

Design and Analysis of Energy Harvesting System for Smart Wearable Device

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ABSTRACT

The world is going through energy crises. There are different alternative sources available to generate energy. But most of the energy generation system fails to fulfill the requirement of portable application. There is need to search alternative energy source. The alternative source of energy is to supplement batteries in portable electronics application. Electromagnetic generator is one of way to generate energy from motion or vibration.

In this research work, the main focus is on converting mechanical energy into electrical energy by using a pendulum. An effort is made to analysis the electrical signal from the movement of pendulum with the help of MATLAB. The shaft of electromagnetic generator is connected to pendulum. The movements of generator move the pendulum and energy will be generate. The way of analysis of Energy generation is explain in this paper. The generated energy further charges the rechargeable batteries used for portable electronic application.

1. Introduction

Portable Wearable electronic is still a fairly new field of research and as a result much of the terminology has still to gain widespread acceptance. All the wearable electronic devices are a portable. A Portable electronic gadget is a device that has a purpose or function, that contains electronic devices in order to work. Although, a lot of efforts are being made to provide alternative energy sources for portable application but increasing demand of efficient power sources, embedded systems and wearable electronic devices. Using more than one source for energy scavenging can be a good solution for most of the applications. [1]

Energy harvesting is the process by which energy is derived from environment, captured and stored.

Energy harvesting devices converting ambient energy into electrical energy have attracted much interest in both the communication and commercial sectors [2]. Another application of energy harvesting devices in wearable electronics is that it can power or recharge cell phones, mobile, radio communication equipment etc [3-4].

The following are different types of Energy harvesting system:

Radiant energy harvesting: Harvesting solar energy is probably the oldest way for powering of electronic devices.e.g. Solar Energy, RF fields and RF waves [5].

Mechanical energy harvesting: Mechanical energy of vibration or strain is converted into electrical through various techniques. For e.g. Electromagnetic, Electrostatics/ Capacitive and Piezoelectric [6-9].

Thermal energy harvesting: Relies of thermoelectric effect to convert thermal gradients into useful energy.e.g. Body heat and external heat [10-11].

Alternative energy generations have gained considerable research attention due to the rapid development of portable electronic gadgets/products. A Portable electronic system includes autonomous device that is powered by a battery. The battery can be recharged by energy harvesting system. This energy is harvested from the human body or from external ambient energy. Energy harvesters provide a very small amount of power for low-energy electronic devices.

Motion and vibration provides possible power sources and a wide range of devices have been developed which exploit them.

2. System under study

In the present work, pendulum based alternative energy harvesting system is designed to increase a battery life by recharging a battery continuously [12]. The pendulum is worked as Electric generator. The generator is one which generates electrical energy. The electromechanical energy generator converts motion of pendulum (Mechanical Energy) into electrical energy.

The following figure 1 shows the block diagram of Electric Energy Generator

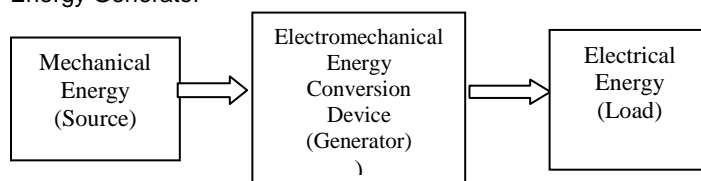


Figure 1: Block diagram of Electromagnetic Energy

Mechanical energy is the energy that is possessed by an object due to its movement of pendulum. In this experiment pendulum is use for this purpose. The oscillations of pendulum generate electrical energy because of that it is also called as

generator. Pendulum is a continuous energy conversion equipment.

Designing of Pendulum

A pendulum is one which can be considered to be a point mass suspended from string of negligible mass.

Consider mass of object connected to a pendulum is 'm' and length of string 'L'. The motion of the pendulum can be completely described by coordinate θ . The angle θ measured from y axes.

For a small angle

$$\theta = \theta_{max} \sin(\sqrt{g/L} t)$$

The period of the motion, the total time for a complete oscillation (outward and return) is

$$T = 2\pi\sqrt{L/g}$$

The pendulum is work as electromagnetic energy generator. The power generated from the pendulum system can be calculated from the formulae given below

$$Power = 2 * g (1 - \cos(\theta)) / \pi \sqrt{g/L}$$

The following Figures 2 show the human hand work as pendulum and Figure 3 shows an Experimental setup of pendulum as energy generator.

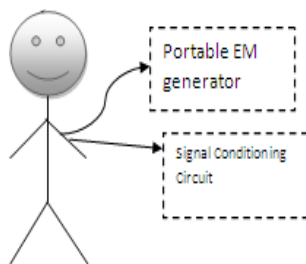


Figure 2: Human hand work as Pendulum

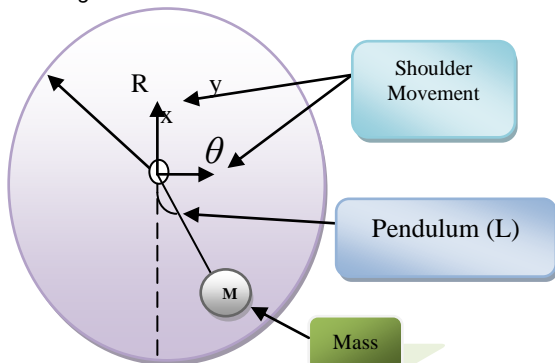


Fig.3: Movement of pendulum as energy generator

3. Experimental Results

For calculating the energy generated from pendulum need to calculate or identify the angle of the pendulum. By using a simulation tool like MATLAB can be easily find out the position of pendulum and angle of pendulum.

That angle θ is used to find out the energy generated from pendulum. The figure 4 and figure 5 shows the simulation results of movement of pendulum and its time series for different angle.

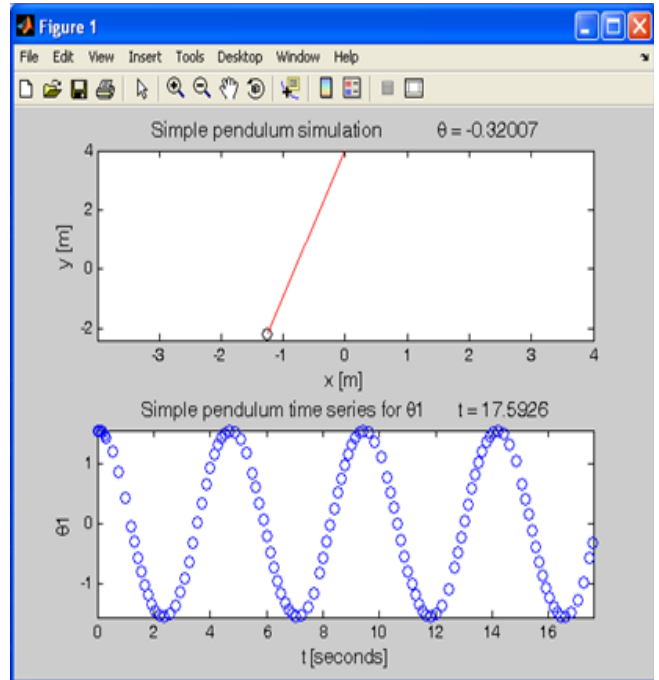


Figure 4: Simple pendulum and its time series

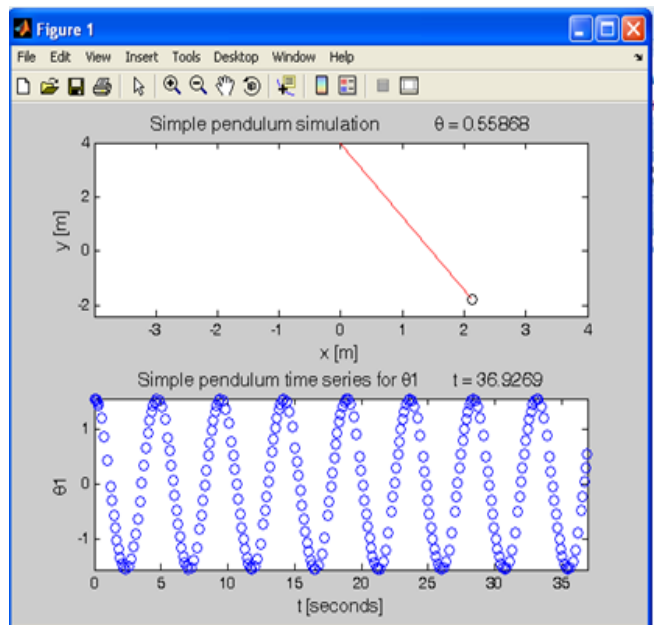


Figure 5: Movement of pendulum and its time series

4. Conclusion

Harvesting energy from the body movement is the best option for portable application. There are several alternative energy sources which can be used for the same purpose. When the angle of pendulum oscillation increased, the generated electric energy also increases. As per above discussed the system designed for energy generator using a Pendulum which is used in Portable Application. The generator power is in mill watt range. In future generated power will be amplify and stored in rechargeable battery or super capacitor. The rechargeable battery or super capacitor is a source of power in portable electronic gadget or applications.

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