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ELECTRICAL POWER GENERATION BY FOOT-STEPS USING PIEZO-ELECTRIC TRANSDUCERS

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ABSTRACT

In this paper we are presenting the methodology of harvesting electrical energy by human footsteps. This project aims the smart use of material properties and public gathering situations for efficient generation of electricity, which not only provides an efficient source of energy but also a clean and pollution free environment. The benefit of application of Electricity Generating Tile (EGT) will be that it is cheap and easy in installation. It will not make any effect on the surrounding and as it is smaller in structure it could be installed anywhere. EGT uses a principle which is completely harmless to the environment. It is a onetime installation and will require a negligible amount of maintenance service thus making it more suitable source of energy generation. This project acts as a transducer for converting stress generated by human weight on the floor to electricity. Power generated from the thousands of visitors to the public gathering places is stored and used for a variety of applications including pedestrian lighting and advertising. The system is not noticeable and does not affect the aesthetics of the area. EGT is noise free power source. Less skilled labor is required for installation and maintenance. The EGT could also be used in dance floors, gyms, exercise machines etc. By utilizing the energy which generally gets wasted the EGT project will be the best option for making these public places independent from the conventional power sources and saving the non-renewable energy sources.

I. INTRODUCTION

Energy is nothing but the ability to do the work. In day to day life, Electricity is most commonly used energy resource. Now-a-days energy demand is increasing and which is life-line for people. Due to this number of energy resources are generated and wasted. Electricity can be generated from resources like water, wind etc. to generate the electricity from these resources development of big plants are needed having high maintenance cost. Some other energy resources are also costly and cause pollution. They are not affordable to common people. Electricity has become important resources for human being hence, it is needed that wasted energy must have to utilize, walking is the most common activity done by human being. The average human can take 3,000 -5,000 steps a day. while walking energy is wasted in the form of vibration to the surface. And this wasted energy can be converted into electricity using the principle called piezoelectric effect. Piezoelectric effect is the effect in which mechanical vibrations, pressure or strain applied to piezoelectric material is converted into electrical form by using piezo-electric materials such as quartz, Lead Zirconate Titanate (PZT), Polyvinylidene fluoride (PVDF), Rochelle salt, Mica etc.

All started in 2005 with the name Sustainable Dance Club, and the idea was to realize a sustainable dance club. Innovators of sustainability worked together with architects, to create the concept of a sustainable dance club, including an energy generating dance floor. The company started by offering consultancy service to club owners or festival organizers that want to become more sustainable and at the same time developed the prototypes of its first product: The Sustainable Dance Floor. In September 2008 Club WATT was opened in Rotterdam as the first ecological dance club showcasing the earliest model of the Sustainable Dance Floor (SDF). As Energy Floors has grown as a company, so have its potential markets. The concepts prove to have natural appeal to marketing agencies, science museums, and commercial events and according to our new developments also with fitness centers, public transport companies and many other public spaces. Since 2010, SDC narrowed its focus on the further development of the energy generating floor and selling and renting it combined with Energy Experiences worldwide for exhibitions, parties, fairs, festivals or corporate events. The Sustainable Dance Club took it to the next level and developed a more cost effective, efficient floor for large scale applications: The Sustainable Energy Floor.

The Energy Generating Tile (EGT) is a profitable energy generation plant in places where there is always a public gathering and a lot of footfall is experienced in a small area. The requirement of EGT is for utilizing the energy produced during the human footfall. This will make some parts of the system autonomous in its own power production and reduction in dependency on conventional polluting power sources.

In India, maximum public movements is observed in railways stations and holy places, hence, such places can be exploited for use of piezoelectric crystals for generation of electricity. Gathering ranging from thousands to millions are observed in holy places, thus installation of piezoelectric crystals at floorings would generate enough power to light up lights of temples as well as air circulation systems.

Literature Review

- ✓ ***Power Harvesting By Using Human Foot Step*** – (International journal of innovative research in science, Engineering and technology , Vol. 2, Issue-7, July 2013) Prabahar R. , Jayaramaprakash A. , Vijay Anand L

In this paper, some of the shortcomings in the existing system has been proposed to be rectified. The advances have allowed numerous ways for power harvesting systems in practical applications in order to meet the power demand. The use of piezoelectric crystal is to generate electric output from surrounding vibrations. Piezoelectric materials have a crystalline structure that they can convert mechanical energy into electrical charge and is vice-versa. These materials have the ability to absorb mechanical energy from their surroundings, usually ambient vibration, and transform it into electrical energy that can be used to power other devices. The produced electrical energy from the piezoelectric crystal is very low in the order of 2-3volts and is initially stored in a 2v rechargeable battery through a charge controller ,since it is not possible to charge a 12V battery through crystal output . In order to increase the voltage, the boost converter circuit is used. The use of boost converter is to increase the level of voltage ranges about 12V and is stored in a 12V battery. In order to supply power to the load an inverter circuit is required by which the generated voltage is fed to the CFL lamp load .This project can be implemented in dense populated areas like railway station, bus stands etc where more amount of vibration energy will be obtained.

- ✓ ***A Unique Step Towards Generation Of Electricity Via New Methodology*** –(International Journal of Advanced Research in Computer and Communication Engineering , Vol.3, Issue-10, October 2014) Itika Tandon., Alok Kumar

In this paper they are representing the methodology of electrical power generation using human footstep. This is about how we can generate electricity using human's waste foot energy and applications for the same. When human walk in surroundings some force exerts on surface this force can be used to generate electricity. The idea of converting pressurize weight energy into the electrical energy is possible by piezo-electric crystal. The power generating floors can be a major application if we use piezoelectric crystals as an energy converting material. The piezo-electric crystals have crystalline structure and ability to convert the mechanical energy (stress and strain) into the electrical energy. Whenever there is some vibrations, stress or straining force is exert by foot on floor then these crystals evenly converts it into electric power which can be used for charging devices viz. laptop, mobiles, electronic devices etc. In this paper, they have discussed about applications and generation of electricity in the area of power harvesting.

- ✓ ***Footstep Power Generation Using Piezoelectric Material*** (International Journal of Advanced Research in Electronics and Engineering , Vol.4, Issue- 10, October 2015) Nitashree V. , Arathi L. , Sayali S.

In this project we are doing generation of power by walking or running. Power can be generated by walking on the stairs. The generated power will be stored and then we can use it for domestic purpose. This system can be installed at homes, schools, colleges, where the people move around the clock. When people walk on the steps or that of platform, power is generated by using weight of person. The control mechanism carries piezoelectric sensor, this mechanical energy applied on the crystal into electrical energy. When there is some vibrations, stress or straining force exert by foot on flat platform.

- ✓ **Footstep Power Generation Using Piezo Electric Transducers** (International Journal of Engineering and Innovative Technology (IJEIT) Volume 3, Issue 10, April 2014) Kiran Boby, Aleena Paul K, Anumol.C.V.

In this paper they conclude that PZT is superior in characteristics. Also, by comparison it was found that series- parallel combination connection is more suitable. The weight applied on the tile and corresponding voltage generated is studied and they are found to have linear relation. It is especially suited for implementation in crowded areas. This can be used in street lighting without use of long power lines. It can also be used as charging ports, lighting of pavement side buildings.

Objectives

➢ ***Capturing energy from everyday motion of people***

Walking is the most common activity done by human being. The average human can take 3,000 -5,000 steps a day. While walking energy is wasted in the form of vibration to the surface. And this wasted energy can be converted into electricity using the principle called piezoelectric effect.

➢ ***Clear and pollution free energy production***

Environmental pollution is one of the major disadvantages of fossil fuels. It is a known fact that carbon dioxide, gas released when fossil fuels are burnt, is one of the primary gas responsible for global warming. Rise in temperature of earth has resulted in melting of polar ice caps, flooding of low lying areas and rise in sea levels. If such conditions continue, our plant Earth might face some serious consequences in near future. Sulphur dioxide is one of the pollutant that is released when fossil fuels are burnt and is a main cause of acid rain. Acid rain can lead to destruction of monuments made up of brickwork or marbles. Even crops can affected due to acidification of loams. Coal mining results in destruction of ecosystems and also endangers the lives of mineworkers. But in our project energy generation is clear and non-polluting.

➢ ***Ensures reduction in the use of conventional energy sources***

As of today, fossil fuels are being extracted at an exorbitant rate to meet the gap between demand and supply and it is estimated that they will be finished in next 30-40 years. Since they are non-renewable, it is more likely that fuel expenses will face a steep hike in near future. It would take millions of years to replace coal, and oil, and this means that we will not be able drive cars anymore unless we switch to electric cars that use energy from renewable energy sources. This means once these non-renewable sources are completely used up, there is nothing more left. This process may slightly reduce the usage of conventional energy sources.

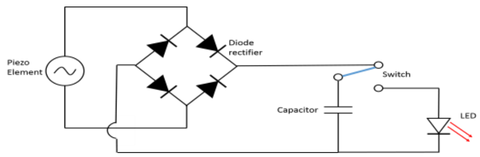
➢ ***Cost effective energy generation***

Now-a-days energy demand is increasing and which is life-line for people. Due to this number of energy resources are generated and wasted. Electricity can be generated from resources like water, wind etc. to generate the electricity from these resources development of big plants are needed having high maintenance cost. Here we are using human footstep as a actuation medium for piezoelectric material which otherwise would have wasted.

II. METHOD

Electronic Circuit

Figure 1: Basic circuit representation of piezo electric material



Components of the circuit:

- ➢ Piezo-electric transducer
- ➢ Diodes
- ➢ Resistor
- ➢ Capacitors
- ➢ LED
- ➢ Switch

Piezo-electric transducer

The key principle behind the energy generating floor is the piezoelectric effect shown by metals. When a person walks he puts some pressure on the floor due to his weight and muscle power. The EGT uses this force to generate electricity by utilizing this force for bending the piezoelectric material.

Piezoelectricity is the electric charge that accumulates in certain solid materials (notably crystals, certain ceramics, and biological matter such as bone, DNA and various proteins) in response to applied mechanical stress. The word piezoelectricity means electricity resulting from pressure. It is derived from the Greek piezo or piezein which means to squeeze or press, and electric or electron, which stands for amber, an ancient source of electric charge. This provides a convenient transducer effect between electrical and mechanical oscillations.

The first demonstration of the direct piezoelectric effect was in 1880 by the brothers Pierre Curie and Jacques Curie. They combined their knowledge of piezoelectricity with their understanding of the underlying crystal structures that gave rise to piezoelectricity to predict crystal behavior, and demonstrated the effect using crystals of tourmaline, quartz, topaz, cane sugar, and Rochelle salt (sodium potassium tartrate tetra hydrate). Quartz and Rochelle salt exhibited the most piezoelectricity.

Quartz demonstrates this property and is extremely stable. Quartz crystals are used for watch crystals and for precise frequency reference crystals for radio transmitters. Rochelle salt produces a comparatively large voltage upon compression and was used in early crystal microphones. Barium titanate, lead zirconate, and lead titanate are ceramic materials which exhibit piezoelectricity and are used in ultrasonic transducers as well as microphones. If an electrical oscillation is applied to such ceramic wafers, they will respond with mechanical vibrations which provide the ultrasonic sound source. The standard piezoelectric material for medical imaging processes has been lead zirconate titanate (PZT).. The word piezo is Greek for "push".

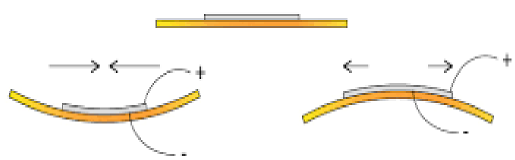


Figure 2: Deformation of piezoelectric material

Electric dipole moment

The nature of the piezoelectric effect is closely related to the occurrence of electric dipole moments in solids. The latter may either be induced for ions on crystal lattice sites with asymmetric charge surroundings (as in $BaTiO_3$ and PZTs) or may directly be carried by molecular groups (as in cane sugar). The dipole density or polarization (dimensionality [Cm/m3]) may easily be calculated for crystals by summing up the dipole moments per volume of the crystallographic unit cell. As every dipole is a vector, the dipole density P is a vector field. Dipoles near each other tend to be aligned in regions called Weiss domains. The domains are usually randomly oriented, but can be aligned using the process of poling (not the same as magnetic poling), a process by which a strong electric field is applied across the material, usually at elevated temperatures. Not all piezoelectric materials can be poled. One with charge +q and one with charge −q, the electric dipole moment p is:

$p = qd$

Where d is the displacement vector pointing from the negative charge to the positive charge. Thus, the electric dipole moment vector p points from the negative charge to the positive charge. An idealization of this two-charge system is the electrical point dipole consisting of two (infinite) charges only infinitesimally separated, but with a finite p. The SI units are Coulomb-meter (C m).

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In direct piezoelectric effect stress or strain applied for the piezoelectric material generates a charge on the electrode faces of the component. In vibration based harvesters deformation is produced by vibrating mass of the piezo element itself or external mass or directly transferring deformation of external system into piezoelectric material. The natural stiffness or Young's modulus of the piezoelectric material is relatively high (typically 50-70 GPa) and therefore vibration cannot normally generate required stresses for the material. In order to overcome this problem bending type structures are typically utilized in vibration based harvesters providing extremely compact internal leverage mechanism for the force amplification. One of the commonly used structures is a unimorph type cantilever which was chosen for this research. The component consists of active PZT and passive copper layers where the copper can be substituted with different materials such as post-processed ceramics to enable e.g. embedded and encapsulated structures. In this structure external mass is usually placed at the tip of the cantilever, in order to tune the resonance frequency and to enhance the coupling of the vibration for the piezoelectric material.

Crystal classes

Any spatially separated charge will result in an electric field, and therefore an electric potential. Shown here is a standard dielectric in a capacitor. In a piezoelectric device, mechanical stress, instead of an externally applied voltage, causes the charge separation in the individual atoms of the material.

Of the thirty-two crystal classes, twenty-one are non-centrosymmetric (not having a centre of symmetry), and of these, twenty exhibit direct piezoelectricity (the 21st is the cubic class 432). Ten of these represent the polar crystal classes, which show a spontaneous polarization without mechanical stress due to a non-vanishing electric dipole moment associated with their unit cell, and which exhibit pyroelectricity. If the dipole moment can be reversed by the application of an electric field, the material is said to be ferroelectric.

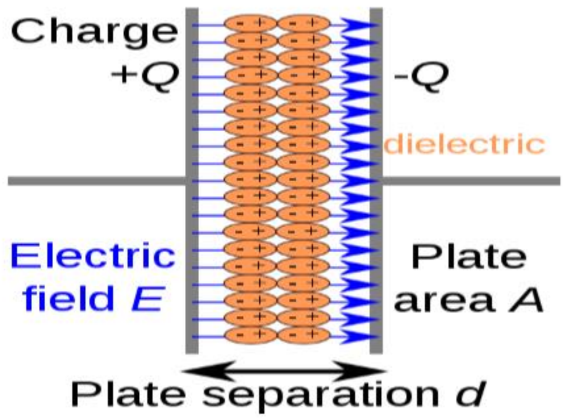


Figure 3: Building up of electric charge in piezo material

For polar crystals, for which P ≠ 0 holds without applying a mechanical load, the piezoelectric effect manifests itself by changing the magnitude or the direction of P or both. For the non-polar, but piezoelectric crystals, on the other hand, a polarization P different from zero is only elicited by applying a mechanical load. For them the stress can be imagined to transform the material from a non-polar crystal class (P =0) to a polar one, having P ≠ 0.

Key properties

- The ability to produce a voltage output in response to an applied stress
- The ability to produce a strain output (or deformation) in response to an applied voltage.

Electromechanical equations

The following relationships apply only to small electrical and mechanical amplitudes, i.e. small-signal values. Only in this region is it possible for polarized piezoelectric ceramics to be described by linear relationships between the mechanical strain (S) or mechanical stress (T) components and the components of the electric field E or the dielectric displacement D. These linear relationships are derived using dielectric, piezoelectric and elasticity "constants".

Because they depend on the anisotropy of the piezoelectric material, these physical quantities can only be defined in terms of tensors which reflect the directionality of the electric field, the mechanical stresses, etc.

In simplified form, the basic relationships between the electrical and elastic properties (for a static or quasistatic application) can be represented as follows

$D= d*T +\varepsilon^T *E$

$S= s^E *T+d*E$

where

- D dielectric displacement
- T mechanical stress
- E electric field
- S mechanical strain
- d piezoelectric charge constant
- ε^T permittivity (for T = constant)
- s^E elasticity constant (E = constant)

Diodes

In electronics, a diode is a two-terminal electronic component that conducts primarily in one direction (asymmetric conductance); it has low (ideally zero)resistance to the flow of current in one direction, and high (ideally infinite) resistance in the other. A semiconductor diode, the most common type today, is a crystalline piece of semiconductor material with a p–n junction connected to two electrical terminals.[5] A vacuum tube diode has two electrodes, a plate (anode) and a heated cathode. Semiconductor diodes were the first semiconductor electronic devices .The discovery of crystals' rectifying abilities was made by German physicist Ferdinand Braun in 1874. The first semiconductor diodes, called cat's whisker diodes, developed around 1906, were made of mineral crystals such as galena. Today, most diodes are made of silicon, but other semiconductors such as selenium or germanium are sometimes used.

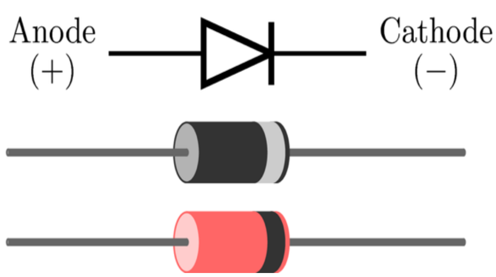


Fig 4: Representation of diode

In this project we are using four 1N4007 diodes. We are using a full bridge rectifier to utilize both the cycles of alternating current generated by piezoelectric material. We have initially used a 1N4148 diode which utilizes only half cycle of AC. But then we have come to know that only a full bridge rectifier utilizes the full cycle effectively. By using 1N4007 full bridge rectifier we got more output than in case of 1N4148. The bridge circuit that we are using in this project is as shown;

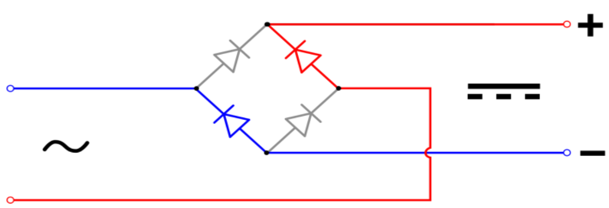


Figure 5: Bridge circuit of diodes

Resistor

Resistor is an electrical component that reduces the electric current. The resistor's ability to reduce the current is called resistance and is measured in units of ohms (symbol: Ω).

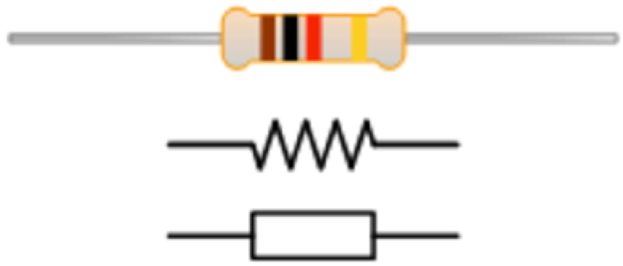


Figure 6: Representation of resistor

Resistor color code

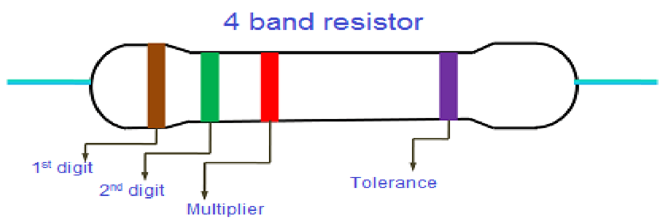


Figure 7: Colour coding of resistor

The resistance of the resistor and its tolerance are marked on the resistor with color code bands that denotes the resistance value.

There are 3 types of color codes:

- 4 bands: digit, digit, multiplier, tolerance.
- 5 bands: digit, digit, digit, multiplier, tolerance.
- 6 bands: digit, digit, digit, multiplier, tolerance, temperature coefficient.

Resistance calculation of 4 bands resistor
$R = (10\times digit_1 + digit_2) \times multiplier$

Resistance calculation of 5 or 6 bands resistor
$R = (100\times digit_1 + 10\times digit_2 + digit_3) \times multiplier$

Here we are using 100□ resistor as a load resistor to resist the current flow to the LED, otherwise excess current may damage the LED.

Capacitor

Figure 8: Capacitor

A capacitor (originally known as a condenser) is a passive two-terminal electrical component used to store electrical energy temporarily in an electric field. The forms of practical capacitors vary widely, but all contain at least two electrical conductors (plates) separated by a dielectric (i.e. an insulator that can store energy by becoming polarized). The conductors can be thin films, foils or sintered beads of metal or conductive electrolyte, etc. The non conducting dielectric acts to increase the capacitor's charge capacity. Materials commonly used as dielectrics include glass, ceramic, plastic film, air, vacuum, paper, mica, and oxide layers. Capacitors are widely used as parts of electrical circuits in many common electrical devices. Unlike a resistor, an ideal capacitor does not dissipate energy. Instead, a capacitor stores energy in the form of an electrostatic field between its plates.

LED

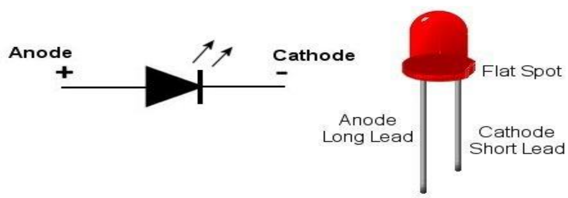


Figure 9: LED symbol representation

A light-emitting diode (LED) is a two-lead semiconductor light source. It is a p–n junction diode, which emits light when activated. When a suitable voltage is applied to the leads, electrons are able to recombine with electron holes within the device, releasing energy in the form of photons. This effect is called electroluminescence, and the color of the light (corresponding to the energy of the photon) is determined by the energy band gap of the semiconductor. LEDs have many advantages over incandescent light sources including lower energy consumption.

Components Of Model

Plywood

We took 4 pieces of plywood of thickness 12 mm out of which 2 were of dimension 450X450 mm. Other 2 were of dimension 380X380 mm. We mounted one piece of dimension 450X450 mm with another of dimension 380X380 mm which is used as upper plate. The same arrangement is done with bottom plate. 8 holes of 12 mm diameter were made on both upper and lower plates. On the bottom surface of upper plate plastic bushes were mount. On the top surface of bottom plate parallel combination of piezo is placed. The top plate helps in uniform distribution of the applied load over the plates.

Springs

Figure 10: Spring

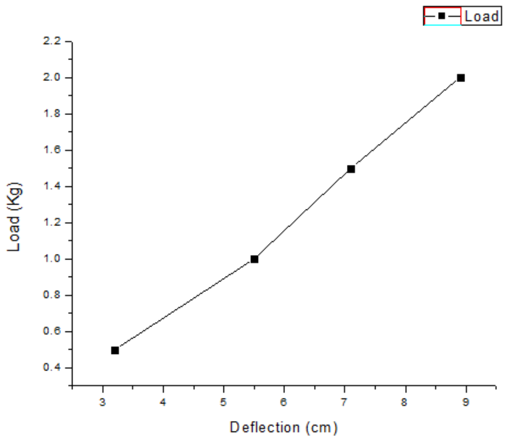
A spring is an elastic object used to store mechanical energy. Springs are usually made out of spring steel. There are a large number of spring designs; in everyday usage the term often refers to coil springs.

Small springs can be wound from pre-hardened steel, while larger ones are made from annealed steel and hardened after fabrication. Some non-ferrous metals are also used including phosphor bronze and titanium for parts requiring corrosion resistance and beryllium copper for springs carrying electrical current (because of its low electrical resistance).

Stiffness calculation

Table 1: Deflection of spring for different weight

Weight in Kg	Initial reading in cm	Final reading in cm	Deflection in cm
0.5	10	13.2	3.2
1	10	15.5	5.5
1.5	10	17.1	7.1
2	10	18.9	8.9



Stiffness, K= W/ẟ
Where, K= Stiffness in N/m
W= Weight in Kg
ẟ= Deflection in cm

From graph, Slope =K= Y/X
K= (4*0.5)/3.8
= 0.5263 Kg/cm
= (0.5263*10)/10^{-2} N/m
= 526.3 N

Bolts and nuts

Nuts and bolts are a type of industrial fasteners used in various products, machines, structures etc. Nuts and bolts consist a major link in the family of industrial fasteners and are used by every industry. Bolt is a piece of metal rod, whose one end is upset and other end is threaded. Nut is the item which rolls on these threads.

Nut and bolts are available in various shapes, designs and sizes. Nuts and bolts are used for fastening purpose in industries where the replacement of pieces and the parts is necessary. There are many industries producing these nuts and bolts of various sizes, but the demand too is increasing as well as the raw material for the production is easily and indigenously available.
In nuts manufacturing the hexagonal rod of desired size is procured and the nuts are cut on the automatic nut-cutting machine. Cut nuts blanks are drilled and tapped on the nut-tapping machine. Finally, these are deburred in the polishing barrel. In bolts making, procured MS rounds need to be straightens. The rounds are pickled in the acid tanks, washed and drawn in a drawing machine. The cleaned rod is fed into the cold heading machine. In the machine, one end of the rod is cut into the desired length with cutting stroke and simultaneously the head formation takes at another end.

Figure 11: Nut and bolt assembly

In this project we are using 8 hexagonal bolts with nuts, these help in holding upper and lower plates together. Also helps in unaltered position of the bushes which continuously hammer the plates.

Plastic bushes

In previous projects, some used screw head for actuation which gradually wears out the piezo disc. Some used two ply woods with piezo disc in the middle which rupture the solder which holds the wires and as a result requires more maintenance.

We are using hardened plastic bushes to continuously ram the materials which are mounted on the upper surface of the bottom plate. The materials are positioned exactly at the center of the piezo disc and are mounted by using screws on the bottom surface of upper plate. We are attaching rubber bushes to these plastic bushes which will not wear the piezo discs. These bushes also transmit the uniform load applied on the upper plate to the piezo discs.

Working Methodology

For energy generation through piezoelectricity piezoelectric crystals made of PZT are arranged in a grid on the plate the unique piezoelectric and converse piezoelectric properties of crystalline PZT allow us to design an electro-mechanical device. By operating the device at its mechanical resonance frequency, we can get a useful electrical output out of it. The active element is the heart of the transducer as it converts the stress due to weight to electricity. The active element is basically a piece of polarized material (i.e. some parts of the molecule are positively charged, while other parts of the molecule are negatively charged) with electrodes attached to two of opposite faces. As the major aim of making the Electricity generating floor is to utilize the stress from human foot fall and generate electricity. The mechanical stress due to human weight is considered as the input power and the electricity generated through it is the output.

Making of model

For making an electricity generating tile, 72 piezoelectric crystals are arranged in 8*9 matrixes.

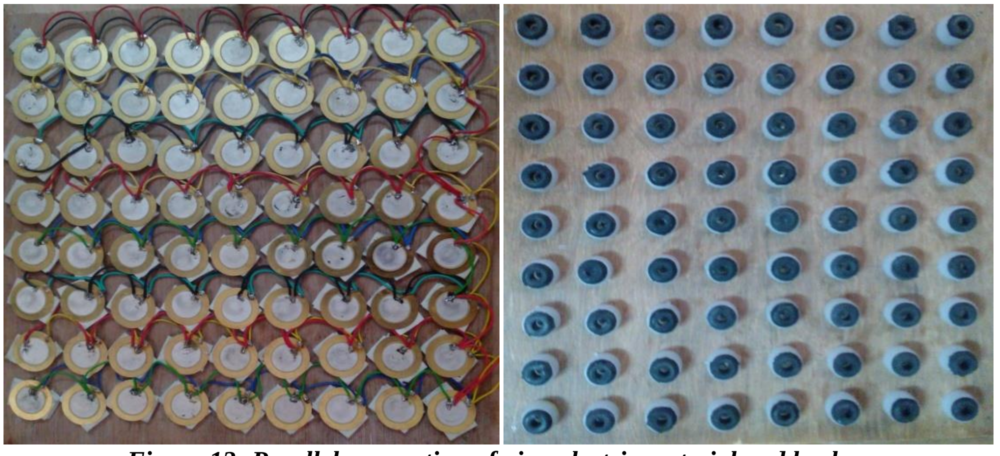


Figure 12: Parallel connection of piezoelectric material and bushes

The plywood measuring 450*450*12mm is used as a base another plywood measuring 380*380*12mm is mounted on the the base plate above which crystals are mounted using double side tape for cushioning. Each crystal when stressed at the center and deflected up to 1 mm from its resting plane generates 15- 18v and about 0.1 mA. Our aim is to charge the battery for which current rating should be high, to achieve high current rating we should connect piezo discs in parallel. Using solder iron and solder wire all 72 crystals are connected in parallel connection.

For the actuation, a plywood measuring 450*450*12mm is used as a top plate and a plate measuring 380*380*12mm is mounted below the top plate. On the bottom surface of top plate 72 plastic bushes with rubber bushes attached at the end are mounted using screws in the 8*9 matrix same as piezo discs. 8 holes of diameter 10mm are made on both the top and bottom plates. Both the plates are joined together using 8 bolts, nuts and springs.

Rectification and storage
The alternating current (AC) coming out of model has a voltage range of 10 - 15 Volts and a current range of 50 - 400 µA. In order to charge the battery, we have to convert this AC into DC which can be done by using a diode. We have used 1N4007 diode which utilized only one cycle of the AC, later we made a bridge rectifier using four diodes which utilized both the cycles of the AC, and as a result we got more voltage and current. The DC obtained is fluctuating, which is filtered by using a capacitor, which is also used as a temporary storage.

Display
We are using 4 LEDs in parallel connection as a display unit which uses the energy stored in the capacitor to glow, adding a load resistor will prevent these LEDs from damaging due to high current flow.

III. RESULTS AND DISCUSSIONS

Study Of Connections

Series-parallel combination of piezoelectric material
Next to determine the kind of connection that gives appreciable voltage and current necessary, three PZT are connected in series- parallel combination. 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 connections are done and the graphs are as in figures.

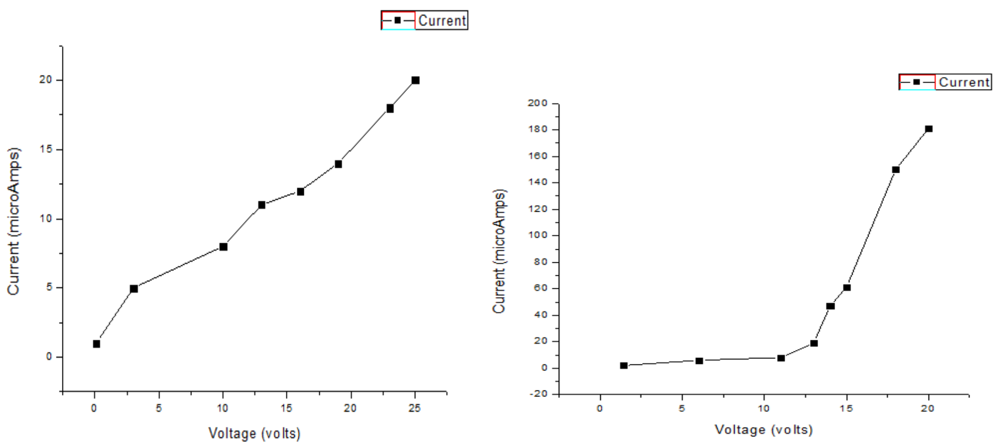
Power , P=VI
Where, P- Power in mW
V- Voltage in volts
I-Current in µA

Table 2: Experimental results of series – parallel connections in AC

SL. No	Weight in Kg	Voltage in volts	Current in micro Amps	Power in mW
1	20	0.1	1	10^{-4}
2	40	3	5	0.015
3	60	10	8	0.08
4	80	13	11	0.143
5	100	16	12	0.192
6	120	19	14	0.266
7	140	23	18	0.414
8	160	25	20	0.5

Table 3: Experimental results of series – parallel connections in DC

SL. No	Voltage in Volts	Current in Micro Amps	Power in mW
1	1.4	2	$2.8 * 10^{-3}$
2	6	6	0.036
3	11	8	0.253
4	13	19	0.481
5	14	47	0.658
6	15	61	0.915
7	18	150	2.7
8	20	181	3.62



V-I graph of series – parallel connections in AC and DC conditions

Parallel combination of piezoelectric material:

Table 4: Experimental results of parallel connection in AC condition

SL. No	Weight in Kg	Voltage in volts	Current in Micro Amps	Power in mW
1	50	4.6	47	0.2162
2	55	6	233	1.398
3	60	9.3	277	2.5761
4	65	9.5	304	2.888
5	70	14.5	349	5.0605
6	80	15.5	462	7.161

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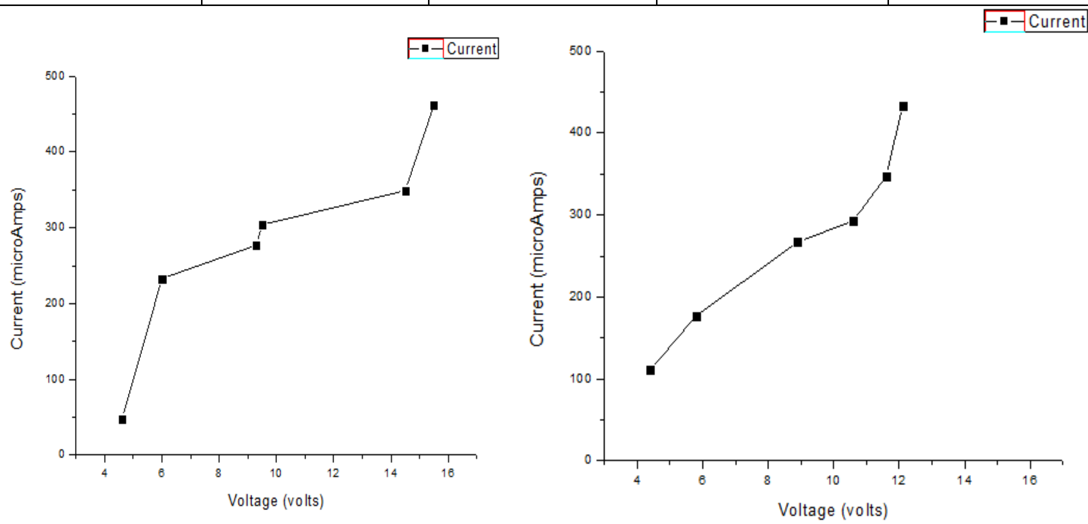
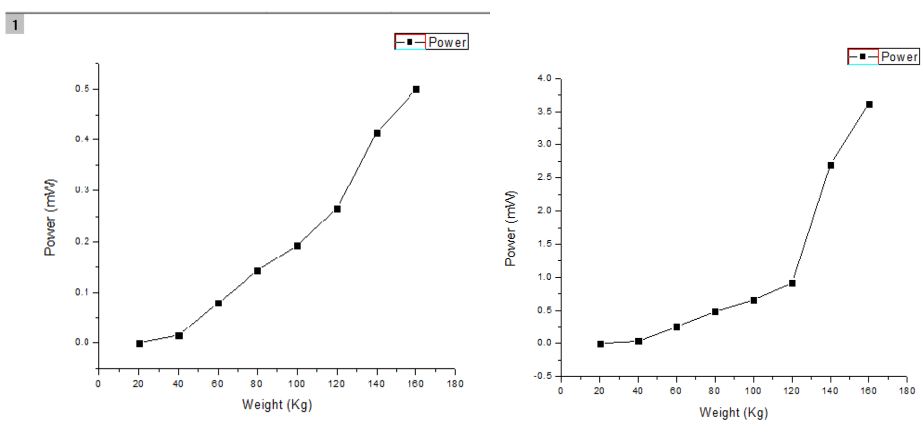
Table 5: Experimental results of parallel connection in DC condition

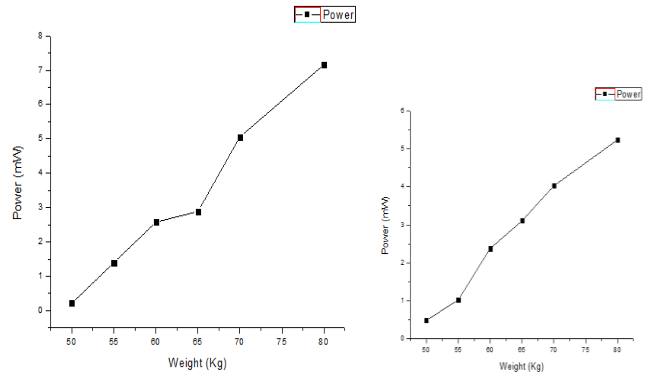
SL. No	Weight in Kg	Voltage in volts	Current in Micro Amps	Power in mW
1	50	4.4	111	0.4884
2	55	5.8	177	1.0266
3	60	8.9	267	2.3763
4	65	10.6	293	3.1058
5	70	11.6	347	4.0252
6	80	12.1	433	5.2393



V-I graph of parallel connections in AC and DC conditions



Weight v/s power graph for series – parallel connection of piezo tile in AC and DC condition



Weight v/s power graph for parallel connection of piezo tile in AC and DC condition

It can be seen from the graph that the voltage from a series connection is good but the current obtained is poor, where as 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.

Discussion

We did experiment tests on both series – parallel and parallel combination connections. From the experimental results we come to know that, to charge a battery it is necessary to have high current. Initially the experiments have done on series – parallel combination connection where the generated current is not enough to charge a battery. The tests on series – parallel connection produce hardly 20µA in AC condition and 181µA in case of DC condition. If the current generation is less than the power production is also less, because the power is vary proportionally with current. So to overcome this problem we changed the connection from series – parallel to parallel connection. The tests on parallel connection reveals that the current generation in parallel connection is higher compared to series – parallel connection. During test on parallel connection we got 462µA in AC condition and 433µA in DC condition. If the generated current is more then time required to charge a battery is less. And the time required to charge a battery is less in case of parallel combination connections than the series – parallel combination connections. So that to charge a battery it is necessary to connects the piezoelectric material in parallel combination.

IV. CONCLUSION

"Energy can neither be created nor be destroyed It can be transferred from one form to another" It is one of the similar approach to generate the energy using piezoelectricity principle. It is inexpensive and easy to install. In future this method will be a promising method for generating eco-friendly electricity. We can use this method at common places like home entrance gates, parking area, bus stands etc. This method will exploits different areas of electricity generation. Experimentally it is conclude that, its efficiency is low as complete amount of energy cannot be utilized. Only up to 30% of the total energy can be utilized. The efforts are still in progress to improve the efficiency.

A piezo tile capable of generating 20V has been devised. Comparison between various piezo electric material shows that PZT is superior in characteristics. It also has a large dielectric constant Also by comparison it was found that parallel combination connection is more suitable. The weight applied on the tile and corresponding voltage generated is studied and they are found to have linear relation. It is especially suited for implementation in crowded areas. This can be used in street lighting without use of long power lines. It can also be used as charging ports, lighting in buildings As the results shows that by using double actuators in parallel we can reduce the charging time of the battery and increase the power generated by the piezoelectric device. So that it is clear by using parallel combination we can overcome the problems like of impedance matching and low power generation. The results clearly show that piezoelectric materials are the future of electric power generation.

In this paper, a theoretical model on the generation mechanisms of electricity by piezoelectric material attached to a flexible structure has been developed and tested experimentally. Thus the flooring is made for withstanding up to 1600N force. This model of piezoelectric generation is completed with good efficiency and further the development o this methodology to railway stations will give greater output.

The proposed work "Electrical Power Generation through footstepss" has been successfully tested and implemented which is the best economical, affordable energy solution to common people. This can be used for many applications in rural areas where power availability is less or totally absent. India is a developing country where energy management is a big challenge for huge population. By using this project we can drive both A.C. as well as D.C loads according to the force we applied on the piezoelectric sensor.

Future Scope

- In future this method will be a promising method for generating eco-friendly electricity.
- If we achieve higher current then it is possible to charge a battery.
- For more effective storage it is better use super capacitor.

V. ACKNOWLEDGEMENT

It gives us tremendous pleasure in presenting this project report "ELECTRICAL POWER GENERATION BY FOOTSTEPS USING PIEZO-ELECTRIC TRANSDUCER" undertaken during 8th semester B.E and accomplished successfully.
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