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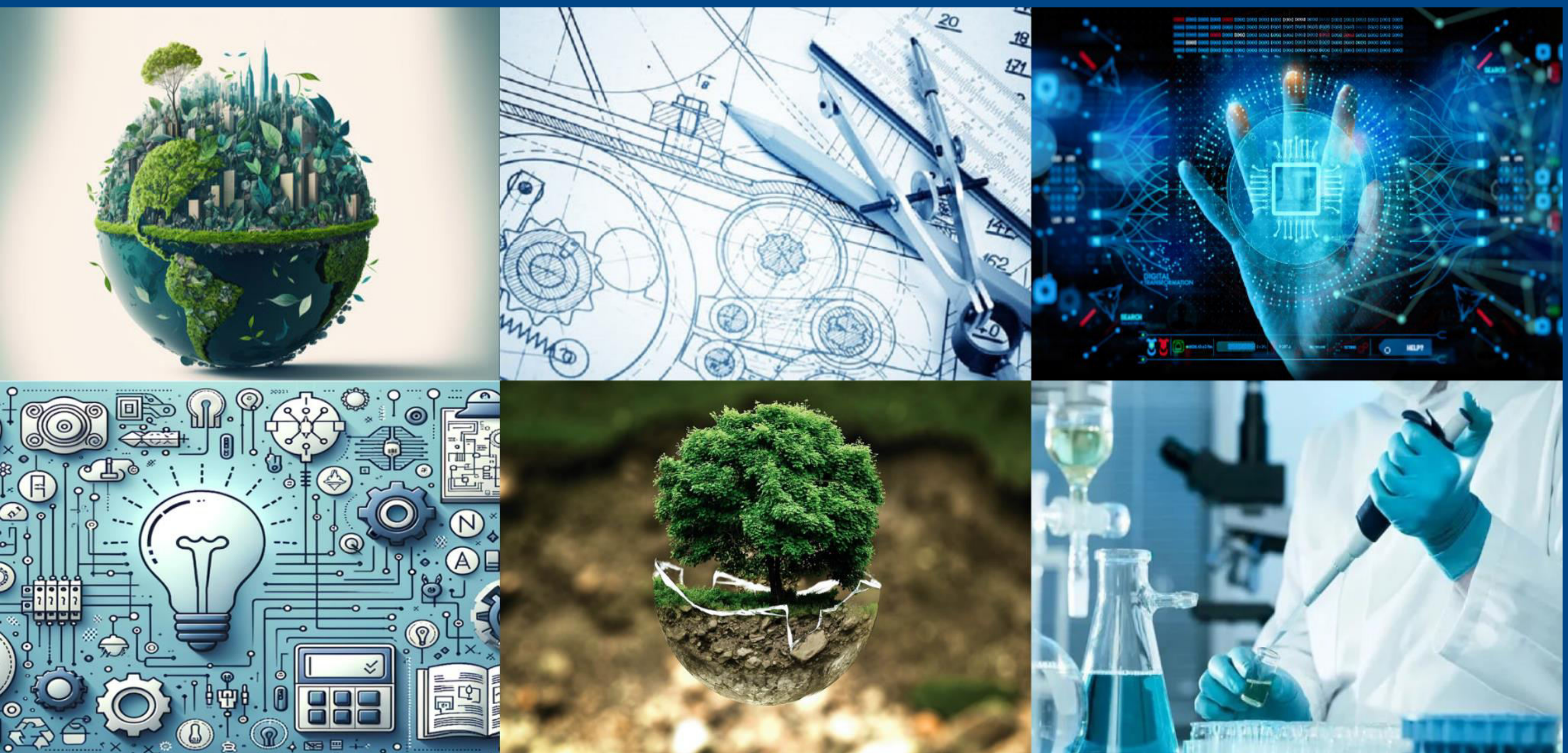

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Footsteps Based Piezoelectric Energy Harvesting

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ABSTRACT: Coming up with the piezoelectric walking energy generator can turn the mechanical energy in human footsteps into power resources, which is required these days due to high energy costs and the environment--indispensable for survival! But hundreds of thousands of footfalls each day bring mechanical energy is often wasted. There's a need for a feasible method of harnessing this waste energy and turning it into usable electrical power. It is with this in mind that our proposed project seeks to develop a system using piezoelectric sensors mounted on floors. When people walk across it, the pressure activates the transmitted-voltage receiving-piezoelectric materials. The voltage thus generated is then regulated by a battery charge controller and stored in rechargeable batteries. The new clean energy lies in outlet arrangement at floor, and this can supply power to appliances which cannot afford an interruption such AS small electronic devices or low-power systems like LED lights on energy harvesting lipstick down charging stations**.**

I. INTRODUCTION

As the global demand for power grows, so does the demand for sustainable and alternative solutions. The traditional ways of producing electricity depend largely on non-renewable materials, which not only dwindle with time but are also bad for the environment struction From severe pollution. Contemporary studies are trying to get energy out of commonplace activities and put it to practical use. One way of doing this is to convert bodily activity into electrical energy via the use of piezoelectric technology. When one walks on such a floor, the pressure exerted by his feet can be translated into electric power. Because floor surfaces are subjected to heavy pedestrian use, places where electricity can be generated are easily set up: for example stations of every kind , shopping malls that need what is now called ``green energy'', street or walkways in public garden sand alike. The generated energy can be collected together, stored and then used later when running small systems such as lights, direction signs or monitoring devices. This concept offers many advantages--it causes no environmental harm, there are few costs involved in running it, and it can be coupled readily with current infrastructure. Moreover, it represents a new aspect of life-assisting technology: technology that can live with--this which in knowledge .destination effects energy A local power generator without any extra energy consumption With continuously advancing technology, such a method does have the potential to become a realistic back-up A energy source that assists it move efficiently and meets suistainable development requirement.

Also, this method can be fitted with contemporary energy management systems improve efficiency and monitoring.The electricity generated can be controlled using power conditioning circuits, which ensure stable output and safe storage.It is also possible to increase overall generation capacity by combining sensors from several units, which makes the system more reliable for continuous operation.In addition, the idea fosters the spirit of energy conservation by showing people how their simple daily actions can lead to producing power--without them ever realizing it.Besides, advances in materials science design technique are yielding more durable and sensitive components which can withstand repeated stress over long periods. The use of such educational institutions, intelligent buildings, and urban infrastructure demonstration points, serves both functional and display purposes.As technology changes, it is possible for this method to undertake a crucial role in the decentralized energy generation of tomorrow and help the coming period transit to a more verdant and intelligent living environment

II. LITERATURE REVIEW

Pressure sensitive materials have attracted considerable attention in several studies as a possible material for human-powered generator.Various earlier researches focused primarily on the basic properties of such materials and what are their characteristics under applied force in terms of generating charge.Several authors have put forward different

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structures and materials combinations for performance improvements and extended life spans.An experimental analysis of the system's behavior (conducted experimentally to date in previous work) provides evidence that energy generated by crowd movement can be utilized for low-level s Applications when multiple sensing elements are used. What's more, it also available offers additional storage methods for energy that arrives due to the human body's motion: on city streets extent of urban Heuristic searches found only a few sites with such data.In addition, researchers have studied the different ways of wiring up these circuits so that energy collection, storage and usage are all efficient.They takeless only direct promise of something but evidence supporting their feasibility in real-life situations, especially places where human activity runs continuously.Lifecycle analysis' reveal that a strong production base is possible only in the major RC regions

long-term inhabitants of these areasystematize the output from 3 completed systems into a complete filestructure, which shall be an open platform for sharing information among users worldwide.

Energy Harvester Designand Power Conditioning[1]..

The work presented here is the experimental application of a piezoelectric energy harvester adjusted with constant impulse strain. The entire machine got a wave input at all times. Output will rise first for a while and finally hold steady until saturation occurs. It has been a rewarding experience to obtain electromechanical energy from mechanical strain. The simulation and experimental result is compared. Operation effect has been tested.

Advantages:

PowerConditioningincluded

Equivalent circuit model included in MATLAB Simulation + Experimental Validation

Disadvantages:

Low Power Output

Complex Circuit Requirements

MaximumPerformanceofPiezoelectricEnergyHarvestersWhenCoupledtoInterfacecircuits[2].

The paper presents a complete system model of a piezoelectric vibration energy harvesting unit. The model integrates the mechanical part (mass-spring-damper system) with the electrical part (piezoelectric transducer, interface circuits and storage devices). A power conditioning circuit with full semiconductor device models (e.g., buck converter and biasing circuits) is included to optimize energy transfer. Optimization focus: Selecting harvester dimensions and circuit parameters. Maximizing energy transfer under constraints like vibration frequency, acceleration, and geometry size. Performance metrics used to evaluate capabilities of the approach include system effectiveness, output power and efficiency.

Advantages:

Provides A system-level optimization that takes into account mechanical or electrical parts individually. Shows the impact of interface circuits on harvester performance in a way that is easy to understand Contributes to avoiding design failures (such as when piezoelectric breakdown voltage is exceeded).

Disadvantages:

Focuses only on vibration-based harvesting--not footsteps, wind, or mixed sources. Lacks accurate information aboutenvironment vibration frequency, so performance needs to be perfect. Higher complexity due to the coupling of circuits and mechanics; resulting in higher cost

Energy HarvestingUsingPiezoelectricTransducers[3].

Really easy to use machines are called transducers. Linear and rotary encoders perform measurements of the precise position of machine parts. In a digital control system, the analog signal that results from movement is converted to digital form so that it can be processed\. Piezoelectric transducers are used to convert energy from vibrations, pressure and mechanical stress into electrical power. When piezoelectric material is subjected to footstep pressure, vibrations, or other mechanical forces, the material deforms and produces an electric charge. Finally, this generated charge is collected and passed through rectifier circuit to change AC into DC. Additionally, the voltage is regulated and a large capacitor/battery used for energy storage. The system can be applied to floors, pavements, roads, railway tracks: in short arrange where there exists frequent vibrations or pressure. Different transducer configurations (cantilevered, diaphragm type, cymbal form, stack) are used depending on the application. Data from energy output, sustainable usesindurability, or the like is analyzed to optimize system for real time use.

Advantages:
Convertsmechanicalwastess(likethat of footstep, vehicularvibrations,railwayvibrations) into useful electricity or other useful power. It provides a clean and renewable energy source without harmful emissions.
Disadvantages:
The usable power output is relatively low and not suitable for large-scale power supply.
Efficiency decreases the more the transducers are used. Noisy unlike solar or hydrogen fuel cells, so as an energy source it is very inconvenient and uneconomic. High cost to fix if used on a large scale (roads, highways).In conclusion, the work presented in this paper is a further development based on previous research into cloud storage environment(also known as the Internet and large-scale computer networks) in order to better understand how people's trust relates to such an environment. While previous work only considered the effects of data storage upon peoples' faith, we focus here on world wide acceptance

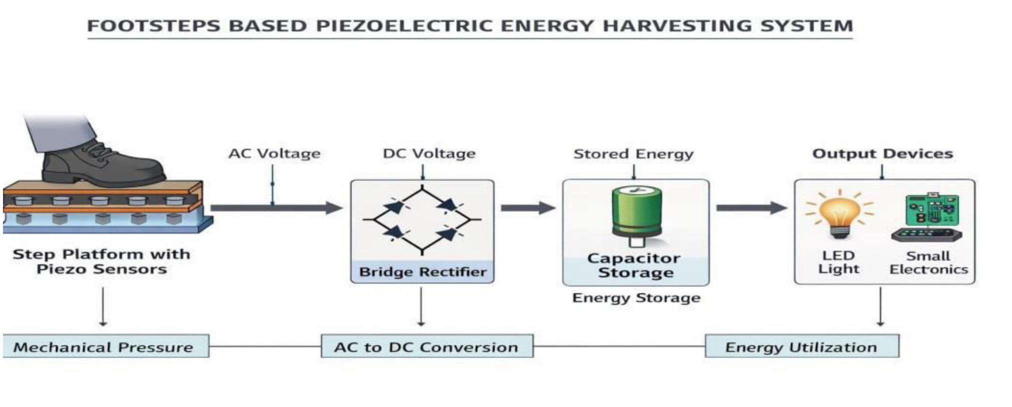
III. METHODOLOGY OF PROPOSED SURVEY

Mechanical Stress: When a piezoelectric material is subjected to a mechanical force (such as pressure, bending, vibration) it strains slightly. This deformation changes the internal structure of the material.Charge Generation: The mechanical stress results in a redistribution of electric charges within the material creating a voltage across the conductor. This occurs as a result of the alignment of electric dipoles within the crystalline structure of the piezoelectric material.

AC Signal Output: The generated voltage is alternating current (AC) because the mechanical stress is typically time varying (e. g., vibrations or repeated impacts).

Rectifying and storing: A rectifying circuit converts the AC signal into direct current(DC). This DC voltage is then kept in a capacitor or rechargeable battery for later use.

Power Delivery: The energy stored can be controlled and employed to drive low-level devices like sensors, LEDs, or wireless transmitters Isolating



Observations:

Number of sensors	Applied force	Output voltage	Observation
1	Varying mechanical pressure	0.2V – 0.5V	Sensor detected low to moderate pressure effectively.
5	Similar mechanical force	0.6V – 0.8V	Series connection increased the voltage but resulted in low current.
25	Normal footstep pressure	0.9V – 1.2V	Footstep location influenced voltage generation.

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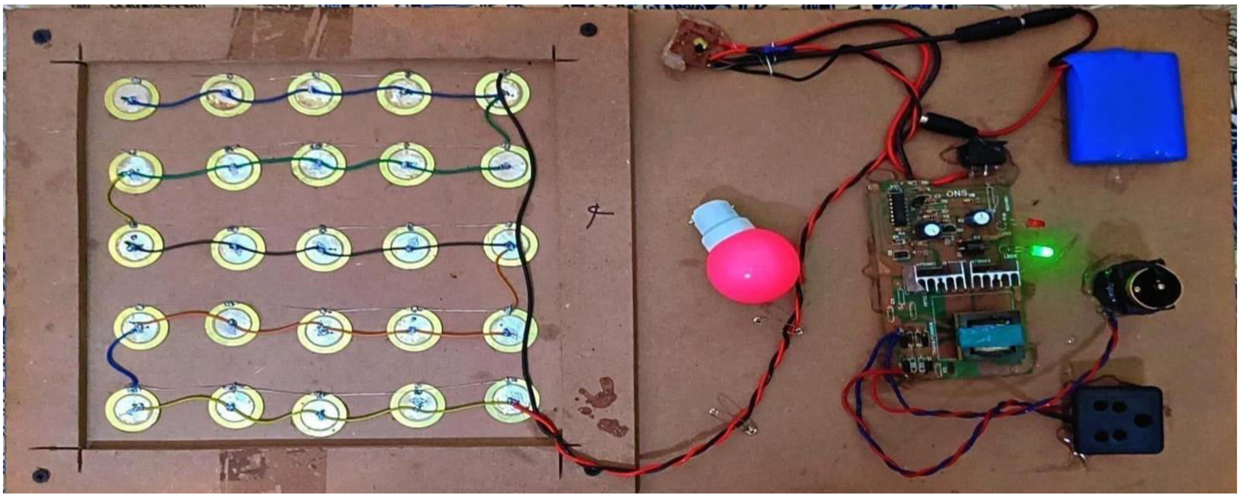
Picture of project:



The capacitor charges:
Unit sudden footfall, piezoelectric sensor produces electrical energy. The AC signal generated is turned into DC through rectification. Energy storage starts with the capacitor accumulated charges. Charging starts out more quickly, but slowly tapers off as the voltage rises. The voltage of the capacitor dies away when some maximum value is reached (saturation). The rate at which a capacitor charges depends on its RC time constant (Resistance × Capacitance).

The capacitor discharge:
At this point with no footsteps, energy is no longer generated. The capacitor will release its stored energy into the load(LED, battery). Voltages across those capacitors gradually dissipate over time. Discharge provides a continuous source of power even without input. The rate of discharge depends on the RC time constant. Eventually the capacitor becomes completely discharged if no new energy is pumped in.

Calculation:

$V_s = 1.2v$
$C = 68\mu F$
Resistors
$R5 = 10K\Omega$
$R6 = 3K\Omega$
Charging using R5 (10KΩ) $V_c(t) = V_s(1\text{-}e^{\wedge}\text{-}t/(RC)$
$\tau = R*C = 10{,}000*68*10^{\wedge}\text{-}6 = 0.68s$
Charging voltage at $t=\tau$, 2τ, 3τ $t = \tau$
$V_c = 1.2(1\text{-}e^{\wedge}\text{-}1) = 1.2*0.632 = 0.758V$
$t = 2\tau$
$V_c = 1.2(1\text{-}e^{\wedge}\text{-}2) = 1.2*0.865 = 1.038V$
$t = 3\tau$
$V_c = 1.2(1\text{-}e^{\wedge}\text{-}3) = 1.2*0.950 = 1.14V$
Discharging Value ($V_c(t) = V_o\,(e^{\wedge}\text{-}t/RC)$ $t = \tau$
$V_c = 1.2*0.368 = 0.442V$
$t = 2\tau$
$V_c = 1.2*0.135 = 0.162V$
$t = 3\tau$
$V_c = 1.2*0.0498 = 0.060V$

Using R6 (3KΩ)

$\tau = 3000 * 68 * 10^{-6} = 0.204s$

Charging Voltage $t = \tau$

$Vc = 1.2*0.632 = 0.758V$

$t = 2\tau$

$Vc = 1.2*0.865 = 1.038V$

$t = 3\tau$

$Vc = 1.2*0.950 = 1.14V$

Discharging Voltage $t = \tau$

$Vc = 0.442V$

$t = 2\tau$

$Vc = 0.162V$

$t = 3\tau$

$Vc = 0.060V$

Comparison:

Time step	Time(R5 =10kΩ)	Time(R6 = 3KΩ)	Charging voltage	Discharging voltage
$t = \tau$	0.68s	0.204s	0.758v	0.442v
$t = 2\tau$	1.36s	0.408s	1.038v	0.162v
$T = 3\tau$	2.04s	0.612s	1.14v	0.060v

R5(10KΩ)-slower charging/discharging R6(3KΩ)-faster charging/discharging using both resistors for these process detect quick steps and stores energy at the same time

Efficiency:

η = (Electrical energy stored in capacitor/Mechanical energy applied by footstep)*100

Emech = F*d F= m*g

m= 70kg , g= 9.8m/s² F= 70*9.8 = 686N

d = 1mm = 0.001m

Emech = F*d = 686*0.001 = 0.686τ Electrical energy in Capacitor C = 68μF = 0.000068F V = 1.2V

Ecap = 1/2 CV² = 0.5*0.000068*1.44

=0.004896τ

η = (Ecap/Emech)*100

= (0.004896/0.686)*100

=71%

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IV. CONCLUSION AND FUTURE WORK

Footsteps used a piezoelectric associated mechanics as potential methods for transforming human motions' mechanical energy into electrical energy that people can use. By embedding piezoelectric sensors into the surface of the walkways, this invention can capture the vibration caused by footfalls and put out electricity. Trying to improve the efficiency (or energy ratio) up to approximately 72% of energy by capturing footsteps in this way is far better than that which conventional small-scale systems can achieve. This method could provide a sustainable and eco-friendly solution for generating power in areas with high pedestrian flows such as railway stations, shopping malls and public walkways. Large-scale applications may require just a low energy output, but for small-power devices such as sensors, 'heart' LEDs or wireless systems this method is ideal. In short, it effectively practices renewable energy and uses a form of energy that would otherwise be waste.

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