MINI PROJECT

ON

POWER GENERATION USING PIEZOELECTRIC

Session 2021-2022

PROJECT REPORT SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARDS OF B.TECH

IN

ELECTRONICS AND COMMUNICATION ENGINEERING

UNDER THE GUIDANCE OF:

Mr. Yogendra Pratap Pundir

(Department of ECE)

PREPARED BY :

Vaibhav Vajpai (19134502026)

Vishwajeet Kumar (19134502027)

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

HEMVATI NANDAN BAHUGUNA GARHWAL UNIVERSITY

(A Central University), Srinagar, Garhwal - 246174

PREFACE

We take the opportunity to present this report **“POWER GENERATION USING PIEZOELECTRIC"** . The object of this report is to make a Bi-directional visitor counting for various visiting places with low cost. The report is supported by images to bring out the purpose and message. We have made sincere attempts and taken every care to present this report in precise and compact form, the language being as simple as possible. The task of completion of the project though being difficult was made quite simple, interesting, and successful due to deep involvement and complete dedication of our group members.

ACKNOWLEDGEMENT

We would like to acknowledge the contributions of those who assisted in the preparation of this report. We are particularly grateful for the work done by members of my group. Before we get into this report, we would like to thank the members of the group who are part of this report and have given their unending contribution from start to end of this report. We would like to express our deep regards and gratitude to Mr. Yogendra Pratap Pundir (Department of ECE). We would like to express our gratitude towards our parents for their kind cooperation and encouragement which helps us in completion of this project. Last but not the least, we want to extend our regards to all the teachers of the department of Electronics and Communication Engineering for providing a consolidated backup in this field. We are also very glad to thank all our classmates and friends who were always the patrons of encouragement to us and accompanied us in the successful completion of our thesis work**.**

DEPARTMENT OF ELECTRONICS AND COMMUNICATION

CERTIFICATE

This is to certify the Mini Project report entitled "**POWER GENERATOR USING PIEZOELECTRIC"** submitted by the following students in the partial fulfillment of the requirements for the award of the degree in Bachelor of Technology in Electronics and Communication Engineering from Hemwati Nandan Bahuguna Garhwal University (A Central University), Srinagar (UK) is a record of bonafide work carried out during academic year 2021-22.

VAIBHAV VAJPAI - 19134502026

VISHWAJEET KUMAR - 19134502027

Under supervision and guidance

INTERNAL GUIDE AND HEAD OF DEPARTMENT

MR. YOGENDRA PRATAP PUNDIR

(DEPARTMENT OF ECE)

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ABSTRACT

The piezoelectric effect is extensively encountered in nature and many synthetic materials. Piezoelectric materials are capable of transforming mechanical strain and vibration energy into electrical energy. This property allows opportunities for implementing renewable and sustainable energy through power harvesting and self-sustained smart sensing in buildings. As the most common construction material, plain cement paste lacks satisfactory piezoelectricity and is not efficient at harvesting the electrical energy from the ambient vibrations of a building system. In recent years, many techniques have been proposed and applied to improve the piezoelectric capacity of cement-based composite, namely admixture incorporation and physical. The successful application of piezoelectric materials for sustainable building development not only relies on understanding the mechanism of the piezoelectric properties of various building components, but also the latest developments and implementations in the building industry. Therefore, this review systematically illustrates research efforts to develop new construction materials with high piezoelectricity and energy storage capacity. In addition, this article discusses the latest techniques for utilizing the piezoelectric materials in energy harvesters, sensors and actuators for various building systems. With advanced methods for improving the cementation piezoelectricity and applying the material piezoelectricity for different building functions, more renewable and sustainable building systems are anticipated.

1.1 INTRODUCTION

Day by day, the population of the country increases and the requirement of power also increases. At the same time, the wastage of energy also increases in many ways. So reforming this energy back to usable form is a major concern. As technology is developed and the use of gadgets, electronic devices also increase. Power generation using conservative methods is becoming deficient. There is a need for a different power generation method. At the same time, the energy is wasted due to human locomotion. To overcome this problem, the energy wastage is converted to usable form using the piezoelectric sensor. This sensor converts the pressure on it to a voltage. By using this energy saving method, a foot step power generation system we are generating power. A piezoelectric sensor is a device that uses the piezoelectric effect to measure changes in pressure, acceleration, temperature, strain, or force by converting them to an electrical charge.
To design a system that generates voltage by the humane footsteps force. Using non-conventional sources and stores it for usage. The system will have piezoelectric sensors that will convert the measurements of acceleration, force and pressure into electrical signals. It will fully depend on the human footsteps' pressure and convert it into useful power.

"Renewable" assets of vitality, for example, Solar Cell Panel, Wind Energy can likewise be utilized to collect power. However these sources are constrained to a specific region for eg. We can say that SOLAR ENERGY can be utilized just at the spot where the sun's focus is entirely great and continuous. Wind Energy can fundamentally be utilized as a part of the seaside territory's the place the wind pace and accessibility is all the time present. Aside from all their human movements such as nonstop driving of the hand wrenches and little generators can be additionally used to deliver power however all these wonders of producing power requires a consistent human exertion and checking. In addition step by step because of expansion in the expense of the assets required to deliver power there is an awesome increment in the expense of electricity [2], due to this reason till today numerous weaker segment individuals of the general public can't get power and are not in any case ready to work even little apparatuses.
Recently, the electricity generation technology using piezoelectric material to recover the compressional or vibrational energy begins to draw attention. The principle is based on the positive piezoelectric effect of piezoelectric material: when piezoelectric material deforms under external force (pressure or stress), an inside polarization phenomenon occurs, and charges of different polarity accumulate on two opposite surfaces; when external force disappears, charges disappear accordingly. If intermittent external force is continuously exerted on piezoelectric material, the charges appearing on the surfaces are simultaneously collected by the charge collector and stored in energy storage equipment, and then the transition from mechanical energy to electric energy is realized. During this process, there is no emission, no electromagnetic conversion, no heat and no big mechanical vibration; therefore, piezoelectric power generation is a new type of green power generation without pollution, electromagnetic interference (EMI), thermal radiation and noise.In short, piezoelectric power generation has a wide range of

application prospects in the electricity generation area, and there are considerable social and economic benefits in the industrial chain from electrical equipment manufacture to electricity generation. The purpose of this paper is to present an overview of the feasibility of piezoelectric power generation system for electricity generation, in which the fundamentals of piezoelectric power generation and the feasible system structure are discussed. This paper serves as an important basis of the subsequent research.

1.2 PROJECT OBJECTIVES

- Generating power out of free energy.
- To spend less money on power generation.
- To encourage people to use different economical ways of generating power.

2.1 IMPLEMENTATION AND WORKING

The piezoelectric sensor designs were addressed with respect to the waste the generator produces. The intent is to minimize power consumption of this design. The power consumption level is an environmental concern because the more power the users. We will lower power parts by generating power from free source. The designs were considered in relation to common morals. The project is able to perform basic tasks that reinforce important EE concepts in footpaths, hospitals, factories etc. Our design was considered with respect to assembly in the lab environment. There are no additional health and safety risks involved with the advanced capabilities module.

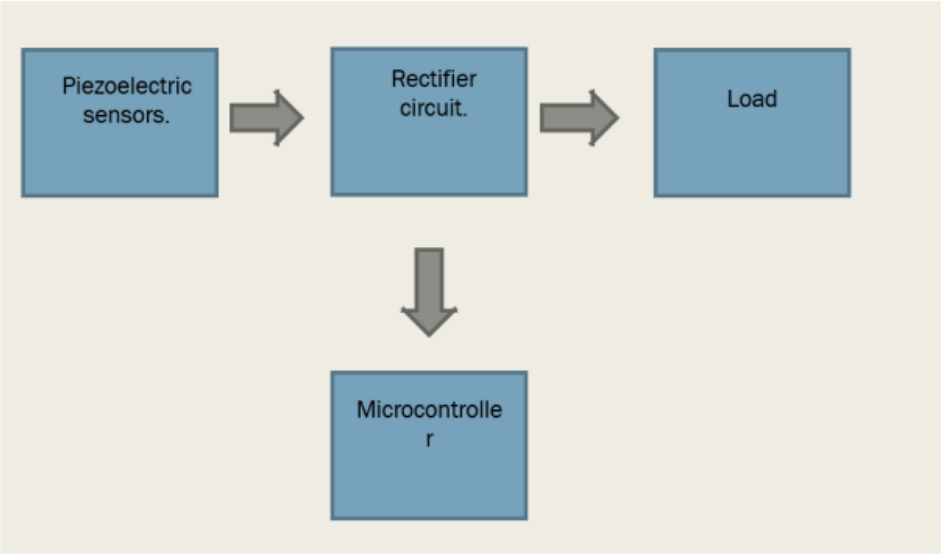


Fig 2.1 : Block Diagram of Power generator using Piezoelectric.

When we integrated our system we simply connected the output of the piezo sensors to a rectifier circuit to convert the voltage to DC and then we fed that voltage into the micro controller in order to display the number of steps and voltage generated across the capacitor. We set our target specifications based on the results of experimenting and research on previous projects. We implemented our design at PMU labs with the help of the lab assistant and our advisor Dr. Samir, as well as group meetings outside the university. We verified our system performance using digital multimeters and the oscilloscope. Piezoelectric sensors or transducers are connected in parallel just like in the image shown below, connection picture of our actual project, for maximum voltage generation. In this method of connection the output voltage from these piezo sensors are at maximum.

Now the output of these parallel connected piezoelectric sensors is Alternating current so in order to convert this alternating current into direct current we feed output of these piezoelectric sensors into a bridge rectifier, made up from diodes. Now this Direct current is pulsating DC, so to convert them into direct current with less AC factor in it we use a capacitor which works as a filter circuit. After this we drill 4 small holes on our sheet in which piezoelectric sensors are installed and in addition we use a new square plywood sheet which is used to apply pressure or stress in the piezoelectric sensors installed in the sheet.

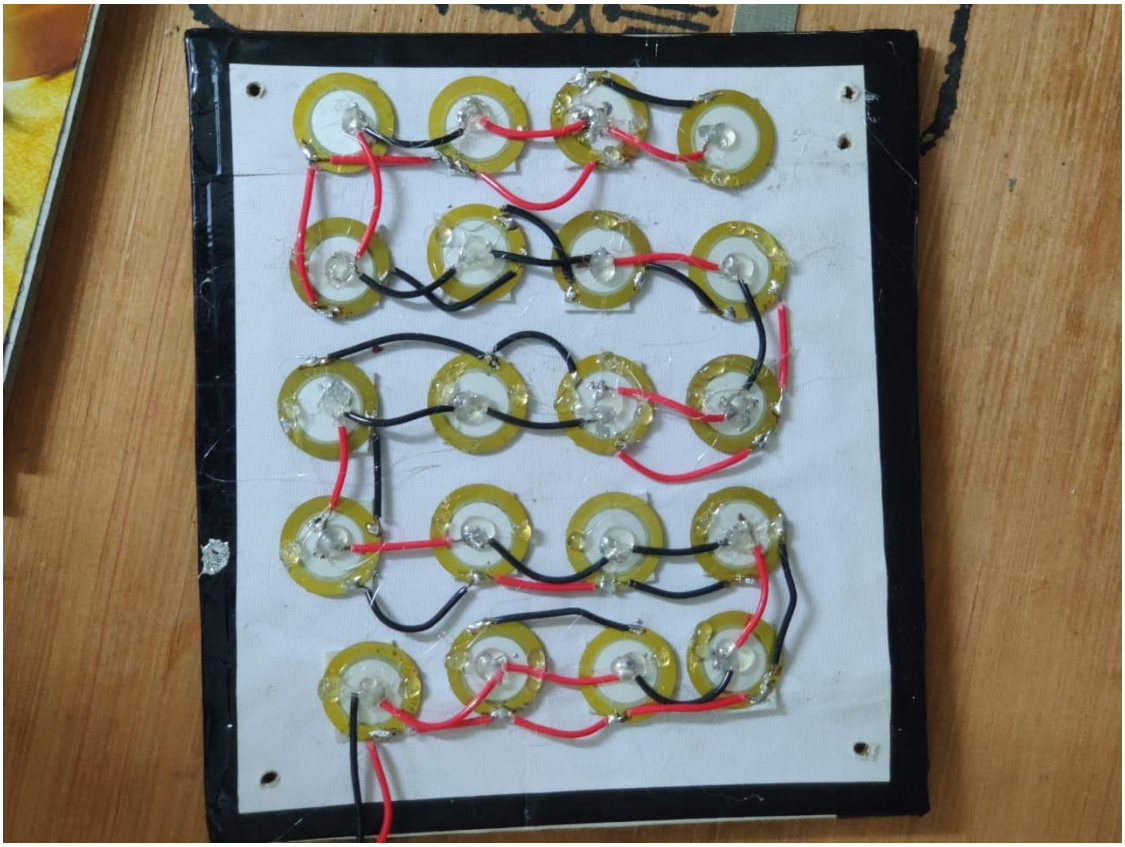


Fig 2.2 : Parallel connection for 20 piezoelectric sensors on cardboard sheet.

This is the picture of the final setup after installing the square plywood sheet above the piezoelectric sensors for providing mechanical stress on the piezoelectric sensors for power generation. After this the output voltage from the rectifier and filter circuit is then fed into the Arduino ESP 8266 board in analog pins present there in the Arduino ESP 8266 board. This microcontroller board has also a LCD display connected to it which is used to display the voltage on the screen.

Fig 2.3 : Final mechanical setup for our Power generator using Piezoelectric.

The output from the piezoelectric sensor received is in the form of Alternating current. This alternating current generated from a piezoelectric sensor is converted into direct current so that it can be stored in a battery or cell. Bridge rectifier is used to convert alternating current produced by piezoelectric sensor to direct current. In addition to bridge rectifier we use filter circuit made up of capacitor to filter pulsating direct current.

A **diode bridge** is a bridge rectifier circuit of four diodes that is used in the process of converting alternating current (AC) from the input terminals to the direct current (DC, i.e. fixed polarity) on the output terminals. Its function is to convert the negative-going AC pulses into positive going pulses, after which a low-pass filter can be used to smooth the result into DC.When used in its most common application, for conversion of an alternating-current (AC) input into a direct-current (DC) output, it is known as a **bridge rectifier**. A bridge rectifier provides full-wave rectification from a two-wire AC input, resulting in lower cost and weight as compared to a rectifier with a three-wire input from a transformer with a center-tapped secondary winding.The essential feature of a diode bridge is that the polarity of the output is the same regardless of the polarity at the input. The diode bridge circuit was invented by Polish electrotechnician Karol Pollak and patented in December 1895 in Great Britain and in January 1896 in Germany. In 1897, the German physicist Leo Graetz independently invented and published a similar circuit. Today the circuit is sometimes referred to as a Graetz circuit or Graetz bridge.

According to the conventional model of current flow (originally established by Benjamin Franklin and still followed by most engineers today), current flows through electrical conductors from the *positive* to the *negative* pole (defined as "positive flow"). In actuality, free electrons in a conductor nearly always flow from the *negative* to the *positive* pole. In the vast majority of applications, however, the *actual* direction of current flow is irrelevant. Therefore, in the discussion below the conventional model is retained.The fundamental characteristic of a diode is that current can flow only one way through it, which is defined as the forward direction. A diode bridge uses diodes as series components to allow current to pass in the forward direction during the positive part of the AC cycle and as shunt components to redirect current flowing in the reverse direction during the negative part of the AC cycle to the opposite rails

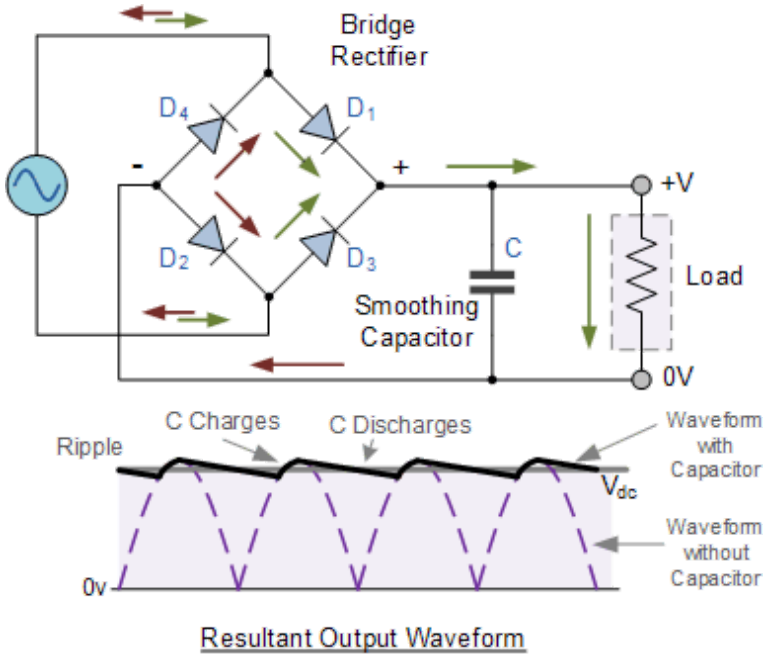


Fig 2.4 : Schematic diagram of Bridge rectifier and Filter circuit.

This is 2nd stage of our project which includes Bridge rectifier using 1N4007 diodes and filter circuit using 100 microfarad and 25 Volt capacitor, this also include Arduino ESP 8266 which is a microcontroller or brain of our project, and a 16x2 LCD Display. ESP8266 is a low-cost WiFi module that belongs to ESP's family which you can use to control your electronics projects anywhere in the world. It has an in-built microcontroller and a 1MB flash allowing it to connect to WiFi. The TCP/IP protocol stack allows the module to communicate with WiFi signals.

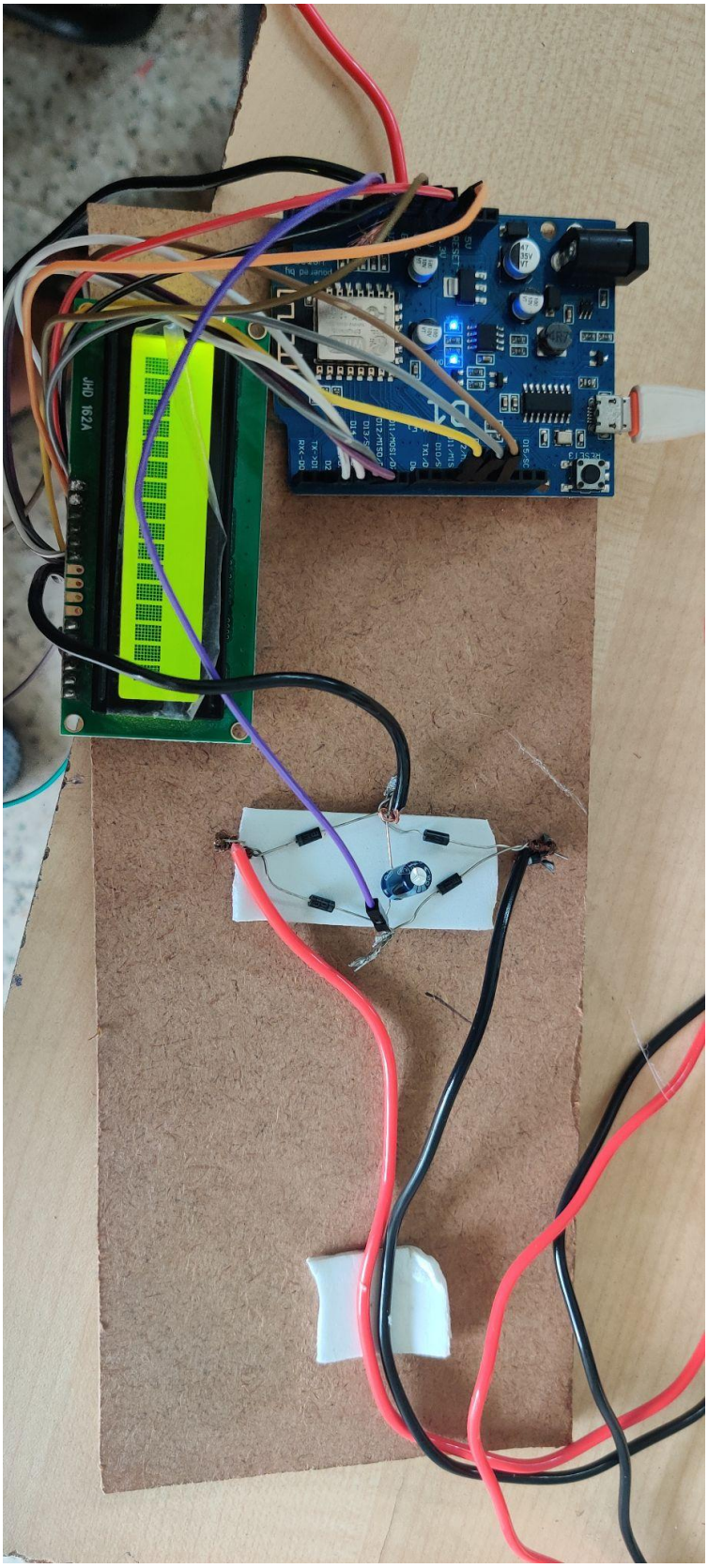


Fig 2.5: Final control unit of Power generator using Piezoelectric.

2.2 COMPONENTS USED

In this project several electronics components have been used and their detailed functioning is as follows.

1) **PIEZOELECTRIC SENSORS :** A piezoelectric sensor is a device that uses the piezoelectric effect to measure changes in pressure, acceleration, temperature, strain, or force by converting them to an electrical charge. The prefix *piezo-* is Greek for 'press' or 'squeeze. Piezoelectric sensors are versatile tools for the measurement of various processes. They are used for quality assurance, process control, and for research and development in many industries. Pierre Curie discovered the piezoelectric effect in 1880, but only in the 1950s did manufacturers begin to use the piezoelectric effect in industrial sensing applications. Since then, this measuring principle has been increasingly used, and has become a mature technology with excellent inherent reliability. Three main groups of materials are used for piezoelectric sensors: piezoelectric ceramics, single crystal materials and thin film piezoelectric materials. The ceramic materials (such as PZT ceramic) have a piezoelectric constant/sensitivity that is roughly two orders of magnitude higher than those of the natural single crystal materials and can be produced by inexpensive sintering processes. The piezo effect in piezoceramics is "trained", so their high sensitivity degrades over time. This degradation is highly correlated with increased temperature.The less-sensitive, natural, single-crystal materials (gallium phosphate, quartz, tourmaline) have a higher – when carefully handled, almost unlimited – long term stability. There are also new single-crystal materials commercially available such as Lead Magnesium Niobate-Lead Titanate (PMN-PT). These materials offer improved sensitivity over PZT but have a lower maximum operating temperature and are currently more complicated to manufacture due to four compounds. three compound material PZT.

Fig 2.6: Piezoelectric Sensors.

2) **DIODE :** In this project we have used 1N4007 which is a standard diode used for small applications, 1N4007 is a rectifier diode, designed specifically for circuits that need to convert alternating current to direct current. It can pass currents of up to 1 A, and have peak inverse voltage (PIV) rating of 1,000 V. Note: This product has a minimum quantity restriction (20 nos) for order. They have been used to design bridge rectifiers.

Fig 2.7 1N4007 Diode

3) **CAPACITOR :** In our project we have used 100 microfarad and 25 Volt capacitors and they are used to design filter circuits from the bridge rectifier. They are the most widely used capacitor type out there and can be used in a wide range of applications like filter circuits, ripple smoothing, Resonant circuits, Isolation and noise removal.

Fig 2.8: 25 Volt and 100 microfarad capacitor

4) **ARDUINO ESP 8266 :** In our project we have used an Arduino Uno microcontroller as a control unit. ESP8266 is a low-cost WiFi module that belongs to ESP's family which you can use to control your electronics projects anywhere in the world. It has an in-built microcontroller and a 1MB flash allowing it to connect to WiFi. The TCP/IP protocol stack allows the module to communicate with WiFi signals. The maximum working voltage of the module is 3.3v so you cant supply 5v as it will fry the module.

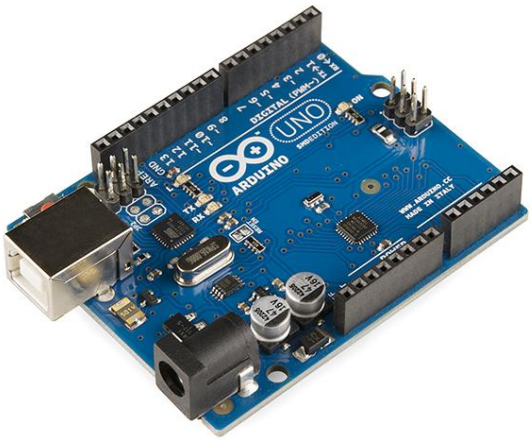


Fig 2.8 : Arduino ESP 8266.

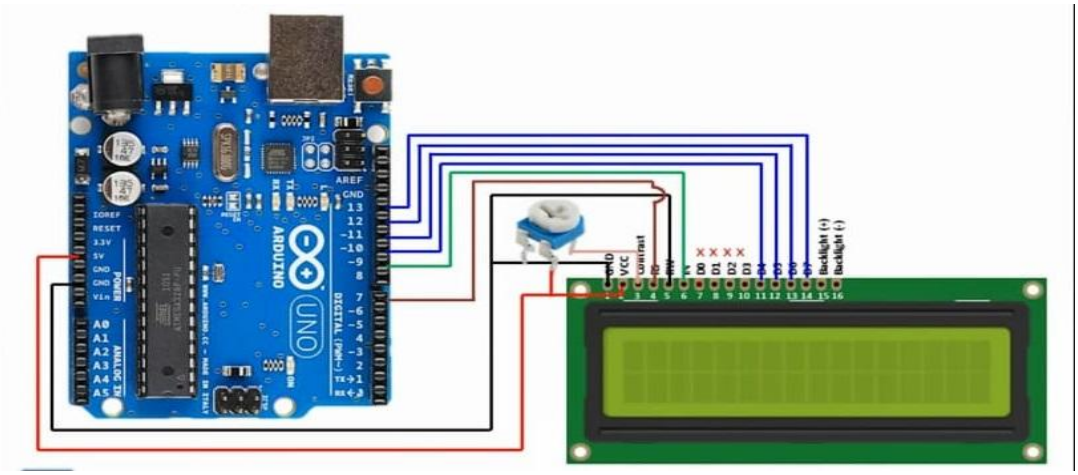
5) **LCD DISPLAY :** In our project we have used LCD Display to display measured output voltage from the piezoelectric sensors.LCD (Liquid Crystal Display) is a type of flat panel display which uses liquid crystals in its primary form of operation. LEDs have a large and varying set of use cases for consumers and businesses, as they can be commonly found in smartphones, televisions, computer monitors and instrument panels.

Fig 2.9 16x2 LCD Display

6) **JUMPING WIRES :** A jump wire (also known as jumper, jumper wire, DuPont wire) is an electrical wire, or group of them in a cable, with a connector or pin at each end (or sometimes without them – simply "tinned"), which is normally used to interconnect the components of a breadboard or other prototype or test circuit, internally or with other equipment or components, without soldering. Individual jump wires are fitted by inserting their "end connectors" into the slots provided in a breadboard, the header connector of a circuit board, or a piece of test equipment.

Fig 2.10 : Jumper Wires

2.3 CONNECTION OF ARDUINO TO LCD DISPLAY



The LCDs have a parallel interface, meaning that the microcontroller has to manipulate several interface pins at once to control the display. The interface consists of the following pins:

A register select (RS) pin that controls where in the LCD's memory you're writing data to. You can select either the data register, which holds what goes on the screen, or an instruction register, which is where the LCD's controller looks for instructions on what to do next. A Read/Write (R/W) pin that selects reading mode or writing mode. An Enable pin that enables writing to the

registers . 8 data pins (D0 -D7). The states of these pins (high or low) are the bits that you're writing to a register when you write, or the values you're reading when you read. There's also a display contrast pin (Vo), power supply pins (+5V and GND) and LED Backlight pins that you can use to power the LCD, control the display contrast, and turn on and off the LED backlight, respectively. The process of controlling the display involves putting the data that form the image of what you want to display into the data registers, then putting instructions in the instruction register. The LiquidCrystal Library simplifies this for you so you don't need to know the low-level instructions. The Hitachi-compatible LCDs can be controlled in two modes: 4-bit or 8-bit. The 4-bit mode requires seven I/O pins from the Arduino, while the 8-bit mode requires 11 pins. For displaying text on the screen, you can do most everything in 4-bit mode, so an example shows how to control a 16x2 LCD in 4-bit mode.

3.1 APPLICATIONS OF PIEZOELECTRICITY

Cell phones, diesel fuel injectors, grill igniters, ultrasonic transducers, acoustic guitar pickups, vibration sensors, certain printers, and musical greeting cards etc. utilizes piezoelectricity. The applications of piezoelectricity includes the following fields:

- In Japan's train stations the concept of "crowd farm" was tested where the footsteps of the pedestrians' on the piezoelectric tiles embedded on the road can generate electricity.
- In 2008 a nightclub in London built the first eco-friendly floor made up of piezoelectric material that can generate electricity to power up light bulbs when people dance on it.
- Piezoelectric effect finds useful application as mechanical frequency filters, surface acoustic wave devices, bulk acoustic wave devices, etc…
- Sound and ultrasound microphones and speakers, ultrasonic imaging, hydrophones.
- Piezoelectric pickups for guitars, biosensors to power up pacemakers.
- Piezoelectric elements are also used in the detection and generation of sonar waves, single-axis and dual-axis tilt sensing.

3.2 LIMITATIONS OF PIEZOELECTRICITY

- The output obtained from the piezoelectric transducers is low, so external electronic circuits have to be connected.
- The piezoelectric transducer is used for dynamic measurement only.
- It has high temperature sensitivity.
- While working with vibrations these devices are prone to pick up unwanted vibrations also.
- Resistance and Durability apply limits to devices when used to tap energy from pavements and roads.
- Less known details of these devices and the amount of research done till date is not sufficient to exploit full usage of these devices.

CONCLUSION

In conclusion, it has been a long and interesting journey for us all. From the start when we picked the topic up to this moment writing the final report. We have had good and bad times putting this project together as we did not get to the goal we had set. On the other hand, we have gained a lot of knowledge with this project. When we first saw the previous project that was done at PMU, we set the goal to go for something different and better. As we have explained every aspect about the project in this report, we have partially failed in the last step which is to have enough power to charge a phone, but we have enough knowledge and experience for others who would like to work on such a project. As well as the knowledge that we have gained for us using this type of sensor which we worked with for the first time. Not only the sensors but so many components we have worked with for the first time such as ultra-capacitors and power transistors. The current researches related to piezoelectric power generation mainly concentrate in the fields of material science, mechanical science and microelectronic science, and certain limited and special application areas, e.g. self-powered wireless sensor network, piezoelectric road signs, piezoelectric power generation shoes, passive safety-belt detecting device and piezoelectric micro-electro-mechanical (MEM) system. This paper actually presents a prospect of the possible application of piezoelectric power generation in the electricity production field. Except for the important topics discussed in this paper, as the subsequent research starts, there will generate many other interesting problems worthy of researching.

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CODE

```
#include "LiquidCrystal.h"

LiquidCrystal lcd(rs, en, d4, d5, d6, d7);

float input_voltage = 0.0;
float temp=0.0;


void setup()
{
  Serial.begin(9600);     //  opens serial port, sets data rate to 9600 bps
  lcd.begin(16, 2);       //// set up the LCD's number of columns and rows:
  lcd.print("DIGITAL VOLTMETER");
}
void loop()
{

//Conversion formula for voltage

  int analog_value = analogRead(A0);
  input_voltage = (analog_value * 5.0) / 1024.0;


  if (input_voltage < 0.1)
  {
    input_voltage=0.0;
  }
   Serial.print("v= ");
   Serial.println(input_voltage);
   lcd.setCursor(0, 1);
   lcd.print("Voltage= ");
   lcd.print(input_voltage);
   delay(300);
}
```