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Energy Harvesting by Using Piezoelectric Material into the Key of a Prototype Keyboard

Asma-Ul-Husna[1], Afsana Hossain Dristy[2], Farhana Afrin Lam[3], Ashraf Siddiquee[4], Pronob Das[5]

[1,2,3,5] Department of Mechanical Engineering, Rajshahi University of Engineering &Technology, Rajshahi-6204, Bangladesh.

[4] Department of Electrical and Electronic Engineering, Bangladesh University of Engineering & Technology, Dhaka, Bangladesh.

E-mail: [1]evu_me04@yahoo.com, [2]afsanadristy.ruet14@gmail.com, [3]farhanaafrin202@gmail.com, [5]pronobdasruet@gmail.com

Abstract

Scientists are continuously investigating pollution free renewable and green sources of energy for electricity generation purposes. World's total reserve energy is diminishing day by day and energy generation is depended on some ancient methods that is threat to our environment, the motive of this work is to minimize the tendency of dependency on the electricity generation at present day. This paper is an experimental work for generating voltage by typing on prototype wooden keyboard using piezoelectric transducer. The pressing weight of the finger on key of the keyboard deforms the piezoelectric material and thus produces electrical energy as output. The ways and instruments of producing prototype keyboard and the voltage storing system is briefly discussed. Maximum power gained was 0.467 mw for 5 minutes tapping on keyboard on average typing speed 110-120 press/minute and average pressing weight 0.98N.

Keywords: Electricity, Piezoelectric material, Keyboard, Pressure, Energy Voltage

1. Introduction

Energy has Piezoelectricity, is the electric charge that accumulates in certain solid materials (such as crystals, certain ceramics, and biological matter such as bone, DNA) and various proteins in response to applied mechanical stress. The word piezoelectricity means electricity resulting from pressure and latent heat [1]. Piezoelectricity, also called the piezoelectric effect, is the ability of certain materials to generate an AC (alternating current) voltage when subjected to mechanical stress or vibration, or to vibrate when subjected to an AC voltage, or both. The most common piezoelectric material is quartz [2]. Most of the wasted energy generated by the human body is dissipated as heat energy in general metabolism and is unusable as parasitic power due to lacking of density. The smallest source of waste energy is dissipated at the time of typing in the keyboard by pressing finger on the key. Keyboard are the most popular input means used in data terminal equipment. Good key-in characteristics are required for them since they are used for a long time, usually at high speed. The motive of this thesis paper is to take advantage of the wasted energy by human typing and to use a pollution free energy sources for electricity generation. Wang and Wu [3]suggested piezoelectric material for energy harvesting purposes. This project exploits piezoelectric components where deformity is produced by human finger weight. The objective of this study is the implementation of this idea into the key of laptop keyboard. Lead Zirconate Titanate (LZT) is preferred for this purpose. But due to not getting laptop key size piezoelectric material of required capacity, it was made a prototype keyboard by implementing quite large size piezo material compared to the laptop key size for producing electricity with the help of typing on prototype keyboard.

2. Methodology

For obtaining voltage from prototype keyboard, circuit was designed and then compacted it (fig. 1). After that piezoelectric material had been placed into the prototype keyboard. Bridge rectifier had been placed just below the prototype keyboard. After pressing by finger on the piezo material, voltage had been produced by piezo material. The produced AC voltage was rectified by diode of the bridge circuit into the constant DC voltage. The obtained AC voltage was stored in the capacitor and at last, apply it where small power is required.

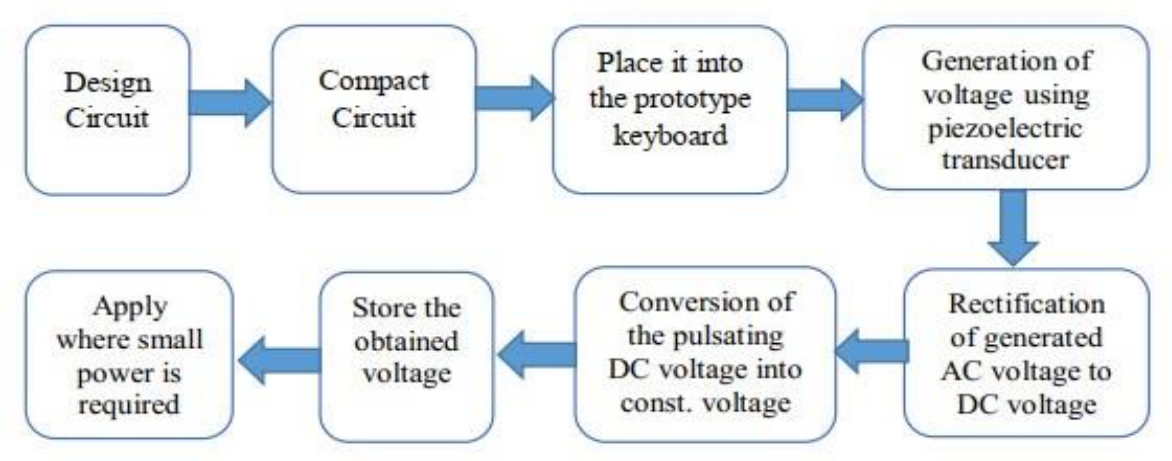


Fig. 1. Block diagram of proposed work

Fig. 2 shows the block diagram of the power generation diagram which depicts the methods of producing electrical energy from typing on the piezo material in the prototype keyboard.

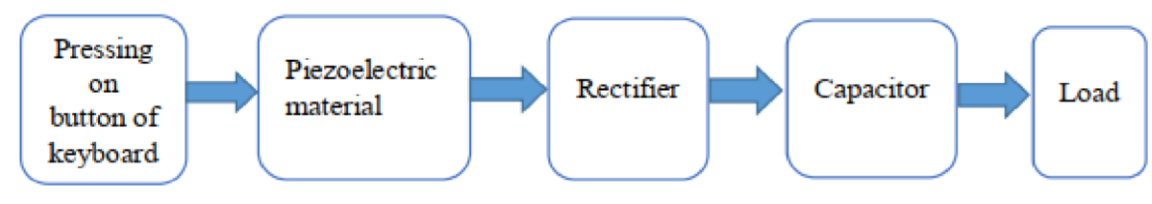


Fig. 2. Block diagram of power generation

3. Experimental Details

The human produced mechanical energy by pressing of the keystrokes during typing can be converted into electrical energy. The proposed apparatus consisted of two parts. One of these, a prototype keyboard where piezo electric materials (piezo) are placed into the upper side of the keyboard and prototype keys are placed on the piezo. Another, an electrical circuit which store the produced voltage. There are four places on key of keyboard where piezo material could be attached such as over the overlay, between overlay and the switch package, between switch package and interface, and under the interface.

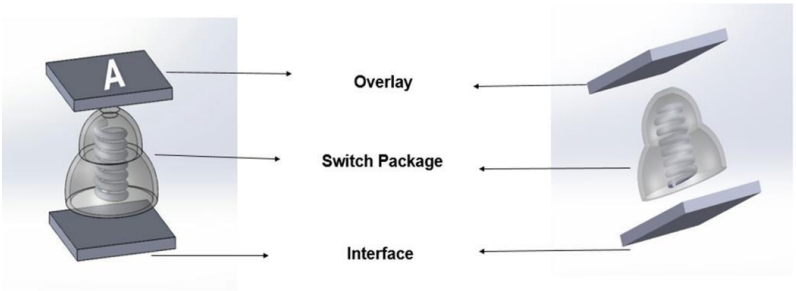


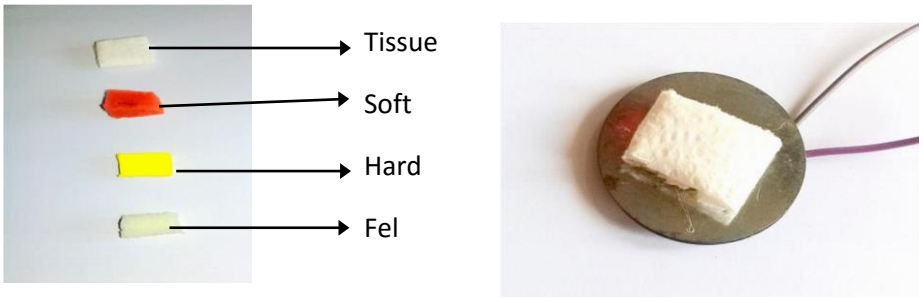
Fig. 3. Internal structure of each key and its different parts.

For obtaining better output and not to hamper the internal circuit of the keyboard, the piezo was put in third position between switch package and interface as output weight is the summation of pressing weight and weight of the key.

Fig. 4 shows the schematic view of prototype wooden keyboard where the length of the board is 12 inch, width is 6 inch and depth is 3 inch. We can also use plastic, metal sheet and PVC board in lieu of wood. It is considered 10 keys in this study. Piezo are set on the upper portion of the prototype keyboard with the proto type key. Wires is passed into the box.

Fig. 4. Schematic view of prototype wooden keyboard.

Piezo works on both mechanical pressure and vibration [4]. Mechanical pressure is given by finger tape. For the use of the effect of vibration piezo should be placed on a soft surface. After using all the materials of fig. 4, tissue paper gives better vibration of piezo and however gives maximum output. Fig. 5 shows the implementation of the tissue paper which is 4 times folded is attached with the piezo. Fig. 6 illustrates the overall setting and combining keys on the wooden board. Each bridge rectifier was used for each key as it gives maximum output. It could be made as a small integrated circuit. The simple bridge rectifier circuit is used to store voltage as piezo cannot produce Direct Current (DC) and Alternating Current (AC) may not be stored [5] (fig. 7). Only one type of diode and 2 types of capacitor could be used in this bridge circuit. Otherwise the circuit may not run properly. The diode model is 1n4148 and capacitors are 220µF with 35V and 220µF with 50V. Fig. 8 shows the total installation of circuit into the keyboard where the bread board was placed into the wooden keyboard. Output voltage could be measured by a multimeter.



(a) (b)

Fig. 5. (a) Vibration creating materials (b) Implementation of tissue paper on lower portion of piezo.

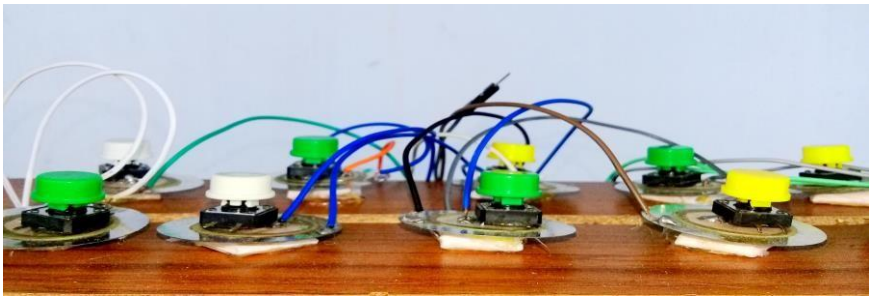


Fig. 6. Combining the keys on the wooden board.

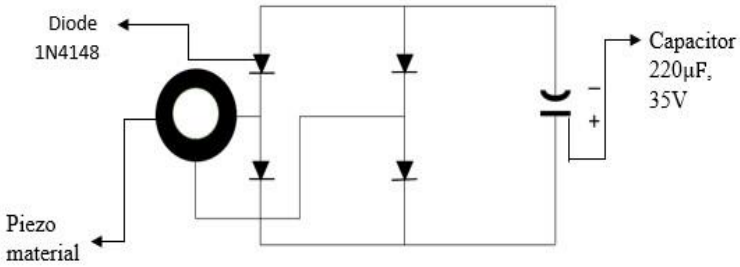


Fig. 7. Simple bridge rectifier circuit.

Fig. 8. Total installation of the circuit with attaching the piezo.

4. Results and Discussion

The power output varied with some factors such as weight of the person, finger weight or pressing on the keyboard, resistance added to the circuit. Here, the voltage is measured by multimeter and the weight is fixed mass taking from physics laboratory of Rajshahi University of Engineering & Technology, Bangladesh, which is then converted into weight. Fig. 9, shows that with the increment of finger pressing weight, the voltage output is increased gradually. In fig. 10, voltage is measured by multimeter and time is measured by stop watch. This graph indicates the voltage variation with changing of time. Fig. 13 indicates that with the increment of time, the voltage output is increased. That means the longer our keyboard is used, the more voltage it will generate voltage. Fig. 11 shows, with the increment of press/min, the voltage output is increased. That mean show fast we tap on the keyboard with sufficient weight, the more voltage will be generated. The voltage and current both of them are measured by multimeter. Fig. 11 shows the voltage variation with the increasing current rate. The power is

obtained by multiplying the corresponding voltage and current and the time is obtained by stop watch. Fig. 12 shows that the power output is increased gradually with increasing time.

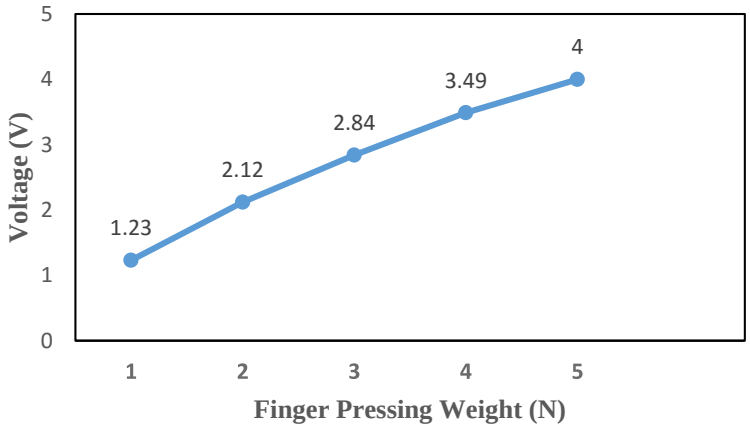


Fig. 9. Voltage vs. varying Finger Pressing Weight curve

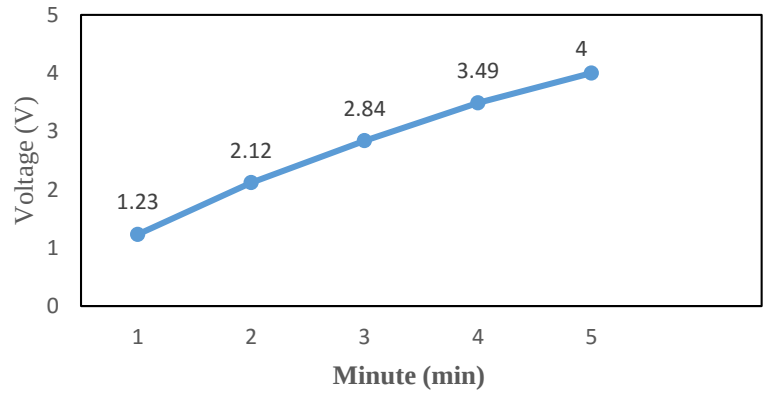


Fig. 10. Voltage vs. Time curve

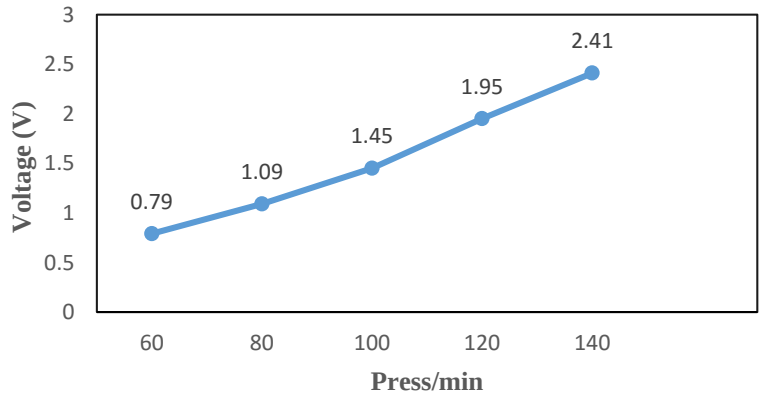


Fig. 11. Voltage vs. Press/min curve

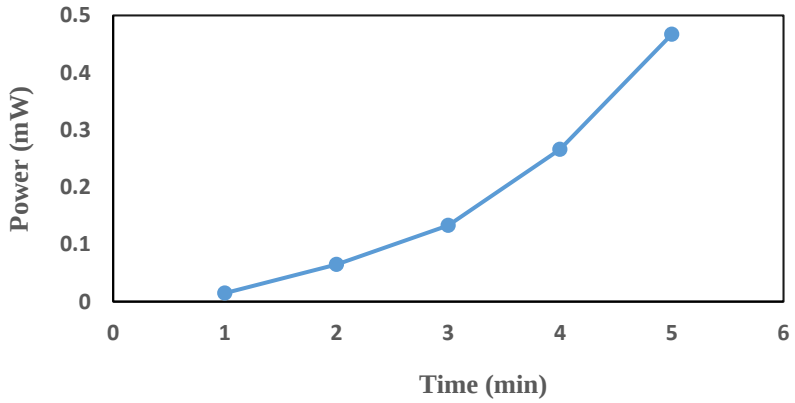


Fig. 12. Power output vs. Time curve

5. Conclusion

In the experiment, integration of piezoelectric material into the key of keyboard produced a certain amount of voltage which was totally wasted energy. The setup is designed for power output with normal typing on the wooden prototype keyboard. The setup is simple in construction and initial cost is high but maintenance cost is low. The system had produced a maximum power of 0.467mW for the 5 minute continuous typing on prototype keyboard of average typing speed 110-120 press/minute and average pressing weight 0.98N. The generated current was used to light up a few number of LED. It can be used for many applications where small power is required.

6. Recommendation

Further research is necessary to store the capacitor voltage in a battery and integrate them in a structure for better future success of this project. The setup should be designed with piezo transducer of smaller diameter with high capacity to place the keyboard of laptop, typewriter, harmonium etc. to gain more output. Any suitable material like plastic, metal, PVC sheet having physical characteristics superior than wood can be used instead of the wooden prototype keyboard.

7. References

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