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Kinetic Generator from Footstep Using Piezoelectric

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Abstract

Nowadays, the development of renewable energy resource technology is increase. There is a lot of research being done to find solutions to increasing energy needs while the energy resources are getting more and more of a concern. There are several types of energy plants with renewable power such as micro hydro, photo voltage, wave energy, footstep, and others. Foot step is a renewable energy resource that has only recently been glimpsed by the world. Therefore, the footstep will be applied on board the passenger ship. It is hoped that the use of this renewable energy source can replace the source of fuel energy to drive ship engines. In this researdh, piezoelectric was used as a energy resources. Piezoelectric will be placed on tiles, when the piezo is stepped on, there will be a voltage came out from piezo. Voltage from piezo will be colect and stored. Each piezoelectric produces a voltage that varies from 0.7 volts to 3.7 volts. If on an average, one piezoelectric can produce 2 volts. The size of the voltage issued by the piezo depends on the size of the pressure on the piezo.

***Keywords**:* Piezo Electric, Footstep Energy, Voltage

1. Introduction

Nowadays, the development of renewable energy is increasing along with the increasing demand for energy. There are many methods that have been applied to obtain renewable energy, such as micro hydro energy, photo voltage energy, etc. Every person have been transfered energy through vibration to the road surface. Therefore a number of researchers have carried out experiment to harvest wasted energy from footfall. Pavagen is a sustainable energy company that uses the energy from footfall, the product is in the form of tiles that can be installed in public areas. Electrical energy can be generated by mechanical footsteps. In other research, piezoelectric is used to convert kinetic energy into electrical energy.

In research[1],[2], the electric energy generated by the mechanic foot step. In which output voltage variation is depending on the weight of the load. Whereas in the research[3]–[5], which used electric foot step to generated electricity. In [3] which uses a piezo electric film sensor, the output voltage is highly dependent on tip deflection. The purposed method in this research footstep generator using piezo electric transducer.

2. Research Method

This research method has been described in Figure 1 where at first data was collected on the average number of passengers / trip, the power required by the ship per

trip, and the size of the ship. These data can be used as a reference for making the initial design *footstep*. *Footstep* will use piezoelectric harnessing the kinetic energy of the trampling of passengers. After getting the initial design, proceed with making a prototype. This initial prototype will be tested on the ground (laboratory scale) first. In testing the prototype, several people with varying weights will try to step on the prototype. In the first trial, the data that will be collected is the power that can be generated by each stamping and the durability of the device (reliability of the prototype). The data data will be re-evaluated regarding the prototype design.

After the initial design is complete, a field survey will be carried out to determine the location of the footstep. The device will be placed in the place that is most traversed by passengers so that the power generated is high. After determining the important points, then the device is installed.Not finished from there, the devices that have been installed will be tested again. The power generated, device durability, power dissipation and effectiveness of placing the device will be evaluated again. If all aspects are close to the design criteria, then the equipment installation can be carried out on the ship's engine system. If the measurement results are still not suitable, it will be re-evaluated as the cause of the imperfect device.

2.1. Piezo Electric

Piezo electric is an electronic device, in this research it can be used as energy converter. Piezoelectric consist of metal and non conductive piezoelectric ceramic or crystal material. The arrangement of piezoelectric components is shown in Figure 1. When mechanical stress applied to piezoelectric ceramic material Mechanical pressure is then applied to the material by the metal plates, which forces the electric charges within the crystal out of balance. Excess negative and positive charges appear on opposite sides of the crystal face. The metal plate collects these charges, which can be used to produce a voltage and send an electrical current through a circuit.

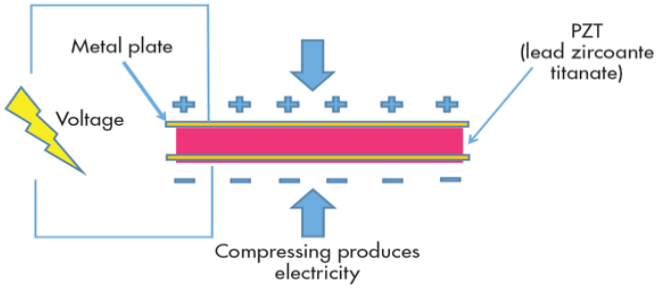


Figure 1. side view of piezoelectric material

2.2. Mathematical Model

The basic theory which used in proposed method is vibration are applied on piezo cristal surface, in figure . The electrical potential occured by the vibration on piezoelectric surface.

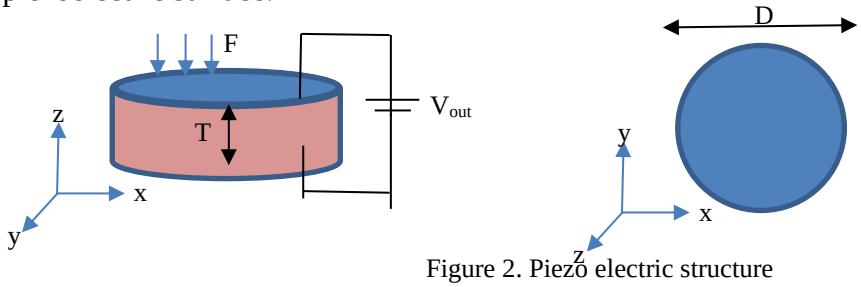


Figure 2. Piezo electric structure

Generated voltage is obtained by:

$$v = \frac{F\ x\ T\ x\ g_{33}}{A} \quad (1)$$

Where:

F : Force applied to the piezo element

T : Thickness of the piezoelectric

A : Surface area

g_{33}: piezo voltage constant

2.3. Research Plan

The scematic of research plan is presented in figure 3. There are three test models that have been experimented. Intially test model, in figure 3.a, when one piezoelectric connect to the voltmeter directly. It was pressed with one hand of cadet, who have weight 65 kg.

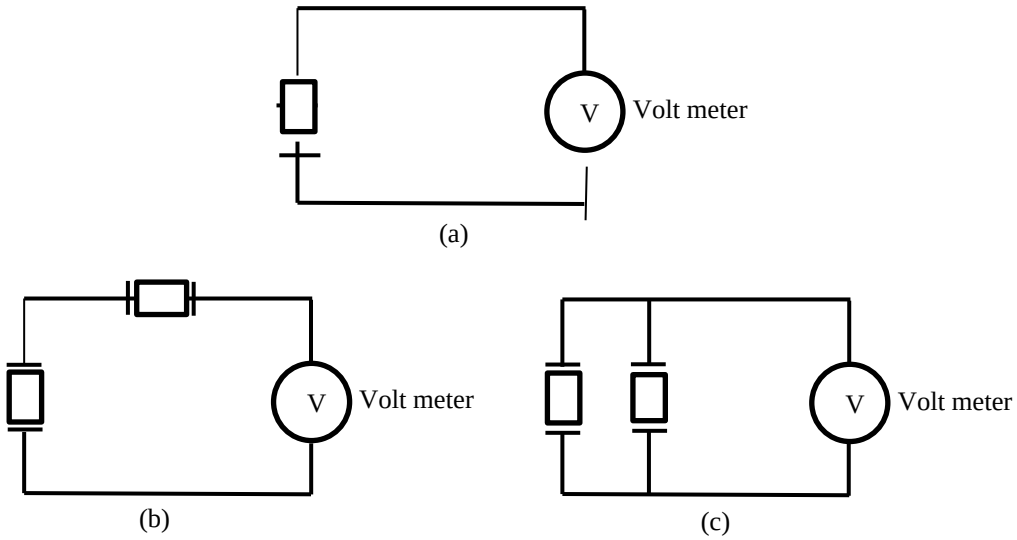


Figure 3 (a) one piezo electric test, (b) two piezo electric test in serial circuit (c) two piezo electric test in paralel circuit

Second model, two pieces of piezo electric are arranged in series circuit, it shown in figure 3.b. And figure 3.c , show the third model that have two pieces of piezo electric are arranged in parallel circuit. Both piezo are pressed at the same time with one cadet. Parallel and series circuit it should have a different voltage output.

3. Results and Analysis

3.1. Results

In this research, there are 4 piezo electric were tested. Each piezo electric is pressed for twenty times. It pressed for two second and interval between two presses is 2 second. Figure 4 ,show the output voltage from one piezo electric tranducer. Third piezo has a worst result when in the first and second trial produced 2,5-3,5 volt. But other trial out put voltage is decreased, around 1 volt. The best performance was shown by forth piezo lectric tranducer. Because it has a significant output voltage. Similiar result is shown by second piezo electric tranducer. The average output voltage from the first model is around 2 voltage, it shown in figure 4.

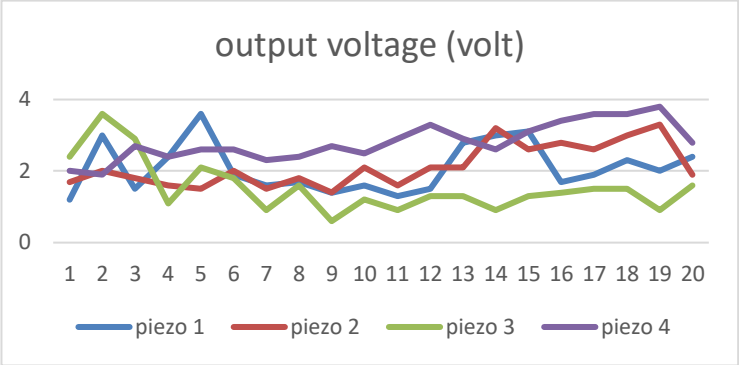


Figure 4. output voltage from one piezoelectric tranducer

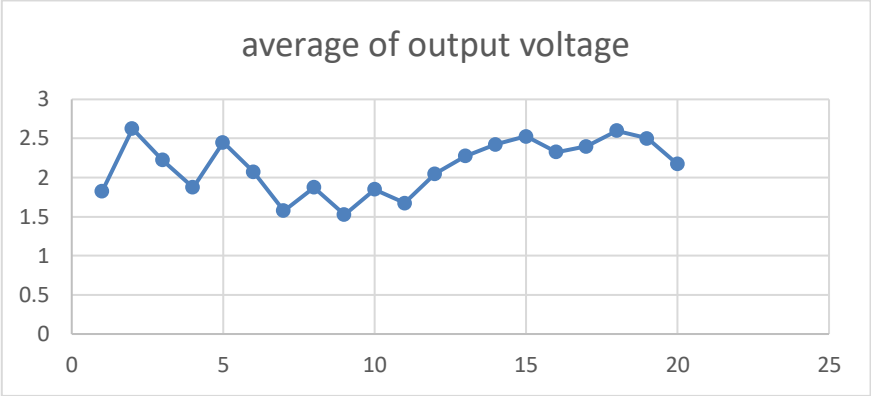
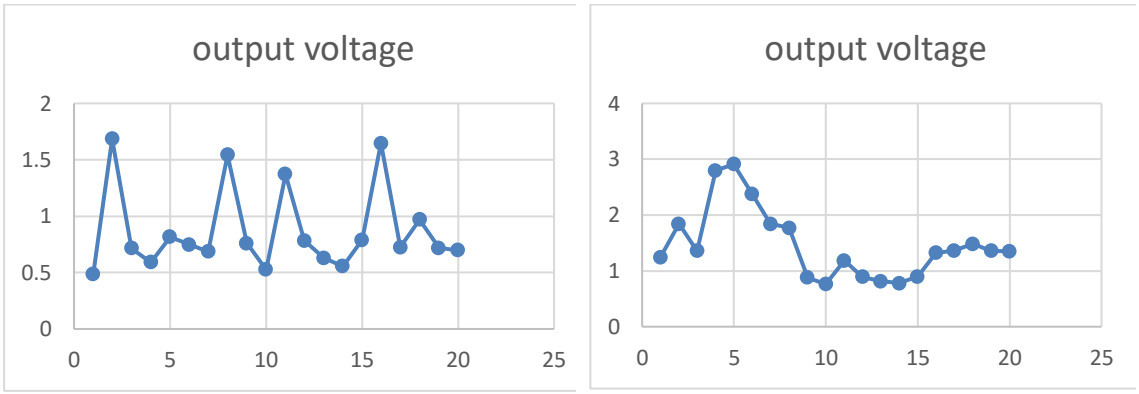


Figure 5. average output voltage from singel piezo electric

In this research, there are two piezo electric, that connected serially or parallel, were tested. Each piezo electric is pressed for twenty times at the same time. It pressed for two second and interval between two presses is 2 second, and so on.



(a) (b)

Figure 6. (a) output voltage from serial circuit
(b) output voltage from parallel circuit

Result for series circuit tested is shown in figure 6.a. Output voltage is dropped, even there are two voltage source are connected in series circuit. Output voltage is very fluctuatif. In other hand, output voltage from two parallel piezoelectric, it shown in figure 6.b, has a good result. The output voltage from the parallel piezoelectric is around 1 volt almost in all condition.

Figure 7. output voltage from one piezo electric

The purposed method is tested by oscilloscope, it shown in figure 7 . From oscilloscope result, is known that output voltage from piezo electric tranducer is AC voltage.

3.2. Analysis

The image above is the data from the test results of four piezoelectrics which were carried out separately. The resulting stress looks very fluctuating, this is due to the strength and weakness of the pressure. The stronger the pressure on the piezoelectric, the higher the voltage generated, and vice versa. This can be proven in the image above, it can be concluded that the highest voltage produced is almost 4 volts, while for the lowest voltage is only 0.5 volts. The four experimental results above, taken the average value of the resulting voltage value which is about 2 volts.

Apart from the amount of pressure imposed on the piezoelectric, changes in the resulting voltage output value are also influenced by the piezo conditions themselves. Because piezo has been exposed to heat from the solder, causing the piezoelectric to shift from a completely ideal state

Then, the piezoelectric, is assembled in series and parallel. In theory, the resulting voltage will be greater if the voltage source is series and will not be bigger if connected in parallel. However, all these theories are not proven in the results of the measurements taken. The voltage value generated from 2 piezo pieces arranged in series is around 0.5 v to 1.7 v only.

Same as piezoelectrics arranged in parallel. When the piezo are arranged in parallel, the piezo produces a voltage of about 0.7 v to 2.7 v. This is caused by output voltage (AC voltage). the voltage produced by the electric piezo is an AC voltage, if there is an AC voltage connected in series, then many things to note such as the phase of the voltage itself. if two AC voltage sources do not have the same phase then the voltage will dissipate. this is evidenced by the figure, which shows the output voltage is very fluctuating. In addition, caused by cable losses as well as heat losses

After testing using a multitester, then the measurement is continued using an oscilloscope to determine and ensure that the voltage generated by the piezoelectric is an AC voltage. In the measurement results obtained, when the piezo is pressed without being released, it produces a voltage of 20 mV. However, at the time of the initial stress, the resulting voltage can reach 2 V. In addition, the speed of piezo compression also affects the amount of voltage generated.

4. Conclusion

Each piezoelectric produces a voltage varying from 0.7 volts to 3.7 volts. If on an average, one piezoelectric can produce 2 volts. The size of the voltage issued by the piezo depends on the size of the pressure on the piezo. Voltage increment per tap on the piezo electric wasn't sufficient enough to be used

In future work, the piezo electric is completely connected to full wave rectifier circuit to convert output voltage to DC voltage so that its voltage can be increased.

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