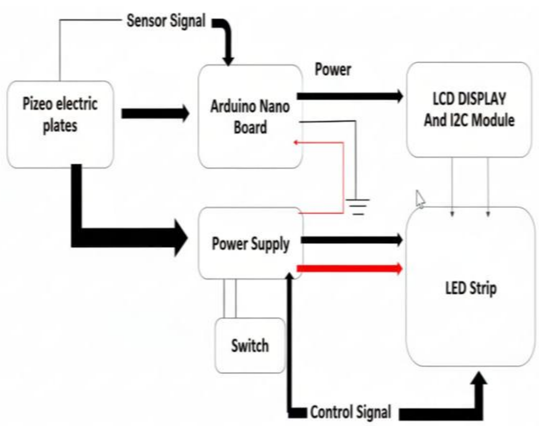

Fig.1: Block Diagram of Electro Floor

V. FLOW CHART

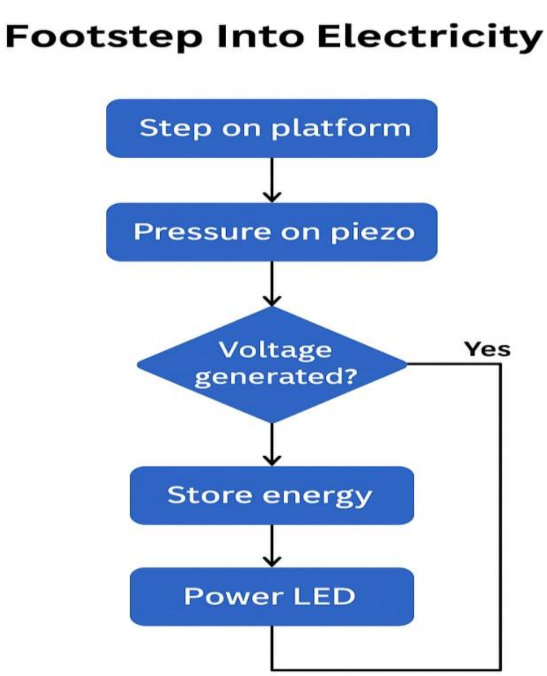

Fig.2: flow chart of ELECTRO FLOOR

VI. HARDWARE COMPONENTS USED

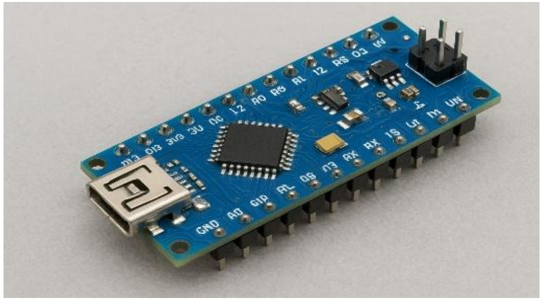

Fig.3: ARDUINO NANO

Fig 4: PIEZOELECTRIC PLATES

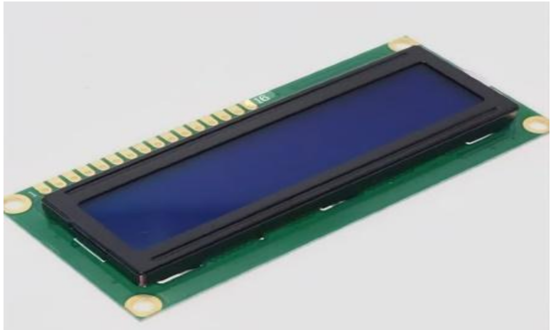

Fig 5: 16*2 LCD DISPLAY

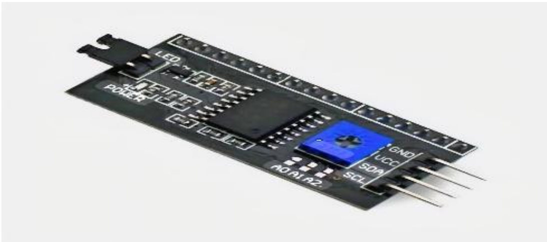

Fig 6: I2C MODULE

Fig 7: LED STRIP

Fig 8: 18650 BATTERY

VII. SOFTWARE REQUIRMENT

In our project, we used C++ in the Arduino IDE because it is the most efficient language for Arduino boards. It helped us control the Arduino Nano, read piezo sensors, and manage the LCD and LED strip quickly and accurately. C++ offers fast performance, low memory use, easy hardware access, and strong library support, which ensured smooth and reliable operation of our system. measurable electrical energy, making it suitable for low-power applications such as step counting, small displays, or sensor activation.

VIII. EXPERIMANTAL RESULTS

The footstep power generation prototype was tested using a piezo disc array connected to a bridge rectifier, storage capacitor, Arduino Nano, LCD display, and LED strip. During testing, each footstep produced a short voltage pulse of about 2–5 V after rectification, with a pulse duration of around 0.15–0.20 seconds. The Arduino measured the scaled voltage through a resistor divider and displayed it on the 16×2 LCD. The energy generated per step was small, in the range of a few millijoules, which was enough to charge a small capacitor and momentarily glow the LED strip but not sufficient to directly power high-load devices. The results confirm that the system can successfully convert foot pressure into measurable electrical energy, making it suitable for low-power applications such as step counting, small displays, or sensor activation.

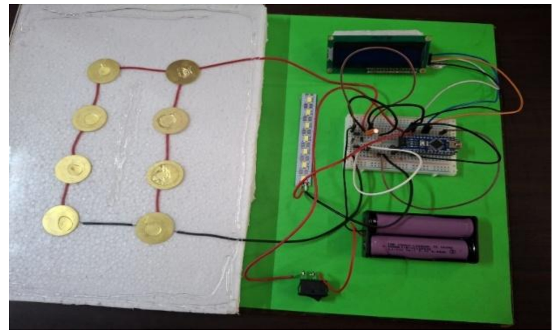

Fig 9: Electro Floor

Our footstep power generation project worked successfully. The piezo sensors generated electricity when pressure was applied, and the output was displayed on the LCD through the Arduino. All components functioned properly, and we achieved the expected result, proving that footsteps can be used to produce usable electrical energy.

IX. CONCLUSION

The Footstep Power Generation System is an effective demonstration of piezoelectric technology for renewable energy generation. It provides an engaging way to learn about energy harvesting and sensor integration, making it an excellent educational tool. By harnessing the energy from footsteps, this system offers a glimpse into the future of sustainable energy solutions.

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