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Every Step Counts: Footstep-Driven Electricity Generation Systems

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Abstract: Non-conventional forms of energy can be harnessed more efficiently to generate power. It is observed that people engage in longer and more frequent walks daily, resulting in a significant amount of wasted energy. This energy can be effectively utilized by incorporating piezoelectric crystals along walking paths. As individuals walk, the compressive forces exerted on these crystals generate an electron flow, which can be stored in batteries for future use. Despite the availability of various power sources, both renewable and non-renewable, our power needs remain unmet. Therefore, this project aims to generate power through walking or running, particularly on stairs. The generated power can be stored and utilized for domestic purposes. This system can be implemented in residential areas, educational institutions, and other locations with constant human movement.

Power can be generated by utilizing the weight of individuals walking on steps or platforms. A control mechanism equipped with a piezoelectric sensor converts mechanical energy into electrical energy when the foot applies vibrations, stress, or straining forces. This generated power can charge devices such as laptops and mobile phones. The present study investigates the feasibility of generating electricity through human locomotion using piezoelectricity as an alternative energy source. Given the rapid decline of traditional energy-producing methods, it is imperative to explore non-conventional energy systems. This research seeks to identify a pollution-free energy source and optimize the utilization of currently wasted energy. To achieve this, a piezoelectric transducer converts mechanical energy from footstep pressure into electrical energy. The transducer is connected in a series-parallel configuration and placed on a wooden tile, simulating a footstep tile. This innovative tile can be utilized in crowded areas, walking paths, or exercise equipment, providing electric energy to power low-power appliances

Keywords: Piezoelectric Sensors, Atmega 328 Microcontroller, Footstep, Capacitor, Diodes, Power.

I. INTRODUCTION

Energy is commonly understood as the capacity to perform work. In our daily lives, electricity stands as the most widely utilized form of energy. In recent times, the demand for energy has been steadily rising, underscoring its crucial role in human existence. Consequently, numerous energy resources are being generated and, unfortunately, wasted. Electricity can be generated from various sources, such as water and wind. However, the development of large-scale plants is necessary to harness electricity from these resources, resulting in high maintenance costs.

Furthermore, other energy resources are both expensive and environmentally harmful, rendering them unaffordable for the general population. Given the paramount importance of electricity as a resource for humanity, it is imperative that wasted energy be effectively utilized. Walking is a common activity performed by individuals, and during this process, energy is wasted in the form of vibrations on the surface. This unused energy can be transformed into voltage through the utilization of the piezoelectric effect. The piezoelectric effect refers to the phenomenon in which mechanical vibrations, pressure, or strain applied to piezoelectric materials are transformed into electrical energy.

The objective of this project is to demonstrate how energy can be harnessed by stepping on stairs. With the increasing prevalence of stairs in buildings, even small structures with multiple floors can contribute to the utilization and conversion of this wasted energy through the piezoelectric effect. The piezoelectric effect is the ability of specific resources to generate an electric charge when lay open to applied mechanical stress.

This generated energy is stored in the batteries. This system will generate efficient outcomes if installed in populated areas. Implementation of this project will become a boon in generating electricity from the pressure of footsteps. The places in India where we can implement this system are roads, railway stations, and bus stands where millions of people move around the clock.

II. LITERATURE SURVEY

According to T.R. Deshmukh, the International Research Journal of Engineering and Technology (IRJET) has described the design and modelling of various parts of the footstep power generation system using 3D modelling software. This process involves the installation of a number of simple setups under the walking or standing platform. The project system operates by converting the linear motion caused by footsteps into rotating motion through a rack and pinion arrangement. However, this mechanism is not effective when there is a variable load, as it leads to balancing issues. Additionally, power is not generated during the return movement of the rack.According to Anirudh Chavan's research in 2017, work in this field involves optimizing and identifying the piezoelectric effect. Chavan's work also focused on designing a ceramic tile with maximum piezoelectric effect. The piezoelectric material in the tile generates energy when pressure is applied, such as when someone steps on it, creating vibrations that trigger the energy production process. The prototype ceramic tile was tested for characteristics such as density, fracture strength, resistive material, and shrinking measurement. These findings demonstrate the potential for piezoelectric ceramic tiles to be used as a source of renewable energy.

According to **Gauri Sahoo** (2016) , devices utilized for energy harvesting can employ velocity controlled harmonized switching harvesting on indicator (SSHI) techniques to automatically harvest piezoelectric energy. SSHI techniques eliminate the need for external power supply to control switching time, as they are self-powered. Additionally, SSHI techniques yield more precise results compared to current techniques. H. Xiong also discussed a piezoelectric energy harvester for roadways, which can generate approximately 0.36kWh of energy per year when installed at the Troutville weigh station in VT, USA.

Generation of Electrical Energy from Foot Step Using Rack and Pinion Mechanism by Md.Azhar, Zitender Rajpurohit, Abdul Saif, Nalla Abhinay, P.Sai Chandu. This research paper examines the use of a regulated 5V power supply with a 500mA power output. A bridge type full wave rectifier is employed to rectify the alternating current output of a secondary 230/12V step down transformer. A rack and pinion mechanism, consisting of a pair of gears that convert rotational motion into linear motion, is utilized as a linear actuator. The "pinion" engages with the teeth on the rack. The power generation system described in this paper harnesses energy from a non-renewable source, eliminating the need for external power sources and reducing pollution. This technology is particularly beneficial for locations such as roads and areas with foot traffic, where non-conventional energy generation, such as electricity, can be derived from footsteps.

III. METHODOLOGY

A. Power Generation Using The Footstep Method

This system presents a method of generating electric power through non-conventional means, specifically by harnessing the energy generated from walking or running. Given the increasing significance of non-conventional energy sources, this system offers a solution that does not require any external input to generate electrical output. The process involves the conversion of force energy into electrical energy.

The fundamental principle of this system involves harnessing untapped energy from the surrounding environment and converting it into electrical energy. The pressure generated by footsteps and waterfalls can be transformed into usable electrical power by piezoelectric materials precisely placed beneath insulating materials such as hard rubber. This energy can then be stored and utilized for domestic purposes.

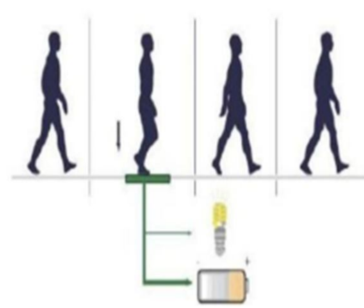

Fig 3.1: schematic representation of the working model

Piezoelectric materials possess the unique property of generating electricity when subjected to pressure. These materials have two axes: mechanical and electrical. When applied along the mechanical axis, pressure creates power along the electrical axis. "piezo" refers to generating electrical polarization in response to mechanical strain. This phenomenon, the direct or generator effect, is extensively employed in producing sensors (e.g., mobile phone vibrator lighters). Additionally, piezoelectric materials are utilized in actuators, exhibiting an inverse or motor effect, causing mechanical deformation in response to an electrical signal.

Electricity has emerged as an indispensable necessity for the global population, with its demand steadily escalating. Specific technologies require substantial amounts of electrical power to execute diverse operations. It is common knowledge that electricity is generated through sources such as water and wind. However, generating electricity from these resources necessitates the establishment of large-scale plants or mills, which incur significant maintenance expenses.

As energy consumption continues rising, more energy resources are generated and subsequently wasted. If this energy wastage trend persists, we will inevitably face a complete depletion of energy resources.

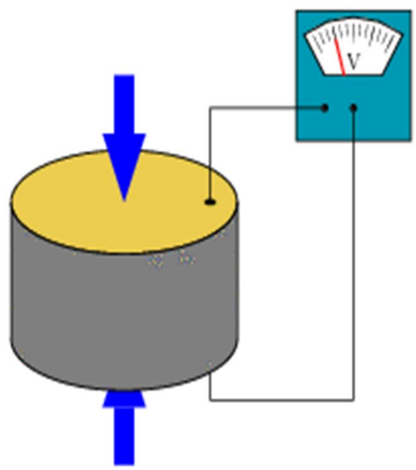

Fig 3.2: basic piezo transducer

The technology in question operates on the principle of the piezoelectric effect, which enables the generation of electrical charge through the application of pressure and strain. Piezoelectric ceramics are classified as ferroelectric materials, crystals that do not require an external electric field to function. Examples of piezoelectric ceramics include PbTio3, PbZro3, PVDF, and PZT, with PZT and PVDF being the most commonly available materials.

B. Power Generation

Currently, a pressing issue is being widely discussed – the energy crisis. The most promising solution to this problem is utilizing adaptive renewable energy resources. While solar and tidal energy are commonly recognized sources, it is worth noting that the human population can be an abundant and untapped energy resource. By harnessing this resource, a significant amount of energy can be generated, making it an ideal option for electricity production. One method of generating electricity from the human population involves utilizing the pressure exerted by individuals as they walk on the floor. This innovative system converts this pressure into electrical energy, then stored in batteries. The effectiveness of this system is greatly enhanced when implemented in densely populated areas. Consequently, the implementation of this project has the potential to revolutionize electricity generation by harnessing the pressure generated by footsteps. In India, there are several locations where this system can be successfully implemented, such as roads, railway stations, and bus stands, where millions of people pass through round the clock. As individuals walk on the floor, their body weight compresses the setup, activating the piezoelectric transducer and generating electrical energy, which is subsequently stored in batteries.

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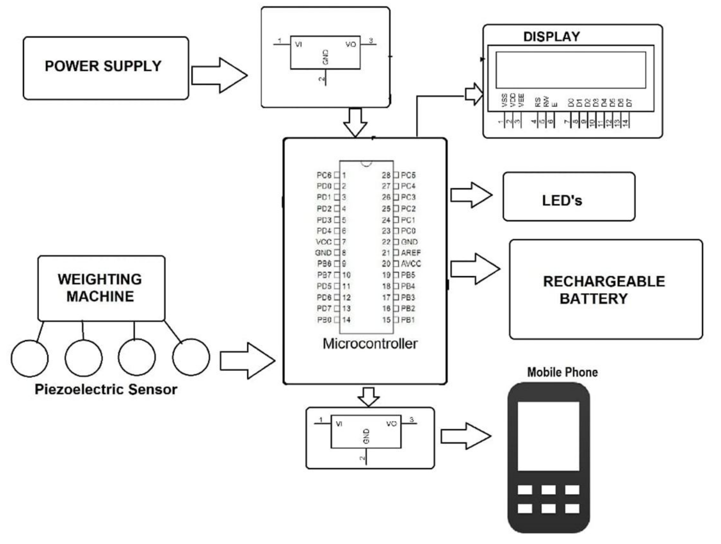
C. Block Diagram



D. Construction and Working

The fundamental principle underlying this system's operation involves converting pressure exerted by footsteps into electrical energy. The magnitude of the electrical output is contingent upon the stress level induced by the weight of an individual walking on the floor.

The system comprises blocks that exhibit a slight depression when subjected to the pressure exerted by human steps. Immediately following these blocks, a piezo transducer setup is positioned within the system to capture this depression. The design includes piezo sensors on the bottom platform and a compressible top medium. Additionally, the system incorporates a weighting platform, voltage regulators, a microprocessor, LEDs, an LCD, and diodes.

Piezoelectric transducers are activated as individuals traverse a flooring surface, converting mechanical pressure into voltage. This is a fundamental characteristic of piezoelectric transducers, which generate electrical output at their terminals, facilitating the acquisition of electric current and power.

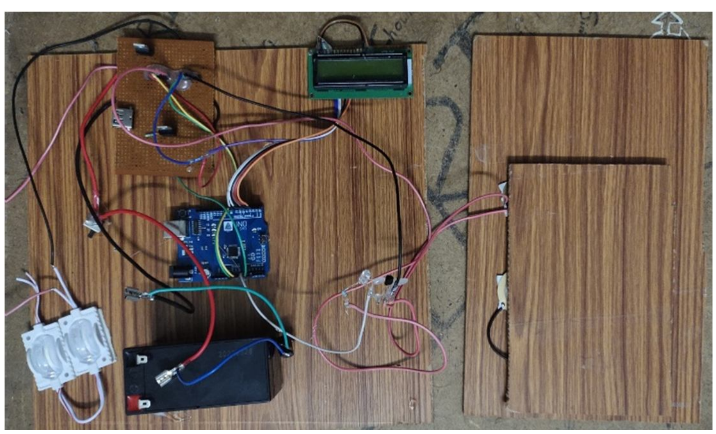


Fig 3.3: finial construction

The efficacy of this process is contingent upon the weight factor, which operates as a function of pressure. When pressure is exerted via a footstep, this method can convert ninety-five percent of the applied force into energy.

IV. RESULTS

A power harvesting system has been developed and executed utilizing a piezoelectric sensor to extract voltage from applied pressure. Additionally, an LCD is incorporated to indicate the voltage status. The generated voltage, dependent on the force applied to the sensor, is substantial enough to charge an electric vehicle. A switch is included in the model, enabling the illumination of a bulb when the button is activated, and electr1ic power is obtained. The amount of electricity the sensors generate can be displayed regarding voltage on a JHD 16A2 LCD screen.

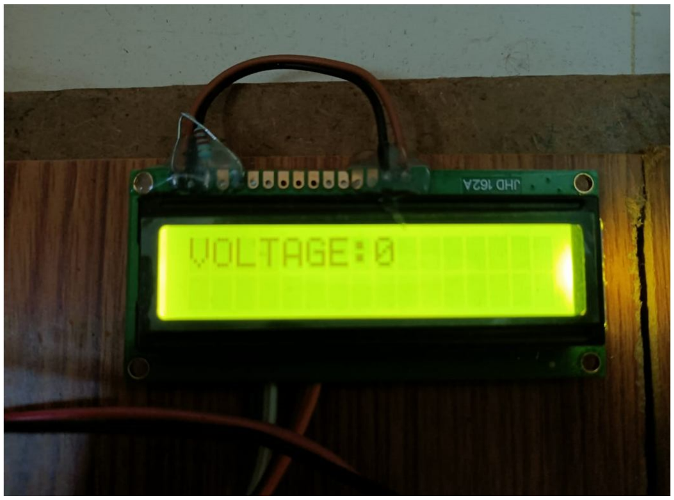


Fig 4.1: before the commencement of the test

At the commencement of the project demonstration, the LCD will indicate zero.
When force is applied to piezoelectric sensors, they generate voltage, which is displayed on an LED display. The LED light will glow with a maximum voltage of 41V – 44V when the piezoelectric elements or sensors are connected in parallel.

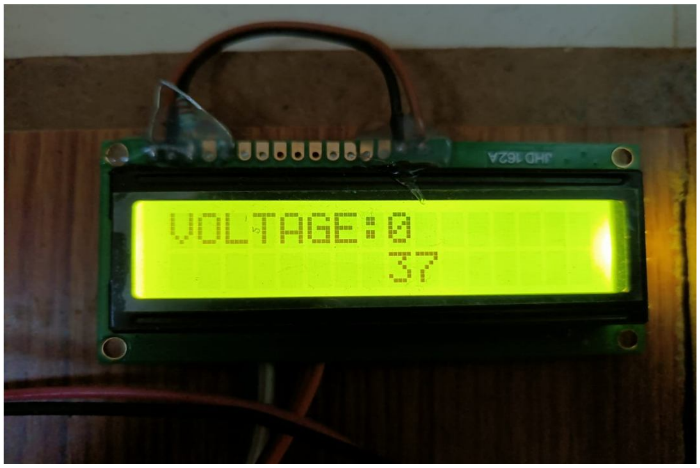


Fig 4.2: after commencement of the test

V. DISCUSSIONS

The voltages created across the piezoelectric materials and the quantity of current flowing through them is measured using voltmeters and ammeters, respectively. The energy can be stored in the capacitor by charging it, and the capacitor can then be discharged when needed. This circuit's energy harvesting capacity, on the other hand, isn't awe-inspiring. After the bridge rectifier step, a DC-to-DC converter can be used to address this difficulty. A switching device is located in parallel with the piezoelectric element. In a twelve V battery, the DC voltage will be stored. An inverter converts the twelve V DC batteries into AC electricity. A single piezoelectric tile may generate a voltage of about 40 V. Depending on the power needs, the tiles are linked in series or parallel.

The transistor's output is supplied to the inverter transformer, which converts 12 volts to 220 volts and lights the bulb. Different values of weight ranging from 20Kg to 120Kg with intervals of 20 Kg has been tested in research by Kunal Soni, Nikhil Jha, Jai Padamwar, Devanand Bhonsle, Tanu Rizvi states that the more the weight of a person the more electrical voltage is generated due to the pressure applied. The voltage increases with parallel connection and current increases with series connection in an electrical power supply.

VI. CONCLUSION

A 40V-generating piezo tile has been developed, with PZT proving superior to other piezoelectric materials. Additionally, a parallel connection was found to be more suitable. The study revealed a linear relationship between applied weight and generated voltage. This technology is well-suited for implementation in densely populated areas, eliminating the need for extensive power lines. It can be utilized for street lighting, charging ports, and lighting in buildings. We are confident that this technology will demonstrate its efficacy as a viable means of generating electricity from human footprints. This innovative approach holds great potential as a solution for densely populated nations such as India and China. Moreover, individuals can harness this technology to fulfill their energy requirements, as walking or jogging over piezo-placed tiles can efficiently and cost-effectively convert mechanical energy into electrical energy.

VII. RECOMMENDATION

My research found that a parallel connection yields a higher output than a series connection. Therefore, I recommend that others experiment with parallel and series connections in various methods including hydraulic pressure system and pneumatic pressure gauge to determine the optimal situation. Based on my findings, parallel connection is superior to series connection while using piezo- electric tiles in addition with a Atmega 328 Microcontroller.

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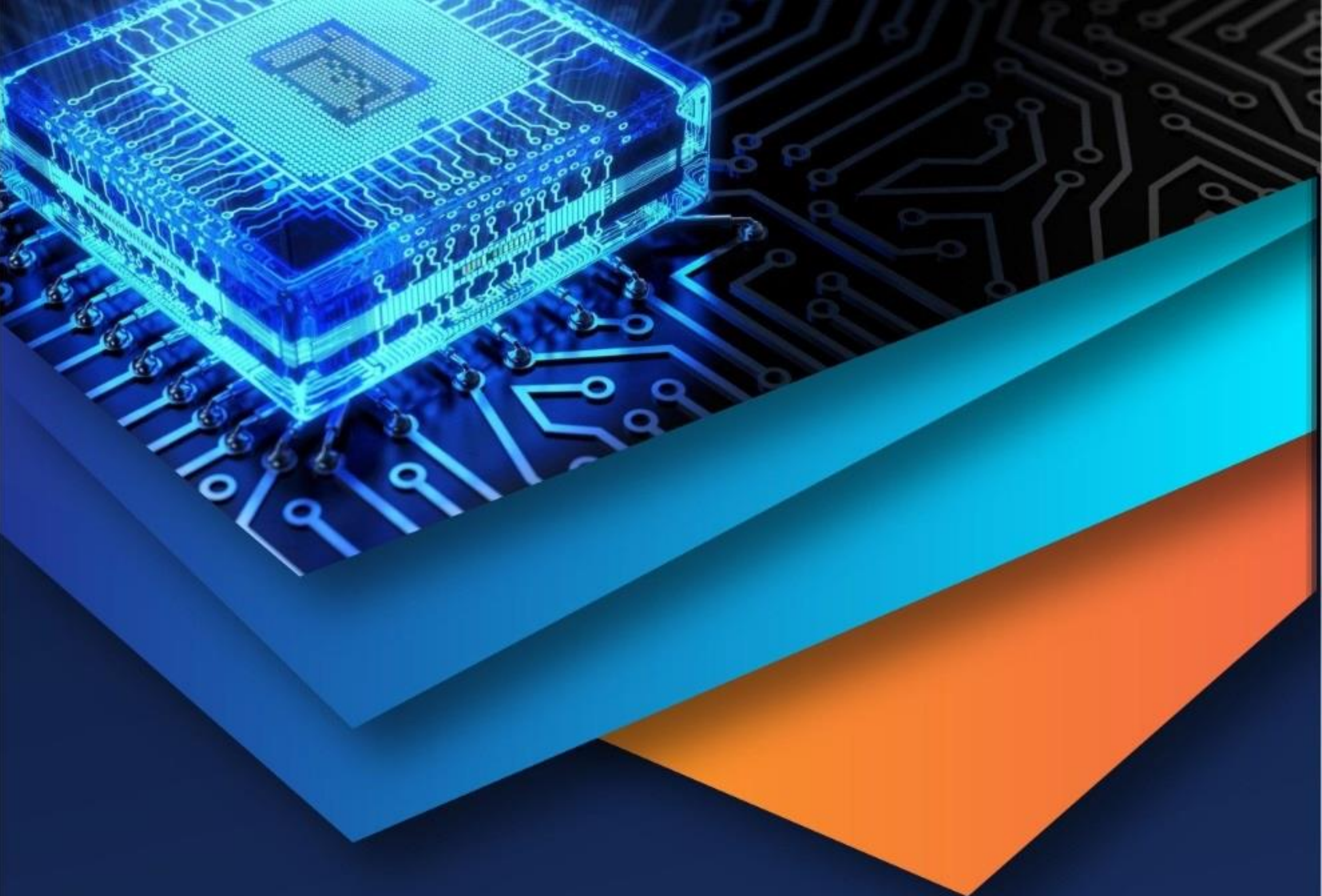

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