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Approach To Power Harvesting With Piezoelectric Material

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ABSTRACT
Nowadays, most of the research in the energy field is to develop sources of energy for the future, With oil resources being over, tapped and eventually bound to end, it is time to find renewable Piezoelectric materials are being more and more studied as they turn out to be very unusual materials with very specific and interesting properties. In fact, these materials have the ability to produce electrical energy from mechanical energy, for example, they can convert mechanical behavior like vibrations into electricity. Recent work has shown that these materials could be used as power generators, the amount of energy produced is still very low, hence the necessity to optimize them. The objective of this work is to study the all of the piezoelectric material systems and calculated the possible power generated from it, and a special case to design and build a fully functional floor tile device that when stepped on will generate enough energy to light an LED, The system will be charge a temporary energy storage device, a capacitor bank, and then use this stored energy to power an LED.

I. INTRODUCTION

In 1880, Jacques and Pierre Curie discovered an unusual characteristic of certain crystalline minerals. When subjected to a mechanical force, the crystals became electrically polarized. Tension and compression generated voltages of opposite polarity, and in proportion to the applied force. Subsequently, the converse of this relationship was confirmed, if one of these voltage-generating crystals was exposed to an electric field, it lengthened or shortened according to the polarity of the field, and in proportion to the strength of the field [1-5]. These behaviors were labeled the piezoelectric effect and the inverse piezoelectric effect, respectively, from the Greek word piezein, meaning to press or squeeze. In the 20th century metal oxide-based piezoelectric ceramics and other man made materials enabled designers to use the piezoelectric effect and the inverse piezoelectric effect in many new applications. These materials are generally physically strong and chemically inert, and they are relatively inexpensive to manufacture, the composition, shape, and dimensions of a piezoelectric ceramic element can be built to meet the requirements of a specific purpose.[6-10]

Piezoelectricity is the power produced from the piezoelectric effect. This process entails the change of the polarization of the piezo material, generally crystals, when applying a mechanical force. This reconfigures the dipole density of the material, producing a large voltage potential difference [11,12]. An example of piezoelectricity's potential is a 1 cm3 cube of quartz with 2kN, approximately 450lbs, of correctly applied force can produce a voltage of 12500V. Thus, piezoelectricity is a very promising field of renewable energy. While the amount of volts produced varies with the piezo material used, some materials like quartz, can generate potential differences of thousands of volts. We are going to be using Lead, zirconate, titanate, commonly known as PZT, PZT is a ceramic perovskite material that shows a marked piezoelectric effect. Being piezoelectric, it develops a voltage (or potential difference) across two of its faces when compressed or physically changes shape when an external electric field is. Being piezoelectric, this material develops a voltage difference across two of its faces when it experiences a temperature change. As a result, it can be used as a sensor for detecting heat. However, we are not using the piezoelectric bender kit in our application [13-18].

Our application of piezoelectric material is commonly known today as energy harvesting. Energy harvesting (also known as power harvesting or energy scavenging) is the process by which energy is derived from external sources (e.g., solar power, thermal energy, wind energy, salinity gradients, and kinetic energy), captured, and stored. Piezoelectric energy harvesting is when The piezoelectric effect converts mechanical strain into electric current or voltage. This strain can come from many different sources, Human motion, low-frequency seismic vibrations, and acoustic noise are everyday examples.

We are going to use our piezo electric to produce energy from human motion. Most piezoelectric electricity sources produce power on the order of milliwatts, too small for system application, but enough for small devices such as LEDs. As piezo energy harvesting has been investigated only since the late '90s, it remains an emerging technology.

Piezoelectric systems can convert the motion of the human body into electrical power. DARPA has funded efforts to harness energy from leg and arm motion, shoe impacts, and blood pressure for low level power to implantable or wearable sensors. However, these efforts have not been successful because piezoelectric devices do pose a risk to the human body. Thus, the idea of using piezoelectric devices to harness energy is a new and rapidly developing concept. Our goal is to study the all of the piezoelectric material systems and calculated the possible power generated from it, and a special case to design and build a fully functional floor tile device that when stepped on will generate enough energy to light an LED, The system will be charge a temporary energy storage device, a capacitor bank, and then use this stored energy to power an LED. We use a storage bank, as opposed to simply connecting our system directly to the output.

II. EXPERIMENT

We studied the amount of energy resulting from the movement of the students in the building of Prince Faisal (Faculty of Engineering Technology), Using 50 piece of piezoelectric designed to be installed at the entrance to the building.

- Knowing that the number of neon's Halogen on the first floor (48). And needs to start up (1344 watt).
- Type of piezoelectric material used in this project called (energy harvesting kit) from PIEZO SYSTEMS, INC company

According to the design of the Figure 1, The piece will be installed in the form of cantilever. Unimorph cantilever configuration Cantilever beam piezoelectric generator has three types unimorph, bimorph series and parallel configurations. When the beam has only one piezolelectrical layer attached to the substrate, the device is known as unimorph. On the other hand, if a metal shim is sandwiched between two piezoelectric layers, the device is known as a bitmap. For energy harvesting, a unimorph structure is chosen. One of the most important design parameter in designing a vibration energy harvesting device is the resonant frequency. The power density would be maximum when the vibration frequency matches the resonant frequency of piezoelectric generator. It has been proved that power density decreases when the resonant frequency deviates from the vibration frequency. The frequency range of common environmental vibrations is between 60 Hz and 200 Hz. Moreover acceleration decreases with higher modes of frequencies. Therefore the fundamental mode is considered in designing the cantilever.

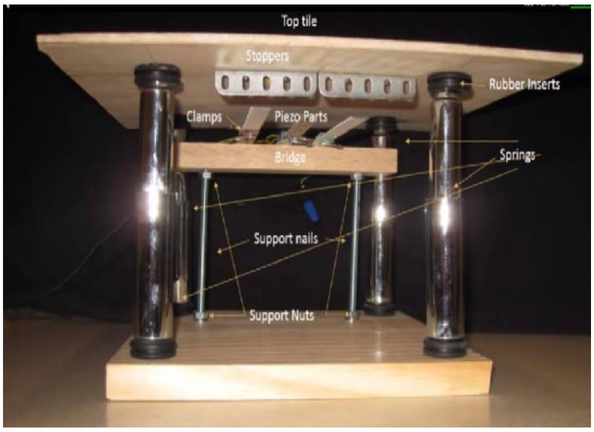

Fig.1 Piezoelectric Design

III. DESIGN COST

You must know this project is benefiting economically and is it costly in all respects, must take into account all expenses and buy a piece and brought in and installed and maintained through the Appendix shows us the following .

. 50 piece of this material would cost $30,000
. With an additional $5,000 in installation and maintenance 35000 $ = 24000 JD

Evidenced by these values, the relatively high cost of the project, but there are several solutions, including that Jordan is extracted best phosphate located around the world and the least cost approximately the cost of extracting 1 tone of raw phosphate equal to $ 100 and through this research study is clear to us the existence of the elements of the piezoelectric in phosphate Jordan The rate is very good

Energy dispersive X-Ray Fluorescence (EDXRF) technique was used to study 58 samples from Jordanian phosphate mines located at russeifa, alabiad, alhassa and eshidiya. The stoichiometry of these samples contained the following heavy trace: U, Th, Bi, Pb, Ba, Sn, Cd, Y and Sr. In addition to these heavy traces, the samples were also found to contain the following elements: Na, Mg, Al, Si, P, S,Cl, K, Ca, Ti, V, Cr, Mn, Fe, Cu, Zr, Ga and As.

IV. SUMMARY OF RESULTS

Through the study of this system and a special case appeared to us theoretical results, these results showed us that are very excellent in comparison with the needs of the building of the capacity of the daily lighting. When compared with other works shows us the economic feasibility of this work, as shown in table 1,2 especially since we've using a piece Piezo Electric and convert it to the generator as opposed to all research projects that are ready to buy a piece of commercial companies and thus become their projects uneconomical. Figure 2 shows the diagram of the piezoelectric connection. Figures 3, 4, 5 and 6 Shows the simulation results obtain from

Matlabsimulink before using the rectifier and the figures 7, 8, 9 and 10 Shows the results after using Rectifier

Table 1 The Summary Of Output Power From PZT With Time.

No. Of piece/ Power	50 piece (kit)	100 piece (kit)
Hour	119.3 watts	238.61 watts
Day (5 hour)	596.5 watts	1193 watts
Weekly	2386 watts	4772.2 watts
Monthly	9544 watts	19088.8 watts

Table 2 The Summary Cost

No. Of piezo/ cost	50 piece (kit)	100 piece (kit)
Material	30000 $=21000 JD	60000 $= 42000 JD
Installation	5000 $= 3500 JD	10000 $= 42000 JD
Total cost	35000 $= 24500 JD	70000 $= 49000 JD

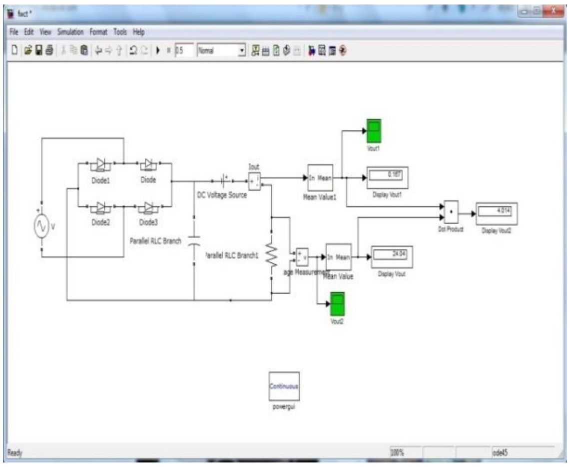

Fig. 2 diagrams of piezoelectric connection

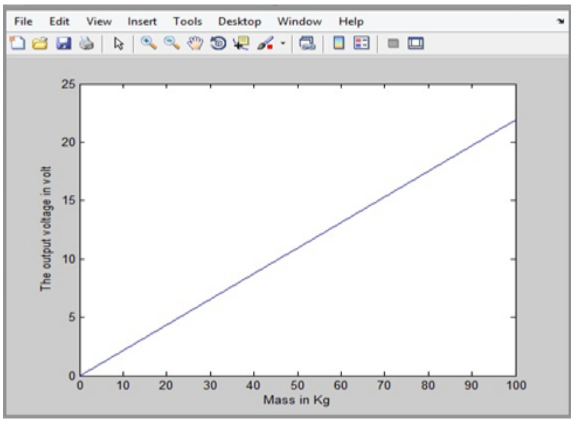

Fig. 3 relationships between output voltage vs Mass

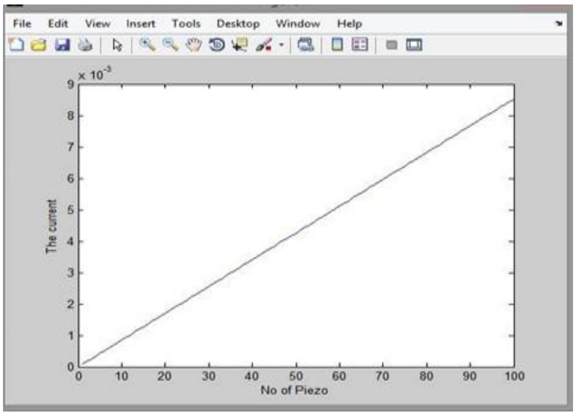

Fig. 4 relationships between current vs no. of piezo

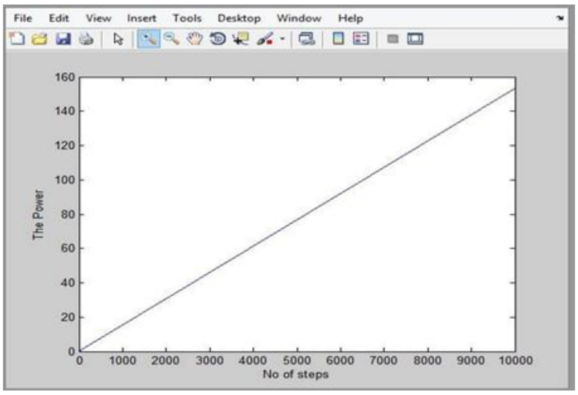

Fig. 5 relationships between power & no. of steps

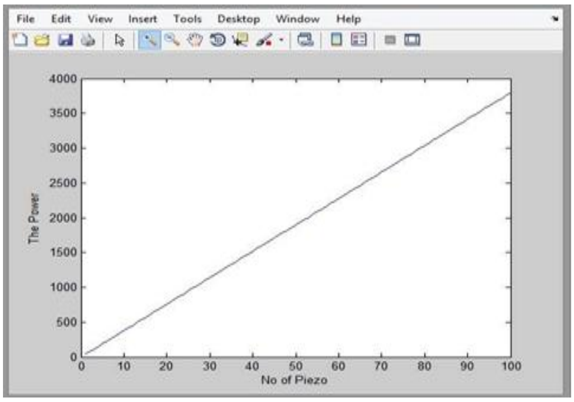

Fig. 6 relationships between power & no. of piezo

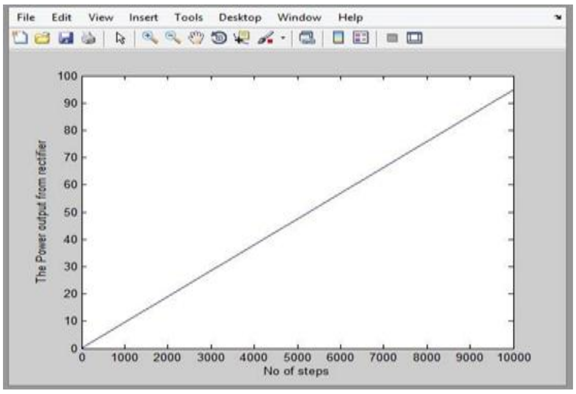

Fig. 7 relationships between power & no. of steps

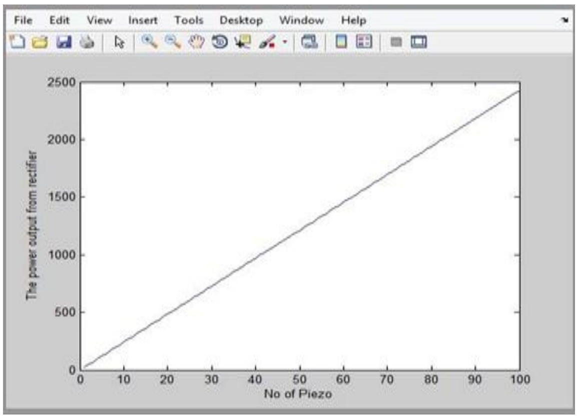

Fig. 7 relationships between power & no. of piezo

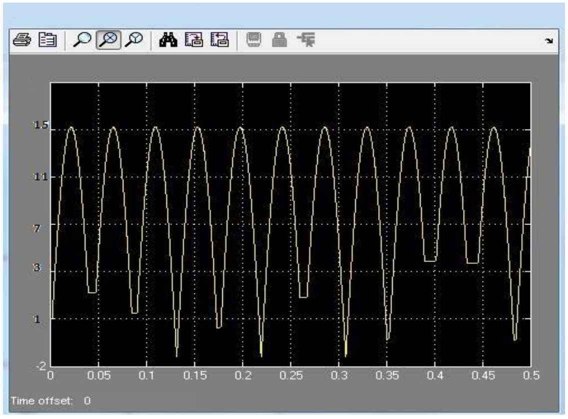

Fig. 9 wave forms of piezoelectric

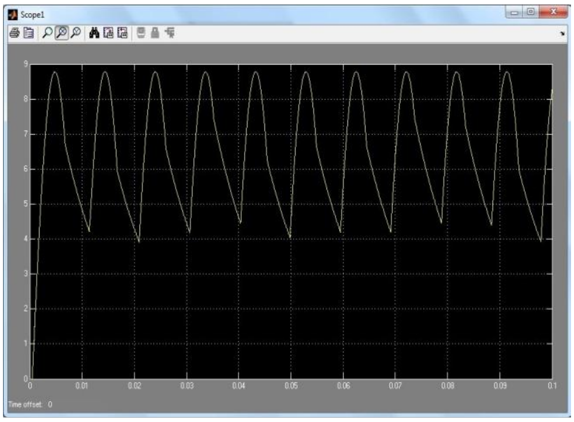

Fig. 10 wave form after rectifier

V. CONCLUSION

In using Matlab programming, we obtained the relationship between the output power and generated from piezoelectric material-which we used in the project ceramic 5A4E- and the number of steps of the students walks across it which was directly proportional, and by increasing the number of piezo pieces used, we can increase the output power in order to light 17 building.

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