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ECO-FRIENDLY ALTERNATIVE OF ENERGY HARVESTING-PIEZOELECRICITY

Ashok Narayan Tripathi, Himanshu Mishra, Ankit Mishra

Abstract: In the present scenario electricity has become an integral part of humans' life. Modern technology for its various operations uses electrical power in huge amount in contrast to this lot of energy resources been already exhausted and wasted. Production of electricity is the only source of pollution worldwide. With the growing population the gap is created between demand and supply of electricity. There comes the need of an alternate source of power generation which is eco-friendly and uses the ever increasing human population for its power generation without any adverse effect on environment. This technique works on the principle of piezoelectric effect. Countries like India where temples, railway stations, airports, etc. are always overcrowded, waste energy of foot power can be utilized and is very much relevant. This power source comes with wide range of applications as in home appliances, street lightning, and agriculture and will prove to be very efficient in remote locations.

Keywords: Energy Harvesting, Piezoelectricity, Piezoelectric Materials, Mechanical Strain, Electrical Potential

I. INTRODUCTION

In the present era, fossil fuels are finite and environmentally costly. Sustainable, environmentally benign energy can be derived from ambient sources. Large-scale ambient energy (e.g. solar, wind and tide) is widely available and large scale technologies are being developed to efficiently capture it. At the other end of the scale, there are small amount of wasted energy that could be useful if captured. Recovering even a fraction of this energy would have a significant economic and environmental impact. This is where energy harvesting comes in. Energy harvesting or energy scavenging is a process that captures small amount of energy that would otherwise be lost as heat, light, sound, vibration or movement. Different types of waste energy can be captured using energy harvesting material.

The most promising micro scale energy harvesting technologies in development includes vibration movements and sound can be captured and transformed into electrical power using piezoelectric material as well as heat can be captured and transformed into electrical power using thermoelectric and pyro electric material.

Here in this paper we emphasize on piezoelectric energy. Piezoelectric energy harvesting is an innovative step toward the modern way of energy harvesting. It is a bit challenging job of extraction energy from piezoelectric effect. Researches are still going on this field. Through this review paper we have described the fundamental and working principles of piezoelectric crystals. Later in this paper, we have showed the current uses of piezoelectric crystals and at last we have proposed its future aspects which are untouched.

II. FUNDAMENTALS AND WORKING PRINCIPLE

Piezoelectricity is the ability of the substance (certain ceramics and crystals) to produce an electrical charge when a mechanical stress is applied (squeezed or stressed). Conversely a mechanical deformation (shrinking or expanding) is produced when an electric field is applied which is called inverse piezoelectric effect.

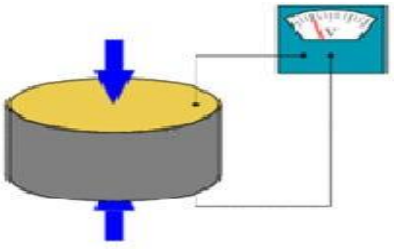

Fig: production of electricity on application of pressure.

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The special properties to show piezoelectric effect exist in many single crystalline materials like quartz, Rochelle salt ,topaz, tourmaline, silk, Cane Sugar, Berlinite (AlPO4), Bone, Tendon, enamel, Dantin, barium titrate((BaTiO3),Lead Titnate (PbTiO3) etc. [1]

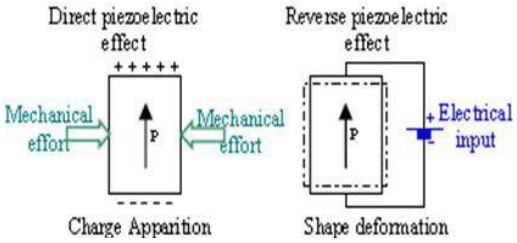

Fig1: Piezoelectricity phenomenon.

Advantages of using piezoelectric crystals

1. Broad frequency range
2. small size
3. light weight
4. Ultralow noise
5. Two wire operation
6. wide dynamic range
7. simple signal conditioning
8. wide temperature range
9. Cost effective implementation. [2]

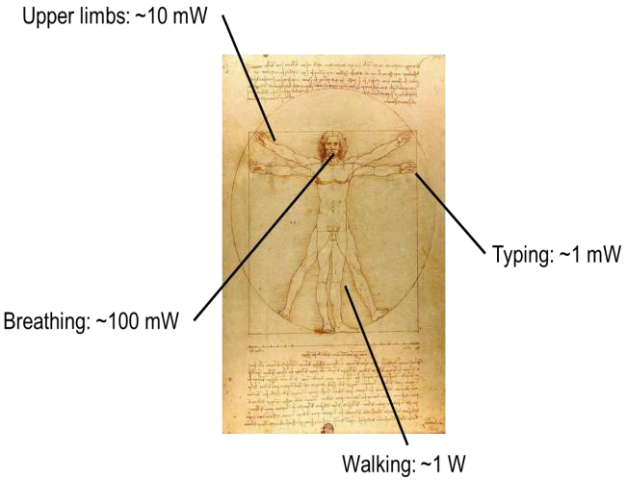

Fig: Estimated harvestable power throgh human activities

The output voltage is different for different crystal which is in the range of millivolts. So to obtain a higher voltage value piezoelectric crystals must be arrange in different manner and the energy thus obtained is stored in batteries or capacitor switch is working principle of piezoelectric harvesting. Researches are being carrying out to get maximum output through various possible connections of the piezoelectric crystals.

Connection Study:

Fig: 3 PZT in series connection

Three PZT crystals are connected in series and varying forces are applied in the connections and the voltage vs. current output is recorded in graphs same experiment is performed with parallel and series-parallel connections and graphs are plotted.

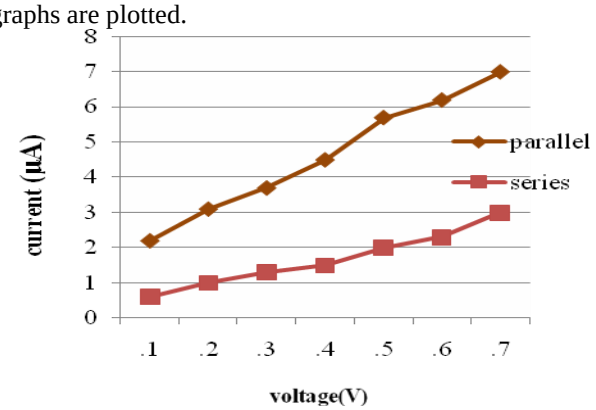

Fig: V-I graph of series and parallel connection

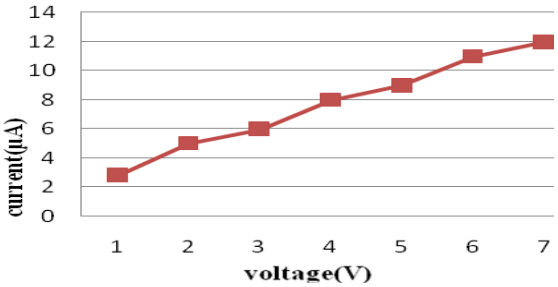

Fig: V-I graph of series-parallel connection

From the graph it can be observed that the variation between voltage and current varies abruptly. In series connection, good voltage is obtained with the lower corresponding values of current. In parallel connection, current is good but the observed value of current is poor, but this problem is sorted out in series-parallel connection where voltage and corresponding observed current values are both satisfactory.[3]

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III. CURRENT USE OF TECHNOLOGY

A. Flooring Tiles

Flooring tiles are made up of rubber. These rubbers are capable of absorbing vibration and when a piezoelectric array is placed under these they are capable of producing electricity.

The flooring tile consisting up of piezoelectric array can be highly efficient if placed in highly crowded areas like railways, bus stand, airport, malls, footpath, side walk, speed breakers etc.

Fig: flooring using piezoelectric tiles

Due to the phenomena of piezoelectric effect when a person steps on these flooring tiles a small charge is build up on crystal surface which can be collected with the help of electrodes. This energy can be stored in capacitor and chargeable lithium battery and can be transferred to different areas.

This process of producing energy can be made highly efficient if the number of person stepping on the flooring tile is more.

The use of this technology is increasing worldwide for instance Japan is using these special flooring tiles in ticket turnstile, so that when a passenger step on this flooring tiles small charge is triggered that can be stored as energy.[4]

B. Dance Floor

it is also used in dance floor for instance in Europe certain night clubs power there stereo and strobes using piezoelectric crystal.

It generates electricity around 220Watts when these floors are compressed by dancers. Depending upon the impact of the feet these piezoelectric tiles can produce electricity which can be stored or used to power low power consuming devices.

Fig: Dance floors using piezoelectric crystals

C. Shoes

Researchers are making great efforts on producing energy from day to day life of a person. For this they are experimenting on putting piezoelectric tiles in shoes. Currently in unites states DARPA (Defense advance research project agency) are researching on powering their equipment by piezoelectric generators fitted in soldier's boots. However this project of DSRPA was abandoned because it was not comfortable and even to generate power as small as 1 to 2 Watts soldiers have to walk long distances. Further research is going on to make these shoes more comfortable and more power efficient. [5]

Fig: piezoelectric materials installed in shoes

IV. UNTOUCHED FUTURE SCOPES

The above proposed work suggests us that the use of piezoelectric material for energy harvesting for requiring future needs is very promising.

Growing population which is one of the major issue we are facing can be used advantageously for producing electricity using piezoelectric material.

Following are the proposed work which can be used to fulfill our daily electricity needs.

A. Wind Mill

With the advancement of the technology the need of electricity and power in rural area are also increasing.

However continuous supply of energy is not possible to ensure availability of electricity in remote places microcells are widely used for low power consuming devices, but they need to charged again and again as there lifetime is very small .

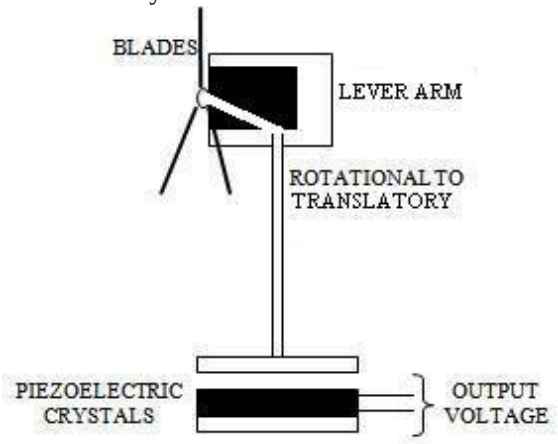

Fig: Piezoelectric Wind Mill

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So for conventional charging various alternative methods are used like wind energy, solar energy in which the wind energy is considered best. The idea of piezoelectric wind mill is shown in figure

A piezoelectric windmill has a fan which has 3 blades to capture the wind flow.

A lever arm is directly connected to the fan rotor and a translator to the lever arm which converts rotational motion into translatory motion. At the lever end of the translator a device is connected which gets compressed whenever translator move upward and downward.

The compression of these piezoelectric crystals produces a huge amount of energy to drive low powered consuming devices [1]

V. POWER GENERATING ROADS

One of the greatest sources of piezoelectric energy is busy roads.

If piezoelectric mats are installed on roads where thousands of vehicles pass each day, it would generate a huge amount of energy which would be enough for city use.

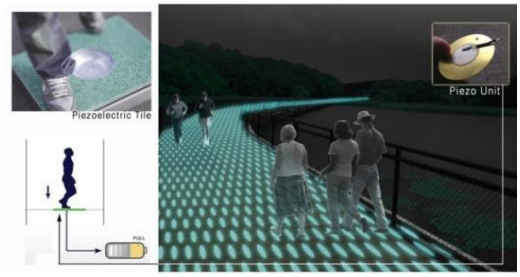

Fig: piezoelectric crystals installed in side walks and roads

A. MOBILE KEYPADS AND KEYBOARDS

Mobiles and computers are one of our greatest needs in this digital era.

Mobiles and computers can be made self-power efficient if we lay down piezoelectric crystal under the mobile units and keyboards.

Fig: piezoelectric material keyboards

When the keys are pressed vibration is created which can be used for producing energy and can be further used for charging mobiles and computer.

B. FLOORS MATS, CARPETS

Piezoelectric crystal can be also be placed under the floors and carpets which are generally used.

This would meet the daily electric requirement of that place.

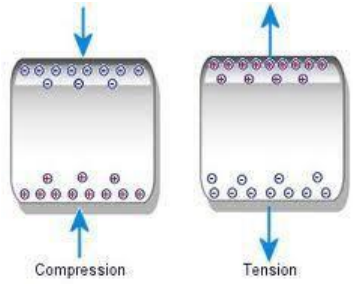

Fig: compression and tension in floor mats and aspects of piezoelectric materials

VI. RAILWAYS TRACK

Thousands of people travel from train daily, this can be used advantageously for producing electricity.

Piezoelectric crystals can be placed under the railway track, which would produce a huge amount of electricity whenever a train passes over it and thereafter fulfilling the need of power used for running train.

VII. CONCLUSION

In this review paper power harvesting technique is shown with the use of PZT materials that can convert pressure energy into electrical form of energy. This electrical energy is used for charging low power devices or stored for after use. The results of series parallel combination were encouraging. Its implementation in crowded areas would be very beneficial. In street lights it can be used without any sorts of long power lines. Therefore, these ideas can be very effective in harnessing the piezoelectric energy.

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