On the Improved Storage Capacity in Power Generation Using Piezoelectric Sensors

M. Keerthana, E. Gopi Chand, B. Sai Prasad, and Ambar Bajpai

Abstract At present, the whole world is sustained because of energy, which is derived from natural resources. As the population is increasing day by day, the energy resources are depleting which produce electricity. Therefore, in order to get electrical energy for our existence, we can make use of the energy waste of human locomotion. By using piezoelectric sensors, we can convert this kinetic energy of human locomotion into electricity. To implement this system, we have used six piezoelectric sensors, a voltage booster, an Arduino Nano board, I2C converter. In this paper, we have discussed a detailed description and processing of the developed prototype. The performance and analysis of the proposed system is presented in a table. The power that can be transferred to the rural villages is shown with the LED indication. This paper gives the analysis of the obtained output voltages from the footstep power-generation model and shows the functionality of the piezoelectric model.

Keywords Electricity · Force · Piezoelectric sensor · Pressure · Voltage booster

1 Introduction

Natural resources produce electricity and are depleting day by day, and there is need for alternative energy resources and in the rural areas, which do not have access to electricity need to be accessed with electricity. Power that is used for our sustainability is generated using natural resources like coal, water, wind, geothermal energy etc. Renewable energies are reasonable, eco-friendly in nature with various forms like solar, wind, tidal, biomass, and geothermal. In the present situation we are wasting energy in various forms. Therefore, the major solution is to reform this

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energy wastage into usable form. Present industries also developing many gadgets, electronic devices that consumes power. As technology increases day by day the gadgets or electronic devices that run on electricity also increases. Therefore, there is a necessity for an alternative power generation method. One of the alternative power generative method is to extract the power from human locomotion that is converting kinetic energy into electrical energy. This can be achieved by using piezoelectric sensor, which converts pressure into voltage. This piezoelectric model is used to generate voltage using human footstep force. This proposed system is useful to generate power using pressure. This piezoelectric model in large scale can be implemented in public areas such as railway stations, shopping malls, colleges, schools, etc. [1–4].

1.1 Challenges

Some of the cities and villages have several power cuts because of the increasing demand for electricity and lack of resources. One of the methods to supply electricity to rural areas is by extracting energy from human footsteps or from wastage pressure. To design a footstep model using piezoelectric sensors to generate and transfer the electricity to rural areas [5].

1.2 Literature Survey

In the earlier piezoelectric models, the voltage produced is small due to small strain sensing devices. Those models require additional power supply to operate the appliances. Later with advent of piezoelectric tales, the voltage level is increased. With the advent of piezoelectric sensors with in-built spring produces higher voltage levels. This is implemented in areas where locomotion or movement is more and is given to appliances, which need lower voltage to operate. The obtained voltage is less and hence given to nearby appliances. There were many losses in supplying the power from system model to appliances [2, 3, 6].

2 Preliminaries

2.1 Piezoelectricity

Piezoelectricity is defined as the electricity that is generated when mechanical energy is converted into electrical energy by piezo sensors. A piezoelectric sensor consists of quartz, when this quartz is squeezed and stretched it generates a slight electrical potential difference between its ends. Through this squeezing and stretching phenomena voltage is generated, this effect is called piezoelectric effect [3, 5] (Fig. 1).

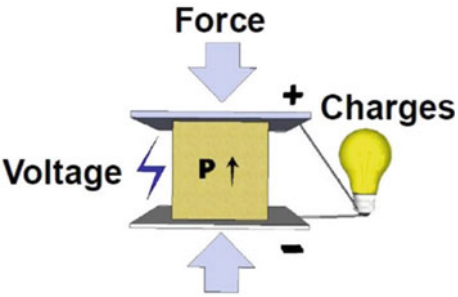

Fig. 1 Piezoelectric effect [3]

Fig. 2 Voltage booster [1]

2.2 Voltage Booster

A voltage booster is a boost converter, a DC-to-DC power converter. Voltage booster is used to step up the voltage that is generated from piezo sensors input to the output. It is helpful in boosting the voltage than the obtained voltage. Voltage booster is used in places where higher voltage is required than the original voltage [1] (Fig. 2).

2.3 Piezoelectric Sensor

A piezoelectric sensor is a device which has both positive and negative terminals. It senses the pressure or force applied on it and converts that force into electricity. It uses the piezoelectric effect principle that generates voltage. Piezo sensors are robust in nature and used in many applications [7] (Fig. 3).

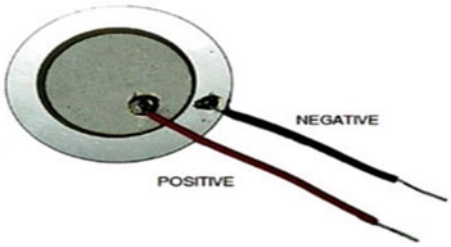

Fig. 3 Piezoelectric sensor [7]

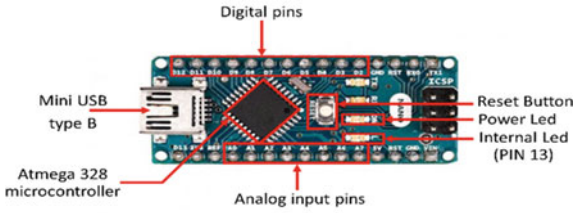

Fig. 4 Arduino nano [7]

2.4 Arduino Nano

The Arduino Nano is type of microcontroller's board, designed by Arduino. This microcontroller is small, breadboard friendly, which is based on the ATmega328P. It is more flexible and smaller as compare to Arduino Uno. The operating voltage of the Nano board is in the range of 5 to 12 V. Arduino Nano has 22 I/O pins, 14 digital pins and 8 Analog pins. The applications of Arduino Nano include robotics, control systems, automations, etc. [7] (Fig. 4).

2.5 I2C Converter

I2C converter is an interface adapter module, which is used for 16 to 2 LCD display. It can make the display easier. This converter uses the PCF8574T ic chip that converts serial data to parallel data for the LCD display [4] (Fig. 5).

Fig. 5 I2C converter [4]

3 Proposed Solution

3.1 Block Diagram

See (Fig. 6).

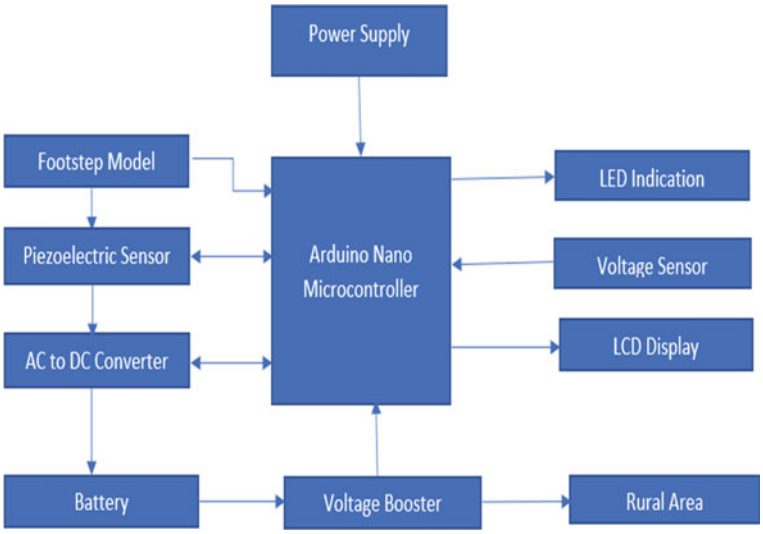

Fig. 6 Proposed block diagram

3.2 Involved Coding

```
#include<Wire.h>
#include<LiquidCrystal_I2C.h>LiquidCrystal_I2C lcd(0*27,16,2);
Const int voltsensor = A0;
float Voltageout = 0.0;
float Voltagein = 0.0;
float S1 = 3000.0;
float S2 = 750.0;
void setup()
{
lcd.init();
//lcd.init();
lcd.backlight();
lcd.print("Measure>25V");
delay(2000);
}
Void loop()
{
value = analogRead(voltageSensor);
Voltageout = (value * 5.0) / 1024.0;
V = Voltageout / (S2/(S1+S2));
//Serial.print("Input =  ");
//Serial.println(Voltagein);
Lcd.setCursor(0,0);
Lcd.print("Input =          ");
Lcd.setCursor (9,0);
Lcd.print(Voltagein);
delay(500);
}
```

3.3 Working Model

This piezoelectric model is based on the principle of piezoelectric effect. When a force is applied on the piezo sensors which is by human locomotion, this pressure is sensed by the piezoelectric sensors. Piezoelectric sensors consist of quartz material that produces potential when it is strained. Thus, piezo sensors produce voltage. This generated voltage is transferred to voltage booster that boosts the original voltage. It acts as a step-up voltage converter. This is further connected with Arduino Nano board. Arduino Nano board is also connected with I2C converter, which is used for LCD display. The final voltage is stored in the batteries, which can store the power for future use. This stored power can be transferred to rural villages for various home applications (Fig. 7).

4 Result and Analysis

The output voltage for our project model is 10 V. After stepping up the voltage using voltage booster it is 12 V. Before the voltage is supplied to LED's, it is stepped down and is stored in the battery for the future use. The table below shows analysis of the project model, Fig. [8] shows the voltage that is stored in the battery, Fig. [9] shows the led indication that is supplied to the rural villages, and LED's glows as per the voltage that is stored in the battery.

In our piezoelectric model, we are able to boost and produce the voltage of about two volts from each piezoelectric sensor. In this project, we used six piezoelectric

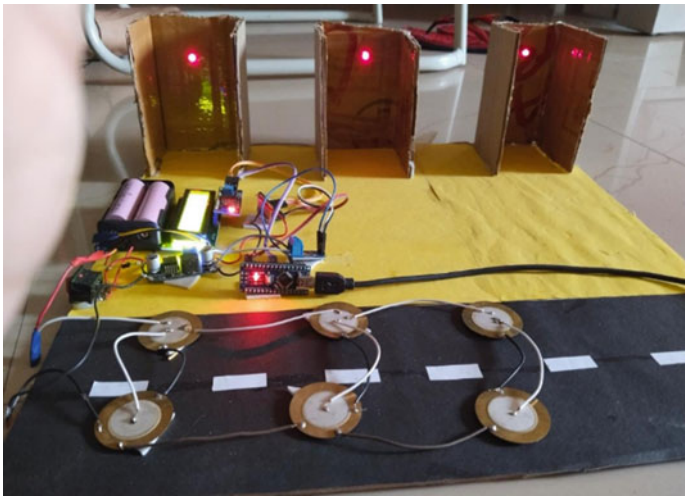

Fig. 7 The system model

sensors that is able to produce the voltage of twelve, which is of about 10.36 V in the existing system. In our project, we are able to produce about 1.24 V more than the existing system [6] (Figs. 8 and 9, Table 1).

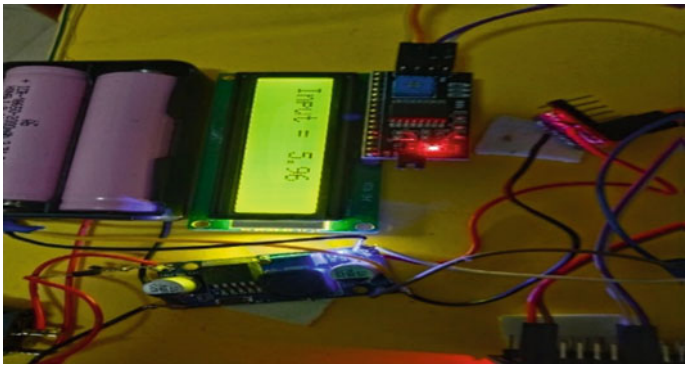

Fig. 8 Voltage output from the charged battery

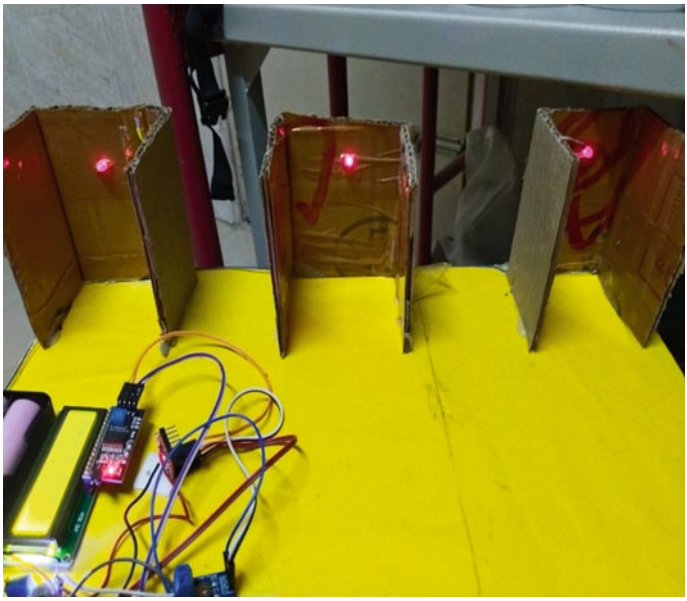

Fig. 9 The LED's indication of system model

Table 1 Analysis of system model

Weight (kg)	Time (sec)			
	5 s	10 s	15 s	20 s
45	1.98 V	2.15 V	2.80 V	3.78 V
50	0.83 V	1.23 V	2.38 V	3.12 V
55	1.76 V	2.73 V	4.66 V	5.65 V
60	2.75 V	4.59 V	5.31 V	9.06 V

4.1 Applications

The advantages of power generated through piezoelectric sensors are zero side effect on human body, and it can be easily installed in shopping malls, roadways or areas with frequent locomotion. The output is proportional to number of steps and energy can be easily extracted. The system is environmentally friendly, easy-to-go utility [7–12].

5 Conclusion

This power generation model using piezoelectric sensors is an innovative method to produce electricity. This method of generating electricity is an alternative way that utilizes non-conventional resources, which are used for producing electricity. This model has a voltage booster, which is used for boosting the obtained voltage from piezoelectric sensors. The generated power is displayed on LCD using I2C converter. This proposed system improves the storage capacity of the footstep model with 12 V. This boosted voltage can transfer to rural areas, which do not have access to power. Thus, we can be able to supply electricity to rural areas without depleting natural resources.

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