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Piezo as Vibration Sensor Using Amplifier Circuit

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Abstract *This article comprises of explaining how a piezo module can be used as a vibration sensor by using amplifier circuit and Arduino UNO as a microcontroller. Usually, seismometer is used as a vibration sensor or to calculate movements of the Earth crust. But, these seismometers are larger in size. And cannot be used for the smaller application. The piezo as a vibration sensor is very much compact compared to the seismometer and can be used in all smaller applications. By amplifier circuit, even the small vibrations can be recorded using piezo.*

Key Words: *Piezo module, operational amplifier, Arduino UNO as micro controller, seismometer, vibrations, amplification*

1. INTRODUCTION

In seismometer, a large weight is suspended by spring to record the vibrations or to predetermine the earthquakes. And for the precise recording of the vibration high-cost components are required. In a similar way for the same application, a piezo module can be used to record the vibrations easily with low-cost components. There are many disadvantages in seismometer and some of those disadvantages can be overcome by the piezo module as a vibration sensor using an operational amplifier circuit. Though piezo as a vibration sensor has many disadvantages for the economical and efficient purpose it can be used. This device is very much compact when compared to a normal seismometer.

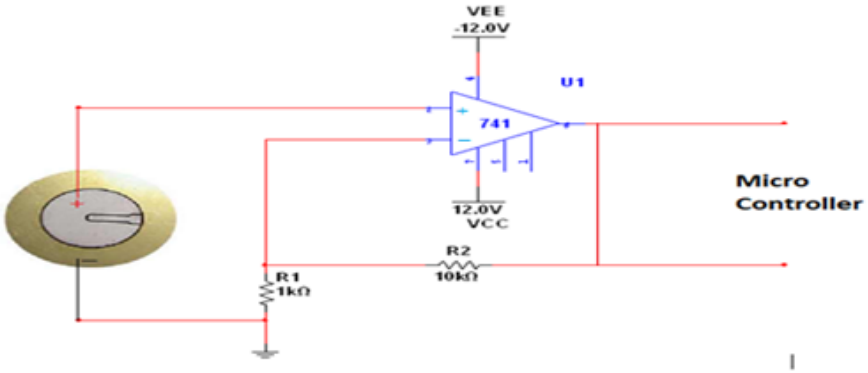
1.1 WORKING OF PIEZO MODULE

The mechanical stress (vibrational energy) applied to piezo crystal is directly proportional to the generated voltage, it is called a piezoelectric effect. Initially, the electric dipoles are at rest and are distributed randomly in the crystal so net polarisation is zero, this will maintain symmetry. When mechanical stress is applied to the piezoelectric crystal, the domains get disturbed which are at rest, and are aligned in particular direction, this causes distribution of charges in opposite phases of the crystal and it results in the generation of electricity, once the domains are disturbed they will not return to their original position and electricity produced by these crystal is an AC current and by using rectifiers we can convert it into DC current.

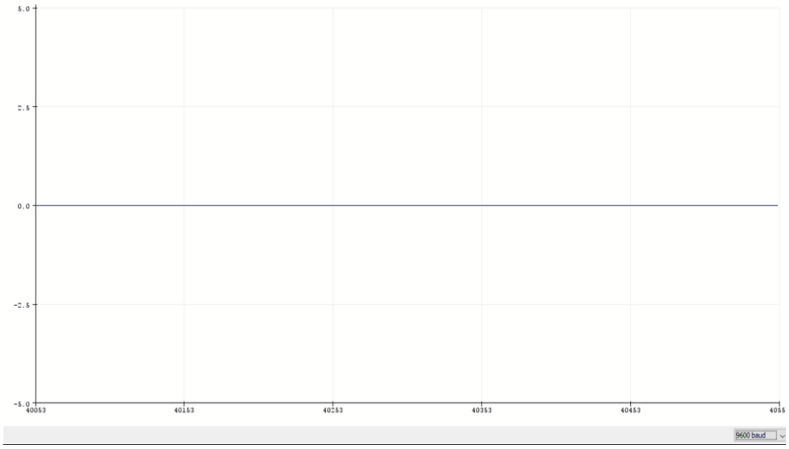
1.2 HOW THE PIZEO MODULE CAN BE USED AS A VIBRATION SENSOR ?

I. As we discussed the working of piezo before, we know that the amount of voltage generated by the piezo module is directly proportional to the amount of stress applied to it. Using this the main origin of an idea.
II. An operational amplifier circuit is used to amplify the voltage generated from the piezo module. Piezo module produces a very low voltage which may not be able to plot a graph hence amplifier circuit come into picture here.
III. Operational amplifier circuit has a capacity of amplifying millivolts and microvolts to volts. The amount of voltage generated form piezo will be in millivolts. when this voltage is passed through the operational amplifier circuit, it amplifies the voltages from millivolts to volts.
IV. Using this output voltage from amplifier circuit a digital graph and voltages can be recorded easily.
V. This can be achieved using the Arduino UNO board as a microcontroller to convert analog input to digital output.
VI. To record vibrations in other planets instead of seismometer, piezo can be used since it has very low weight than seismometer and it is very economical when weight is reduced.

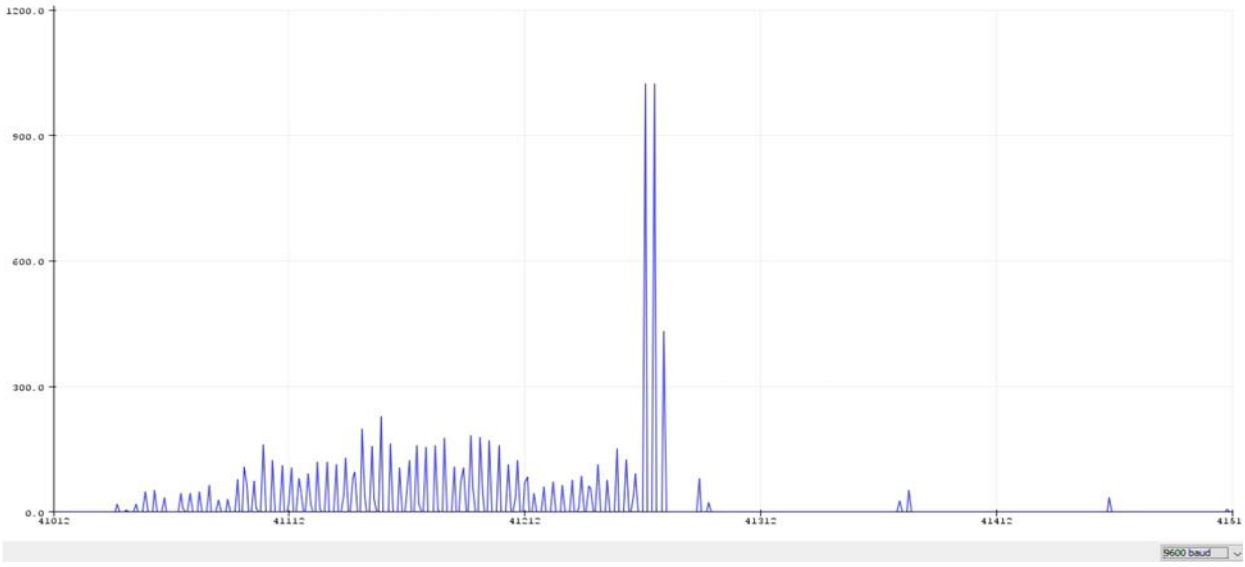
2. OPERATIONAL AMPLIFIER CIRCUIT USED



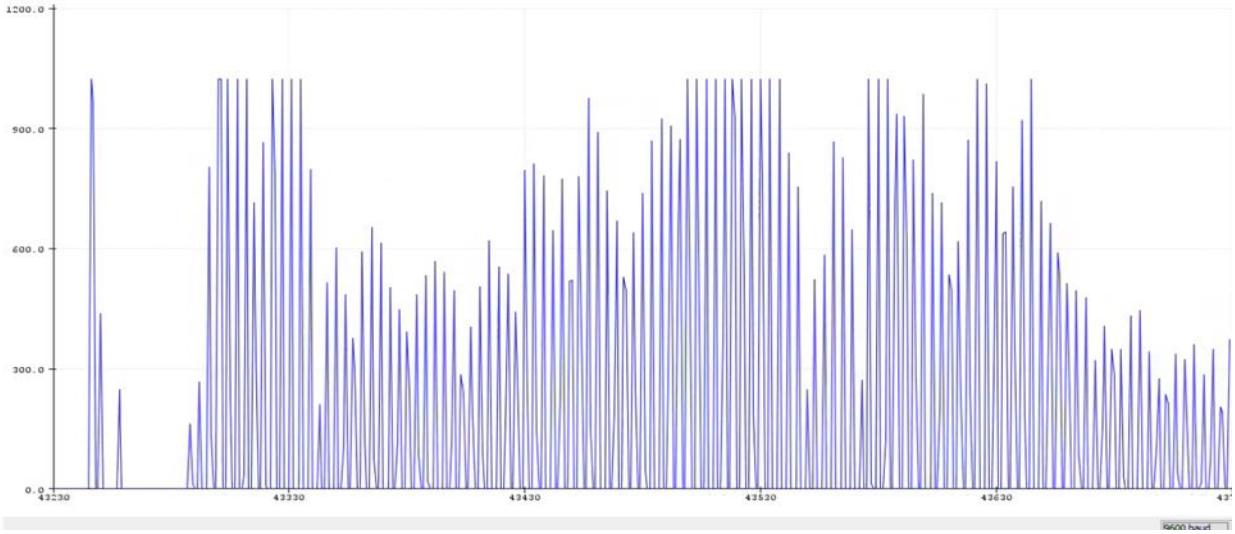
3. Observation during experiment



No vibrations recorded



Small vibration are recorded

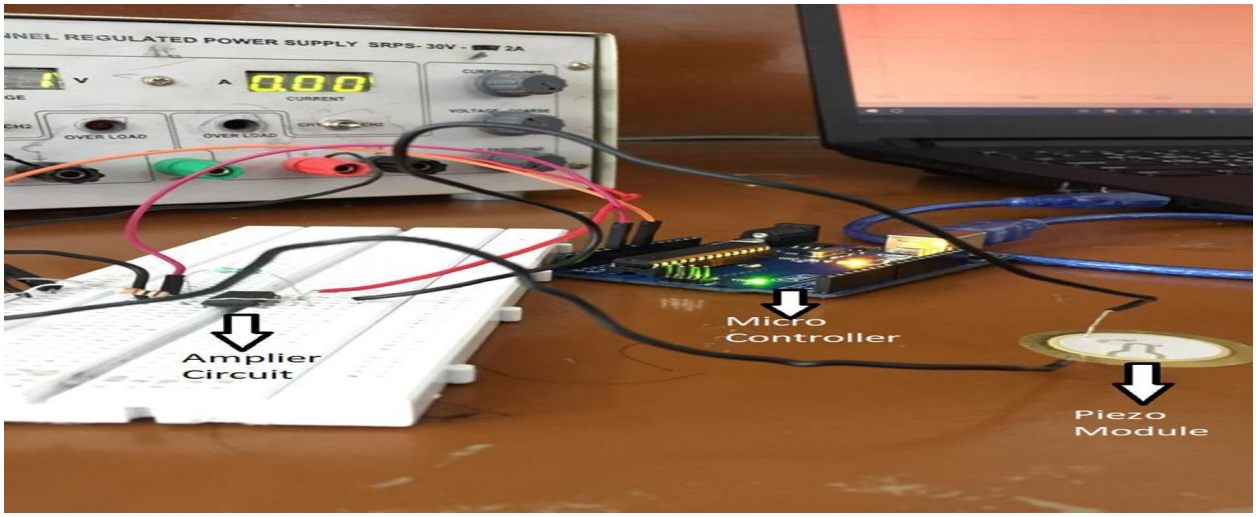


Large vibrations are recorded

4. Code Used to record vibration values through micro controller (Arduino UNO) Programming language – Java

```
int Pr = 0; // will be used for analog 0.
int PrValue = 0; // value of output
void setup()
{
Serial.begin(9600); //start serial Monitor
}
void loop()
{
PrValue = analogRead(Pr);
Serial.println(PrValue); //prints  value
delay(5); // value updated every perticular period of time.
}
```

5. Model representation



6. Advantages of piezo module as vibration sensor

- Compact physical device
- It has negligible phase shift
- Can be used for smaller apllications
- Simple and easy code to program micro controller
- Vibrations are not recorded which are caused by wind
- Good frequency response

7. Disadvantages of piezo module as vibration sensor

- High temperature sensitivity
- Some crystals get dissolved in high humid environment
- One single module can record vibrations from one directions only

8. Conclusion

Since the device is very compact in nature, for space research applications it can be used instead of sending heavy weight devices like seismometer. As the weight decreases its more economical in space research applications

9. References

- Introduction to Seismology by Peter M. Shearer text book
- Piezo electric ceramics principles and applications by APC text book