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ELEC-GO HARNESSING HUMAN MOTION FOR SEAMLESS WIRELESS CHARGING

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Abstract
A piezoelectric shoe is a type of footwear that integrates piezoelectric materials within its sole and heel to generate electricity from mechanical pressure. These materials produce electrical energy when compressed by the wearer's movement, converting kinetic energy into usable electrical power. This energy can then be harnessed to power electronic devices or charge batteries, offering a sustainable energy solution. The technology holds significant potential for applications in various fields, including sports and fitness tracking, military operations, and emergency response systems. As wearable technology continues to evolve, the piezoelectric shoe stands out as an innovative way to tap into the body's natural energy. By transforming the mechanical energy produced from walking or running into electricity, it provides an efficient means of energy harvesting. This abstract highlights the core functionality, potential benefits, and future applications of piezoelectric shoes, demonstrating how they could revolutionize energy harvesting in wearable devices.
Keywords: Piezo sensor, HC-05Bluetooth Module, Aurdino Nano, Voltage Divider, LCD

1. INTRODUCTION
In recent years, there has been growing interest in the research and development of advanced smartphone technologies. However, as these technologies evolve, so do the challenges that accompany them, with one of the most prominent issues being rapid battery drainage. Almost every smartphone user desires longer battery life. Now, imagine a scenario where your phone charges wherever you go. This is made possible through the innovative Piezoelectric Wireless Power Transfer (WPT) mobile charging technique.
At the heart of this technology are two key concepts: piezoelectricity and wireless power transfer.

Piezoelectricity refers to the electrical energy generated from mechanical pressure, such as the motion of walking or running. When pressure is applied to a piezoelectric material, it generates a negative charge on the expanded side and a positive charge on the compressed side of the material. As the pressure is relieved, an electrical current flows through the material. Wireless power transfer, on the other hand, involves transmitting electrical energy from a power source (in this case, piezoelectric energy) to a device (such as a mobile phone) without the need for physical connectors like wires.

2. MODULE DESIGN
The Design consists of two units. Generation - transmission unit and receiver - charging unit. The

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Generation - Transmission unit side consists of the Piezo electric generator, capacitance bank, oscillator, and transmitter TX unit. This unit is integrated inside the shoe. Fig. 1 shows the design of the system.

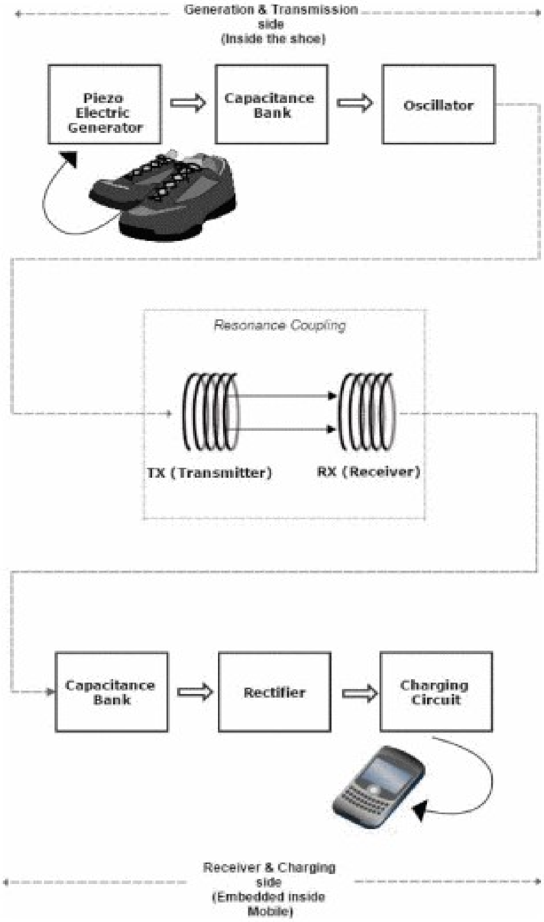

Fig:.1: Block diagram of piezo electric wireless power transfer mobile charging technique.

The receiver and charging unit consist of a capacitance bank, a rectification circuit, and a charging circuit. This system can be designed as a standalone unit or embedded directly within the mobile device. The receiver captures the energy, which is then converted into a DC supply through the rectification process. The converted output is subsequently fed to the mobile device's battery via the charging circuit, enabling efficient power transfer and charging.

A. Piezo Electric Generator Design

The Piezo electric generator is placed inside a Shoe. A shoe has two points where the pressure exerted in maximum and they are the heel and the toe, and this is the exact place where the piezo electric unit is placed. Fig. 2. Shows the arrangement of the piezoelectric generator inside a shoe.

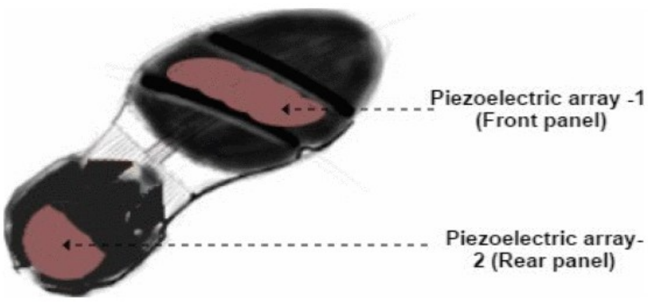

Fig. 2. Arrangement of piezoelectric generator inside a shoe.

The design features a pair of piezoelectric generator arrays connected in series. The front panel incorporates a linear arrangement of piezoelectric generators, while the rear panel utilizes a circular arrangement. The receiving and charging system captures both intermittent and continuous energy from the piezoelectric generators and efficiently stores the energy in a capacitor bank. Throughout the charging process, the voltage across the capacitors is continuously monitored. Once the voltage reaches 5.2V, the module output is activated, allowing power to be supplied to the rectifier and charging unit.

B. Wireless Power Transfer (WPT)

In the early 20th century, before the widespread use of electrical grids, Nikola Tesla dedicated much of his work to wireless power transmission. However, early methods, such as Tesla coils, produced undesirably large electric fields. In the past decade, the rise of autonomous electronic devices has rekindled interest in wireless power technology [3]. As Wi-Fi became widely adopted, the focus shifted towards eliminating the "last cable," further fueling the demand for wireless power solutions [4]. The wireless power technique employed here relies on the strong coupling between resonant electromagnetic coils to transfer energy wirelessly. [5] This approach differs from traditional methods like simple induction, microwaves, or air ionization.

The system consists of transmitters and receivers that use magnetic loop antennas, both critically tuned to the same frequency.

The principle of Evanescent Wave Coupling builds upon electromagnetic induction [6]. Electromagnetic induction works by generating a magnetic field with a primary coil, which induces current in a secondary coil placed within that field. However, this method has a limited range due to the power required to generate the magnetic field. As the distance increases, non-resonant induction becomes inefficient, losing much of the transmitted energy. Resonance enhances this process by "tunneling" the magnetic field to a receiver coil tuned to the same frequency, significantly improving efficiency.

Theoretical analysis suggests that when electromagnetic waves are directed through a highly angular waveguide, evanescent waves are produced, which carry no energy. When a properly resonant waveguide is placed near the transmitter, these evanescent waves can tunnel the energy to the receiver coil, where it can be rectified into DC power. Since the waves "tunnel" rather than propagate through the air, they avoid energy loss, interference with other devices, or potential harm to humans.

3. SYSTEM DESIGN & CIRCUIT

The schematic design of the generator and transmission side for the piezoelectric wireless power transfer mobile charging technique is shown in Fig. 3.

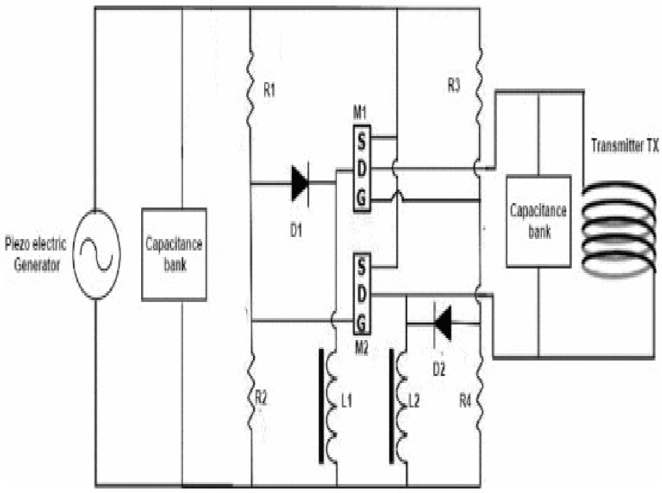

Fig. 3 Generation and transmission circuit

It can be observed from the circuit that the piezoelectric generator serves as the power source for

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the entire system, with the power being transmitted wirelessly via the wireless power transfer technique.

The schematic design and circuit of the receiver and charging side are shown in Fig. 4. As illustrated, the receiver (RX) and the capacitance bank are connected in parallel, with a rectification circuit also incorporated. This circuit converts the power into DC form, which then powers the charging circuit, ultimately charging the device's battery. If necessary, a regulator can be added between the rectifier and the charging circuit for additional control.

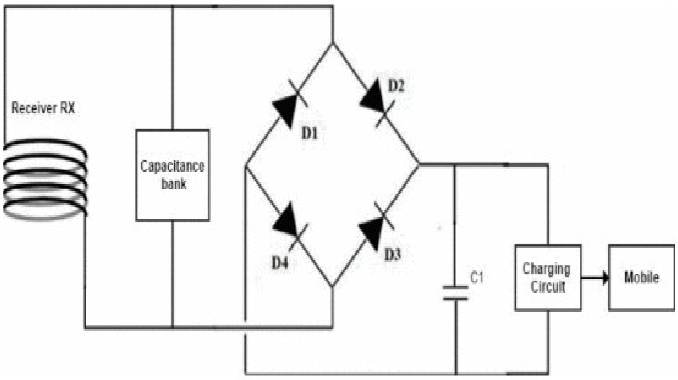
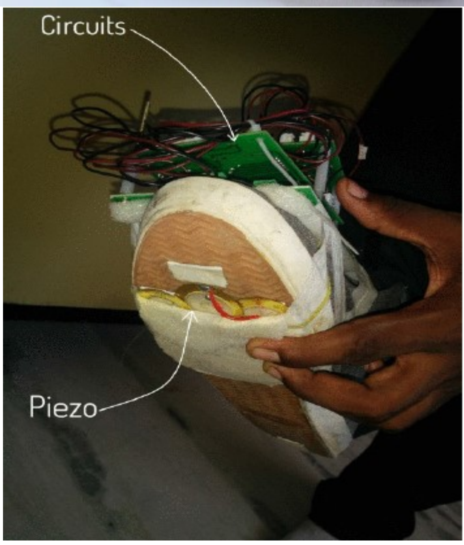


Fig. 4. Receiver and charging circuit

4. PROTOTYPE



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5. CONCLUSION

In this project, we have presented a system designed to harness the power generated by human movements and wirelessly transfer that energy to a device. We believe this research could provide a solution for uninterrupted smartphone usage. The system is versatile, as it can be built independently of footwear or as a compact version that can be easily strapped onto any shoe.

This project addresses a common issue faced by nearly every smartphone user. With approximately 1.8 billion people using smartphones, the desire for longer battery life and the ability to charge their devices on the go is universal. Our research provides a potential solution for continuous smartphone use, removing the need for traditional charging methods.

Energy harvesting from human motion offers a promising approach for obtaining clean and sustainable power. This project has broad applications within consumer electronics, offering an innovative way to power devices. Future work will focus on developing authentication and monitoring systems to further enhance the functionality and security of the system.

FUTURE SCOPE

There can be a lot of future enhancements related to this research work, which includes:

Enhanced Energy Harvesting Efficiency
Integration with Wearable Technology
Miniaturization and Flexibility
Improved Wireless Power Transfer (WPT) Systems
Smartphone and Device Compatibility
Sustainability and Environmental Impact
Real-Time Energy Monitoring and Management
Commercial and Military Applications
Autonomous Power Systems
Integration with Smart Cities

By addressing these areas, the piezoelectric shoe and wireless charging system could evolve into a more efficient, widely applicable, and environmentally sustainable technology, creating new possibilities for personal electronics, wearable tech, and energy harvesting solutions.

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