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Footstep Power Generation

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Abstract: ***Piezoelectric energy harvesting is the new upcoming green and clean energy which works on piezoelectric principle. The lost energies are being captured and restored by the transducer and piezoelectric sensor in to a battery. The vibrations and motions caused by humans and machines will be used and stored in battery are being used by the small and low power electronic component and wireless technology, starts being to develop recently and so, necessary steps are taken to develop and find a new power source from harvesting technique. The power and energy from different sources are commonly used and simple power harvesting circuits will replace the power supplies which is currently used. These materials harvest small amount of energy which are ignored and wasted in the surrounding but this energy can be useful for powering the small electrical components in a system. The research made to accumulate the power through this method and sources so an estimate amount of energy can be produced and stored. At the end of this project, the outcomes should be a stable power source to charge a battery and light a bulb of small watt and further can be used for multiple tasks and applications.***
Keywords: Energy harvesting, Piezoelectric sensors, Solid works Analysis.

I. INTRODUCTION

Piezoelectric materials generate electrical energy when exposed to mechanical stresses, vibrations, forces, pressures, and more. The energy conversion characteristics of the piezoelectric transducer make it suitable for energy harvesting applications.

The energy harvesting process involves harnessing the surrounding energy near the sensor and converting this energy into usable electrical energy. Compared to batteries, energy harvesting presents a potentially limitless source of energy to power wireless sensors and general on-board electronics. Energy harvesting (EH) is the process of obtaining small amounts of energy from external natural energy sources, storing it, and storing it for later use. In many cases, EH equipment converts ambient energy into electrical energy. By combining the right electronics, EH devices can be used to create a self-contained power supply system.

The energy generated by this unique method depends on human daily activity (walking). This energy is then stored in a lead acid battery so that we can charge any device like a mobile phone. In addition, this system allows us to visualize the output voltage using the LCD display.

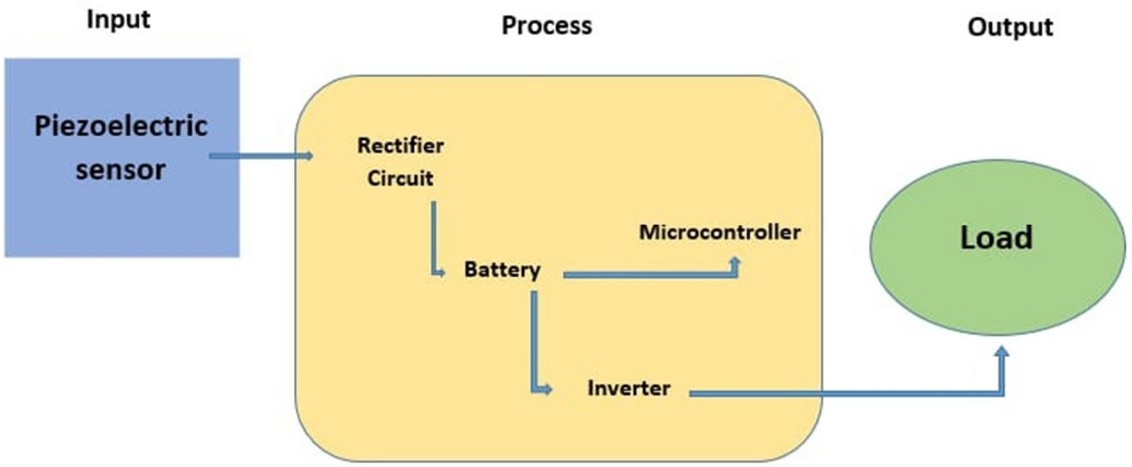
The design of the system is based on the force of the foot applied to the "piezoelectric" sensors located under the base of the machine. The force is converted into electrical energy and this process is known as the piezoelectric effect. The power supply to the circuit then allows the user to monitor the voltage across the inverter's DC loads. The voltage is stored in the lead-acid battery. Finally, the circuit is connected to a USB cable for recharging. All of these components convert voltage into electricity allowing devices to be charged: cell phones, tablets, MP3 players, and rechargeable light.

II. PIEZOELECTRIC MATERIAL

Piezoelectric materials are good convertor of mechanical energy into electrical energy. They are very sensitive to the applied pressure and can convert the pressure or force into voltage. The main principle of piezoelectricity lies behind the crystals. Electrical voltage is induced when crystalline materials are subjected to external force and pressure. Due to this the dimension of crystal changes this effect is known as electrostriction effect. Piezoelectric effect is observed in materials such as Quartz, Rochelle salt, Braium titanate etc. falls under the category of synthetic type. Table 1 shows the properties of some piezoelectric. In this table, G denotes the voltage sensitivity in volt meter per newton and K is charge sensitivity in coulomb per newton

Sr No	Material	Type	G(Vm/N)	K(PC/N)
1	Barium titanate	Synthetic	0.00012	150
2	Quartz	Natural	0.00050	02
3	Dipotassium tartrate	Synthetic	0.00060	155

III. BLOCK DIAGRAM



IV. LITERATURE REVIEW

Sr No.	Name of paper	Author	Year of publish	Finding of paper
1.	Piezoelectricity: a literature review for power generation support	Denis O. Urroz-Montoya1, a, Jeffrey R. Alverto-Suazo1, b, Julio R. García-Cabrera1, c and Cesar H Ortega-Jiménez1,2,3,d,e,f	2019	From this paper we understand that, It is undeniable the potential of piezoelectric materials as an energy source. In this paper there are different methods of piezoelectric harvesting are described.
2.	Piezoelectric Energy Harvesting Solutions: A Review	Corina Covaci and Aurel Gontean	2020	In this paper it is determined that ,the development of the Internet of Things concept, wearable's devices, and wireless technologies has led to the need for self-powered systems due to the inaccessibility of batteries for changing. A solution for these self-powered systems is to harvest mechanical energy using piezoelectricity.
3.	Footstep Power Generation Using Piezoelectric Sensors	C. H. Murali Krishna, R. Harshavardhan Reddy, C. Mahesh Babu, T. Mahesh, V. Madhusudhan, I. Ishaq Khan,D. Nikhitha	2020	The power generated with this non-conventional method depending on the human daily activity (walking). This energy is then stored in a Lead Acid battery so we can charge any device such as mobile phones. Also, this system enables us of viewing the amount of output voltage using an LCD.
4.	Footstep Voltage Generator using Piezo-Electric Transducers	Shrimoyee Poddar, Mohuya Dutta, Debashree Chowdhury, Abhinaba Dey, Debasis Maji	2017	A force sensor and voltmeter is connected to this series combination. As varying forces are applied on this connection, corresponding voltages are noted. Also the voltage generated across the series connection and the current is measured. Similarly the connections are done for parallel and series-parallel connections are done. They also done an experiment which determine that, the voltage from a series connection is good but the current obtained is poor, whereas the current from a parallel connection is good but the voltage is poor. But this problem is rectified in a series- parallel connection where a good voltage as well as current can be obtained.

V. CALCULATION

1) When a force is applied on piezo material, a charge is generated across it.
2) Thus, it can be assumed to be an ideal capacitor. Thus, all equations governing capacitors can be applied to it.
3) Considering on one tile, we connect 3 piezo in series .Thus when 3 piezoelectric discs are connected in series, its equivalent voltage is calculated.
4) So, we are considering 64 piezo and the calculation of equivalent voltage generated corresponding to number of peizo is shown below.

A. *Capacitance Equation for Series*

$$\mathbf{1/Ceq = 1/C_1 + 1/C_2 + 1/C_3} \text{ ..... eq1}$$

Since we know that,

$$\mathbf{Q = C \times V}$$

$$\mathbf{C = Q/V}$$

Hence.

$$\mathbf{Veq = V_1/Q + V_2/Q + V_3/Q} \text{..... eq2}$$

Therefore,

$$\mathbf{Veq = V_T = V_1 + V_2 + V_3} \text{ ..... eq3}$$

Since we know that **39 Volt** is generated by a force of **75kg** and **0.1 watt** of power using 3 piezoelectric sensors. We had taken a plate over which 64 such sensors are placed which will be generating **2.1 watt** of power. So we can state that a person of ideal weight **75 kg** can generate **2.1 watt** of power.

B. *Nomenclature*

C = Capacitance

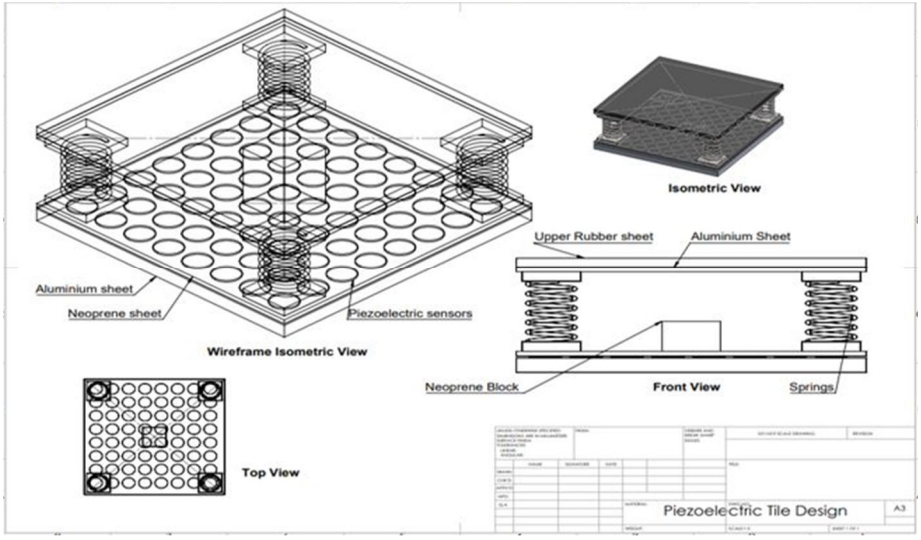
Ceq = Equivalence Capacitance

Q = Charge

V = Voltage

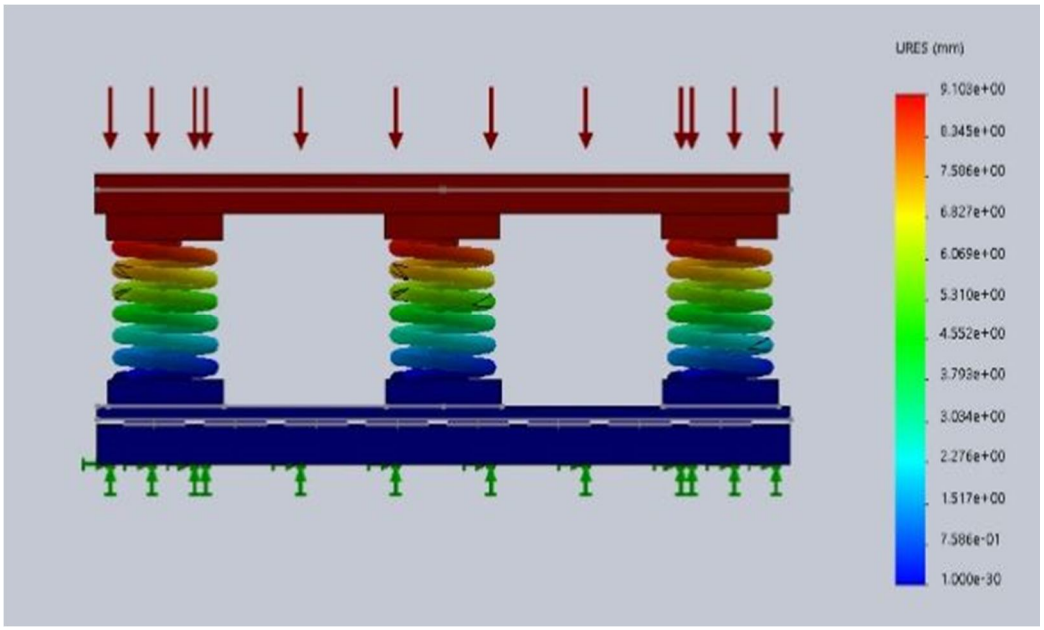
Veq = Equivalence Voltage

VI. DESIGN



Our piezoelectric tile contain four springs arranged at four corners between upper and lower plate for equal distribution of load to piezoelectric sensors so we can get maximum output. Piezo sensors of 27 mm diameter is used which are placed at lower plate, they are connected in series and parallel combination in total there are 64 sensors. A small neoprene block is placed between plates, at the center of lower plate. The purpose of neoprene block is to give output by a small displacement of upper plate. Rubber sheets are installed in upper plate in order to protect the design also it aesthetically looks good. Both the plates are of aluminum as it is light in weight, corrosion resistance and cheap.

VII. ANALYSIS



Deformation analysis for a load of 125kg

VIII. ADVANTAGES

A. The main advantage is that it can be available in cheap cost and have a very long life.
B. More sustainable and has very less impact on environment as it does require any fuel to run.
C. In Remote areas and in any season along with day and night time, it can produce energy whenever it exerts pressure, force or any vibrations on it.
D. More materials distributions and will be noticed by the crowd and will have more access to such materials and devices.

IX. DISAVANTAGES

A. Piezoelectric sensors are delicate and fragile so it needs proper protection from harsh environment
B. The circuits should be stable to produce and distribute energy in a proper manner to the applicants.
C. Durability and stability cannot be achieved if not placed properly.
D. Limited life to piezoelectric sensors if not provided maintenance

X. APPLICATION

A. The main benefits we can achieve using this technology is that we can utilise the waste energy which was ignored as smaller amount and can be added to some better result.
B. The charging stations and petrol pump lights, pedestrians and street light can be powered throughout the year, along with that we can also store the amount of waste energy that was harvested will be in a battery to power any usable electrical component.
C. Railway Station Bridge, malls, buildings light can have access to this technology easily.
D. The remote located village and people can be benefitted through piezoelectric harvesting technology.

XI. CONCLUSION

A. A Energy Harvesting device that can generate electricity from human steps is designed
B. Unutilized energy is harnessed through this device which can be used for various purposes
C. A system of three layers of tile, four springs, a rubber block and 64 piezoelectric discs are used on a single unit for efficient and maximum power generation
D. 64 piezoelectric discs are used in a 8x8 square pattern for maximum utilization of induced stress and covering maximum possible space on the tile
E. Springs allow gradual increase of load on piezoelectric discs which helps in maximum power dissipation from piezoelectric discs
F. Rubber block is used to transmit total applied load over a small displacement of the springs
G. One step of an average person weighing 75kgs can generate a power output of 2.1 Watts

XII. FUTURE SCOPE

A. Currently the piezoelectric tile is generating 2.1 watt power, in order to increase the output power we can use step-up transformer which can double the output.
B. The excess energy generated can be stored in battery.
C. The energy extracted from piezoelectric devices is minimum also the output generated is needed to rectified, therefore we need to design a Tile which eliminates all those limitations.
D. The power and energy from different sources are commonly used and simple power harvesting circuits will replace the power supplies which is currently used.
E. This Technology can be used in wearable product.

XIII. ACKNOWLEDGEMENT

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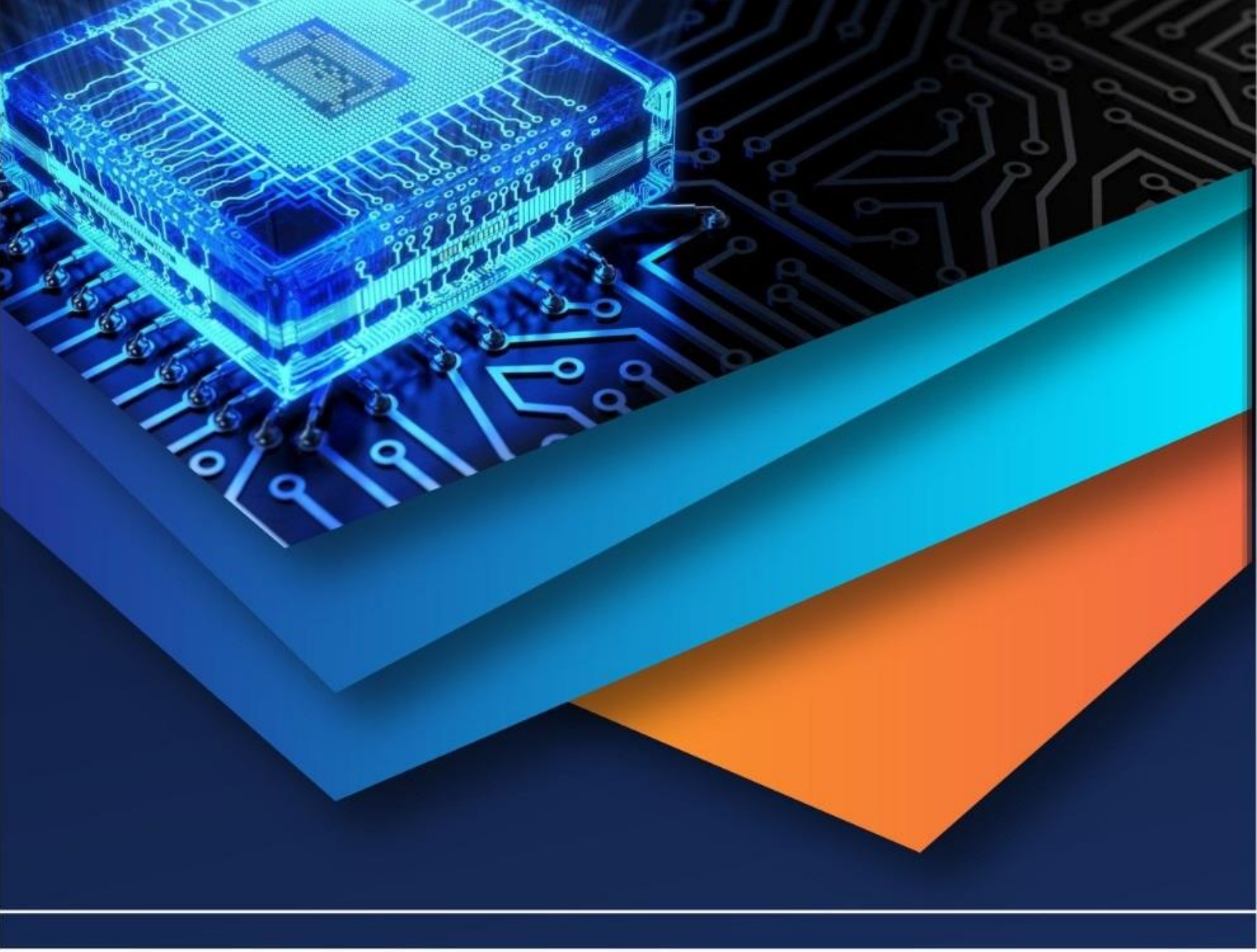

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