ABSTRACT

Energy Harvesting Through Piezoelectric Technology and its Applications

Introduction:

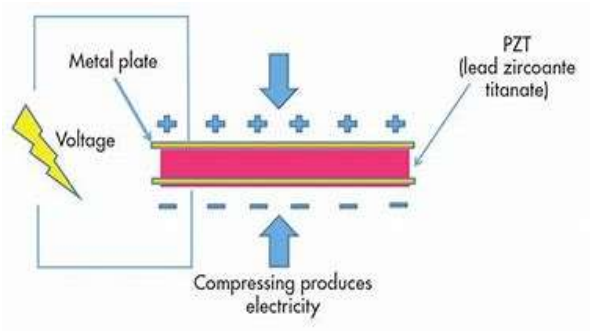
The scarcity of non-renewable sources of energy such as fossil fuels, electricity is one the greatest crisis that humanity is facing. With the advent of machines, human life has become more dependent on machines. These machines need an adequate supply of energy for their functioning. During such energy crises, new methods of harvesting energy are being proposed. One of the emerging methods is the harvesting of energy through piezoelectricity. Piezoelectric energy harvesting is a method where by mechanical energy is converted into electrical energy. The energy harvested though piezoelectricity can be used to power many devices. In many of the machines, there will be mechanical stress and strain. These mechanical forces can help make this equipment self-sustainable. This abstract highlights the use of piezoelectricity for the generation of electricity, its conditioning and its storage.

Objective:

As stated above the demand of the energy needs to be met readily for the civilisation to sustain. The objectives of this project is improve efficiency and try to make an alternative methodology to extract energy with the use of piezoelectric materials, crystals, films, etc. using day -to-day activities. Our project aims at bridging the gap between energy demands and energy supply.

Ideation:

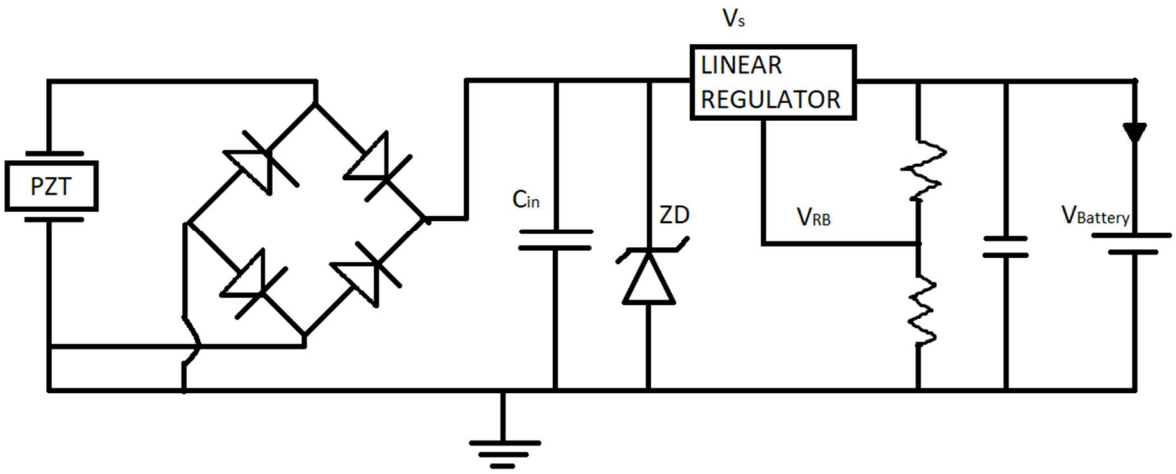
Piezoelectricity is commonly used for more than a century to describe the ability of materials to develop electric displacement D that is directly proportional to an applied mechanical stress σ. Piezoelectric effect is the ability of certain materials to generate electric charges under the influence of a mechanical force. Under the influence of mechanical stress, a shifting of the positive and negative charge centres in the material occurs. This, in turn produces an external electric field which cause current to flow. This effect is reversible. Subsequently, the application of an external field on the material will either create compression or expansion. This effect can be used to generate electricity using mechanical stresses and strains.



The maximum output voltage obtained from the piezoelectric harvesters can be transduced into a more stable and viable output by using full wave bridge rectifiers and supercapacitors. The energy produced by the piezoelectric harvesters is in both phases and hence, is unsuitable to charge a supercapacitor, so it requires to be sent through a rectifier. We prefer using a full wave rectifier, which also ensures that the supercapacitor is charged using the generated voltage during either of the phases.

Supercapacitor is characteristic intermediate between general capacitors and batteries. Because of this ability, they can be used as secondary batteries when applied to a DC current. If low capacity supercapacitors are used, the output voltage generated is not enough in many cases, wherein we can use step-up DC-DC converter which can accept an input voltage as small as 1.2V and convert it to higher regulated output voltage adjusted to 14V. Advantages of supercapacitors are high power density, very high rates of charge and discharge, little degradation of over 10,000 cycles, environment friendly and light weight. Since, our main aim is energy harvesting, we must use a high hysteretic DC-DC buck converter which will convert any dissipated excess power from voltage regulator into usable power.

The circuit diagram of our project basically would be like this:



Applications:

The electricity stored can be used for various purposes, which includes:

1. Roads and Floor: One of the most fundamental means of generating electricity is by the mechanical forces generated by walking. Thus, the sole of the shoe can be integrated with a piezoelectric circuit. Upon application of pressure (Walking, Running) electricity is generated. This can be later stored in portable battery pack. Further, they can be used to recharge any gadget such as a mobile phone. This technology can be implemented used to power the street lights and traffic signals. The generated electricity can also be supplied for domestic use. This technology can also be implemented in a discos and dance clubs. The piezoelectric circuit can be integrated under the dance floor. When the people dance, a mechanical stress is created on the circuit which will result in voltage production. This can be used to supply electricity for the dance club and make the dance club self-sufficient for electrical energy usage.

2. Keyboards and Mobile Chargers: The piezoelectric technology can also be integrated into a keyboard so that the system becomes self-sufficient. Hence, it would not need external power supply to function. The system that is in discussion does not only refer to a laptop but also to musical instruments such as piano and musical keyboards both electrical and non-electrical. The piezoelectric circuit can be integrated into the keyboard in a manner by which the mechanical forces created due to the key strokes can generate electricity. This electricity can be used to supply energy to the system. The system can refer to the laptop in case of a typing keyboard. Modern day smartphones make use of touch screen technology. This technology requires that the user execute operations by applying pressure on the screen. Here we can use Piezoelectric thin films, from material systems such as Pb(Zr, Ti)O3 (PZT), ZnO, AlN and BaTiO3 (BT) are comply applied for applications such as sensors. The thin film is applied on the smartphone screen and when the pressure is applied and removed continuously, it gives rise to a voltage because of piezoelectric materials. One of the problems faced by smart phone users is the short duration of the battery life. Using piezoelectric technology, the pressure applied on the screen can be utilized to charge the battery of the mobile phones.

3. Drums

Timeline:

- 1-7 January 2018: Research on how we can use piezoelectric materials, different approaches and various ideas to increase efficiency .
- 8 January 2018: Presentation of our idea.
- 9-20 January 2018: Discussion on how to effectively carry out the project

- 21 January - 3 February 2018: Collecting the materials required
- 4-20 February 2018: Working on the project.
- 21 February – 7 March 2018: Testing, rectification and improvement
- 8-15 March 2018: Completion and Submission of the project.

Team Size:

Currently we are a team of 4 members comprising of Himani Patel(B.Tech EEE 1st Year), Saurabh Agarwala (B.Tech IT 1st Year), Rahul Reji, (B.Tech ECE 1st Year), Nakul Suresh (B.Tech CSE 1st Year). We are a determined and disciplined team and are always ready to learn more and dwell deep in the ocean of knowledge. We would definitely like to learn about various circuits and technology regarding smart energy systems and their storage.

References:

1. Energy Harvesting Technologies-Shashank Priya, Daniel J. Inman

2. Piezoelectric and Acoustic Materials for Transducer Applications –Ahmad Safari, E.Koray Akdogan

3. Piezoelectric Transducers and Applications – Antonio Arnau and Editors