GOVERNMENT COLLEGE OF ENGINEERING, AURANGABAD.

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GECA Government College of Engineering, Aurangabad

शासकीय अभियांत्रिकी महाविद्यालय, औरंगाबाद

In pursuit of Technical Excellence

महाराष्ट्र शासन

A PROJECT REPORT ON

' POWER GENERATION THROUGH FOOT STEPS '

For the course

Eskill Workshop

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1. INTRODUCTION

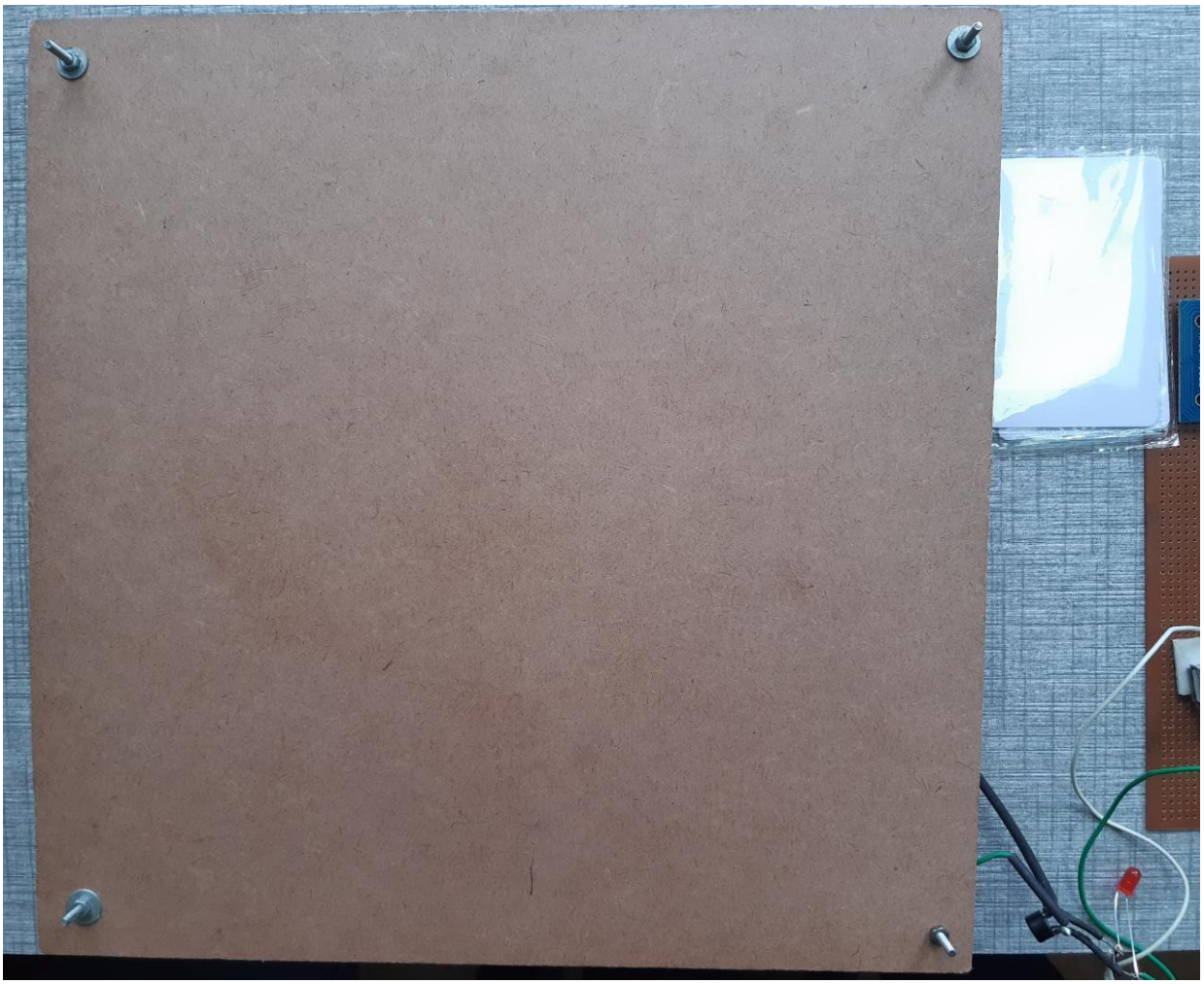
Day by day, the population of the country is increasing and the requirement of the power is also increasing. At the same time the wastage of energy is also increasing in many ways. So, reforming this energy back to usable form is the major solution. In this footstep power generation project, we are generating power with the help of human's footsteps; this power is then used to charge battery. The power is stored in a battery that can be used to charge a mobile phone using RFID card. This system is powered by Atmega 328 microcontroller, it consists of Arduino IDE, RFID sensor, USB cable and LCD. When we power on the system, the system enters into registration mode. We can register three users. Once all the user is entered in the system then the system asks to swipe the card and connect the charger. Initially all the user is given 5 minutes of charging time as default. When we swipe the card and if the user is authorised, the system turns on for charging and will charge the Mobile phone. If the user is un-authorised then the system will display as unauthorised user, just in case if the user wants to stop the charging in midway the user needs to swipe the card again. As soon as the card is swiped again, the remaining time balance is displayed and the charging stops. In order to recharge a card, we need to press recharge button which is on the system, and then system will ask to swipe the card, once the user swipes the card, it adds more 5 minutes to the particular card of the user.

In this study, lead zirconate titante (PZT) piezoelectric transducer has been used to harvest the kinetic energy from the footstep. The output voltage of this piezoelectric transducer is dependent to the structure of the ceramic and magnitude of strain and stress that applies on its structure. This transducer has diameter of 5 cm crystalline structure. The common output voltage is around 0-12 V. However at instant impact on this transducer, it can achieve until 30 V while the output current is about 5 mA. There are two shape of PZT piezoelectric transducer that been considering in this study which are the circular shape and the square shape. The circular shape of piezoelectric transducer is more suitable to accept the stress or strain at the middle of the transducer meanwhile, the square shape of piezoelectric produce high output voltage when the strain or stress applied on the tip of the transducer.

This circular shape piezoelectric transducer has been choose because it is most suitable transducer for footstep rather than square piezoelectric transducer. The circular shape of piezoelectric give higher output voltage when testing on oscilloscope. This is due to the deflection on its structure when foot press is applied on it. The piezoelectric transducer is connected in series-parallel connection where the value of voltage as well as current output are both satisfactory. The output of the piezoelectric is in AC form. Before being stored in storage components such as battery or capacitor, it needs to be rectified into DC form then, supply it to the DC loads. In this study, the full wave bridge rectifier was used to rectify the output from the piezoelectric tile. The full wave bridge that is used in the study consist of four diodes and two capacitors as shown in Figure 1. One of the capacitors acts as smoothing capacitor to filter the output waveform and another one as a storage component to store the energy.

This full wave bridge rectifier operation is divided into two-cycle which are positive half-cycle and negative half-cycle. The four diodes labelled D1 to D4 are arranged in “series pairs” with only two diodes conducting current during each half cycle. During the positive half cycle of the supply, diodes D1 and D2 conduct in series while diodes D3 and D4 are in OFF condition as they are now in

reserve biased and the current flows through the two capacitors. During the negative half cycle of the supply, diodes D3 and D4 conduct in series as they are in forward biased, but diodes D1 and D2 are in reverse biased. The current flowing through the capacitors is the same direction as before. One of the capacitor acts as smoothing filter and another one acts as storage element. Both of them are connected in parallel. The voltage in the AC form is being rectified in the DC form in full brigde rectifier circuit, then it goes to the smoothing capacitor to remove any ripple factor that still left in the DC voltage form after the rectifier process. Lastly, the output from the piezoelectric tile is stored in the storage capacitor and ready to be used by another low power devices.



The experiment setup of the piezoelectric

RESULTS AND ANALYSIS

The piezoelectric transducer output is in AC waveform. The output of the transducer needs to be rectify and filtered before being used to the storage or to the DC loads. Figure 3 shows the output of the piezoelectric transducer before being inserted to the full bridge rectifier.

2. PROBLEM STATEMENT:

Electrical energy is important and had been demand increasingly. A lot of energy resources have been wasted and exhausted. An alternative way to generate electricity by using a population of human had been discovered When walking, the vibration that generates between the surface and the footstep is wasted. By utilizing this wasted energy, the electrical energy can be generated and fulfill the demand.

4. HARDWARE AND SOFTWARE REQUIREMENTS:

List of Components

- RFID RC522
- Relay Module
- RFID Tags
- UNO Arduino
- Lithium Ion Battery 3.7 V
- Piezoelectric Material
- LED
- Buzzer
- Mini Power bank circuit
- LCD Display

Hardware Description:

RFID RC522

The RC522 RFID Reader module is designed to create a 13.56MHz electromagnetic field that it uses to communicate with the RFID tags (ISO 14443A standard tags). The reader can communicate with a microcontroller over a 4-pin Serial Peripheral Interface (SPI) with a maximum data rate of 10Mbps. It also supports communication over I2C and UART protocols.

UNO ARDUINO

Arduino UNO is a low-cost, flexible, and easy-to-use programmable open-source microcontroller board that can be integrated into a variety of electronic projects. This board can be interfaced with other Arduino boards, Arduino shields, Raspberry Pi boards and can control relays, LEDs, servos, and motors as an output.
Arduino UNO features AVR microcontroller Atmega328, 6 analogue input pins, and 14 digital I/O pins out of which 6 are used as PWM output.

RELAY MODULE

The relay module is a separate hardware device used for remote device switching. With it you can remotely control devices over a network or the Internet. Devices can be remotely powered on or off with commands coming from ClockWatch Enterprise delivered over a local or wide area network. You can control computers, peripherals or other powered devices from across the office or across the world.
The Relay module can be used to sense external On/Off conditions and to control a variety of external devices. The PC interface connection is made through the serial port.

The Relay module houses two SPDT relays and one wide voltage range, optically isolated input. These are brought out to screw-type terminal blocks for easy field wiring. Individual LED's on the front panel monitor the input and two relay lines. The module is powered with an AC adapter.

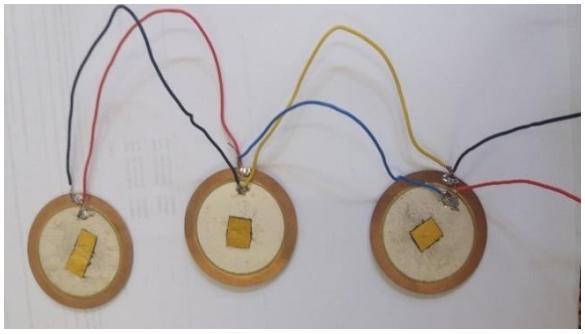
LITHIUM ION BATTERY

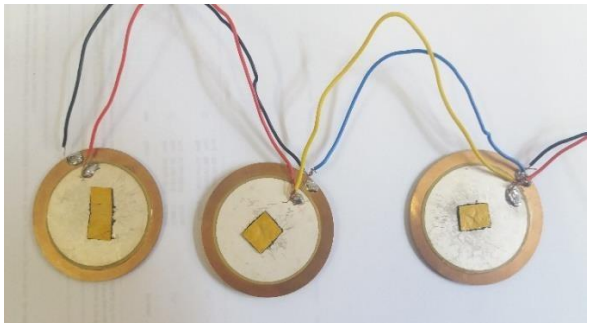
A lithium-ion battery or Li-ion battery is a type of rechargeable battery composed of cells in which lithium ions move from the negative electrode through an electrolyte to the positive electrode

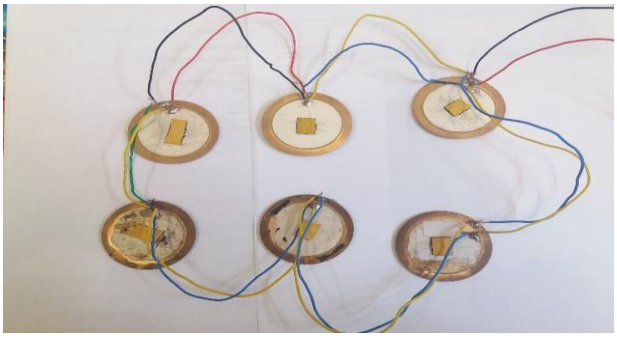
during discharge and back when charging. Li-ion cells use an intercalated lithium compound as the material at the positive electrode and typically graphite at the negative electrode. Li-ion batteries have a high energy density, no memory effect (other than LFP cells) and low self-discharge. Cells can be manufactured to prioritize either energy or power density. They can however be a safety hazard since they contain flammable electrolytes and if damaged or incorrectly charged can lead to explosions and fires.

PIEZOELECTRIC MATERIAL

The piezoelectric transducer was connected in series and parallel connection. Before using the piezoelectric transducer to generate electric energy, the connection needs to be determined to choose the better output from the piezoelectric transducer. Figure 4 shows three piezoelectric transducers were connected in series. Figure 5 shows, three piezoelectric transducers are connected in parallel connection. Two sets of three piezoelectrics that connected in series were attached in parallel for series-parallel connection as shown in Figure 6. The multimeter was connected to the piezoelectric transducers to measure the voltage and current across the connection. A double-sided tape 3mm is placed on the top and the bottom of the piezoelectric transducer to maximize the output of this transducer. Figure 7 and Figure 8 shows the output of the piezoelectric based on the connection that being done.







Software Description:

Arduino IDE

The open-source Arduino Software (IDE) makes it easy to write code and upload it to the board. This software can be used with any Arduino board.

SOURCE CODE

Active development of the Arduino software is hosted by GitHub. See the instructions for building the code. Latest release source code archives are available here. The archives are PGP-signed so they can be verified using this gpg key.

5. CODE

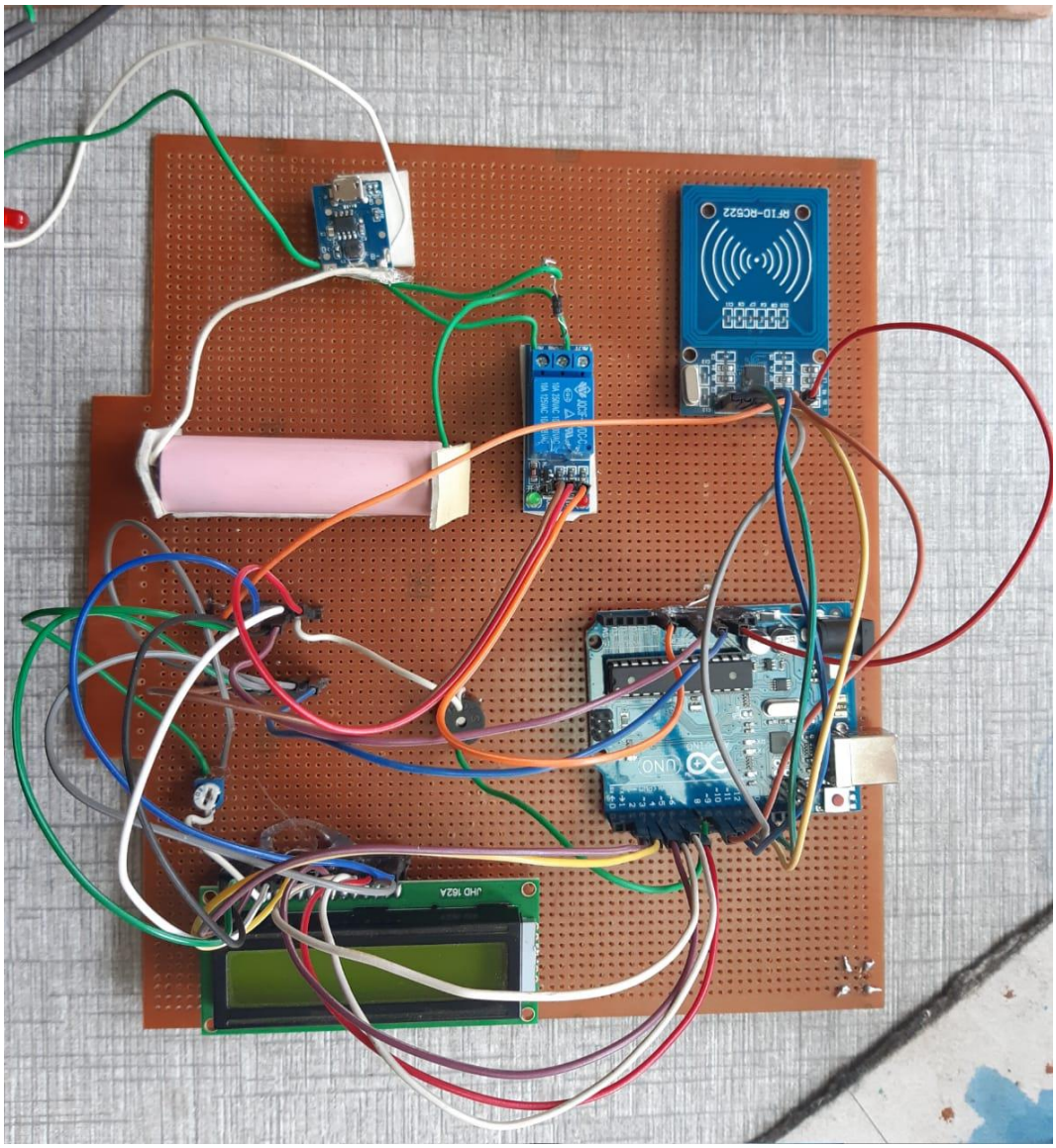
```
#include <SPI.h>
#include <MFRC522.h>
#include <LiquidCrystal.h>

#define SS_PIN 10
#define RST_PIN 9
MFRC522 mfrc522(SS_PIN, RST_PIN);   // Create MFRC522 instance.

#define beep_pin 8
#define rly_pin A0

LiquidCrystal lcd(2, 3, 4, 5, 6, 7);

void setup()
{
  Serial.begin(9600);   // Initiate a serial communication

  pinMode(beep_pin,OUTPUT);
  digitalWrite(beep_pin,LOW);
   pinMode(rly_pin,OUTPUT);
  digitalWrite(rly_pin,LOW);

  lcd.begin(16, 2);
  lcd.setCursor(3, 1);
  lcd.print("Welcome!!");
  lcd.setCursor(0, 0);
  lcd.print("Circuit is Ready");
  delay(1500);
  lcd.clear();
```

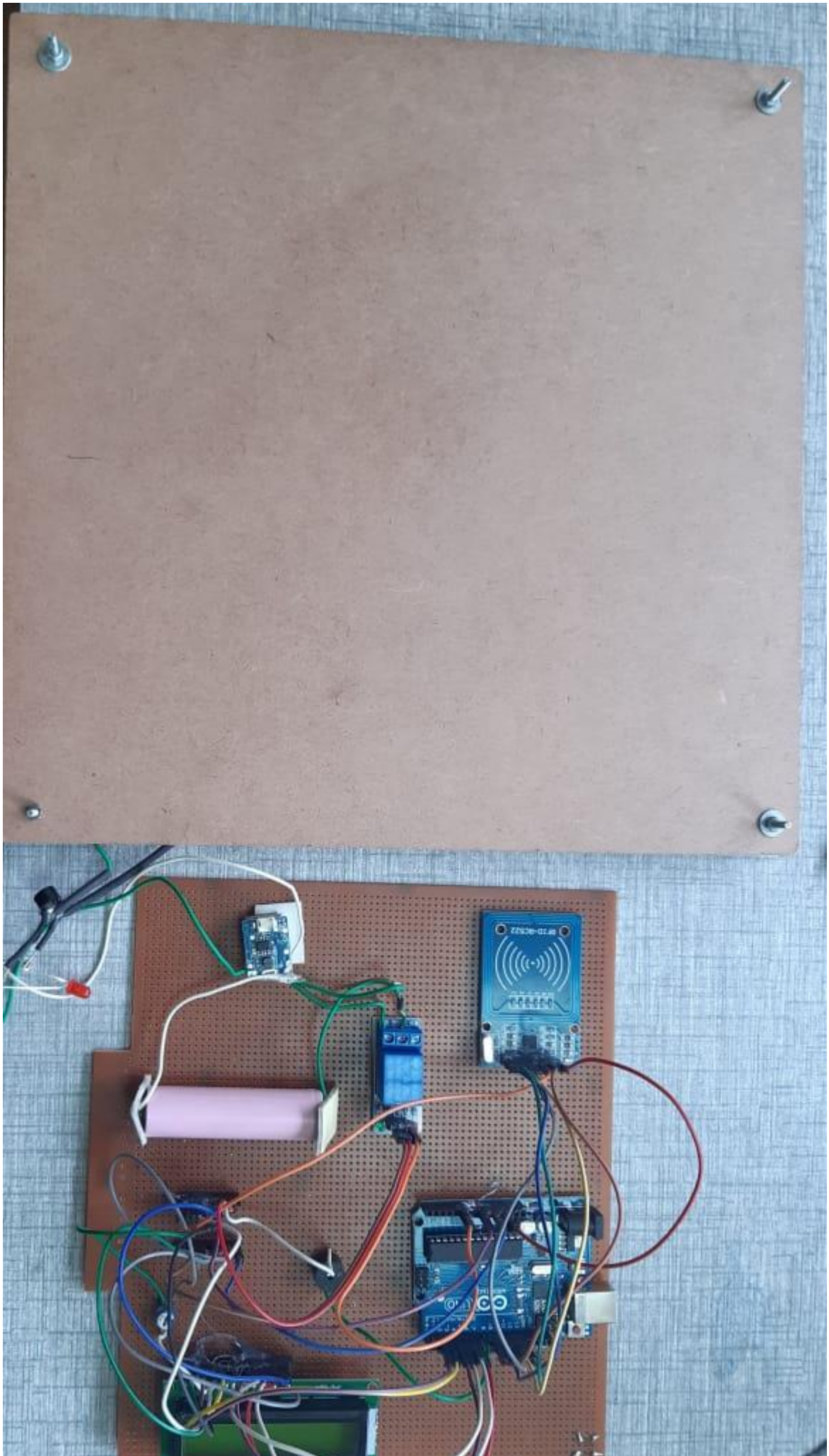
```
  SPI.begin();      // Initiate  SPI bus
  mfrc522.PCD_Init();   // Initiate MFRC522
  Serial.println("Put your card to the reader...");
  Serial.println();

}
void loop()
{
  digitalWrite(beep_pin, LOW);
  digitalWrite(rly_pin, LOW);
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("Put your card to");
  lcd.setCursor(0, 1);
  lcd.print("the reader......");
  delay(300);

  // Look for new cards
  if ( ! mfrc522.PICC_IsNewCardPresent())
  {
    return;
  }
  // Select one of the cards
  if ( ! mfrc522.PICC_ReadCardSerial())
  {
    return;
  }
  //Show UID on serial monitor
  Serial.print("UID tag :");
  String content= "";
  byte letter;
  for (byte i = 0; i < mfrc522.uid.size; i++)
  {
```

```
    Serial.print(mfrc522.uid.uidByte[i] < 0x10 ? " 0" : " ");
    Serial.print(mfrc522.uid.uidByte[i], HEX);
    content.concat(String(mfrc522.uid.uidByte[i] < 0x10 ? " 0" : " "));
    content.concat(String(mfrc522.uid.uidByte[i], HEX));
  }
  Serial.println();
  Serial.print("Message : ");
  content.toUpperCase();



  if (content.substring(1) == "D0 1D 44 25" || content.substring(1) ==
"D0 29 30 25")//change here the UID of the card/cards that you want
to give access
  {
    digitalWrite(beep_pin,HIGH);
    delay(200);
    digitalWrite(rly_pin,HIGH);
    delay(10000);
    digitalWrite(beep_pin,LOW);
    digitalWrite(rly_pin,LOW);
    delay(100);
    lcd.setCursor(0, 0);
    lcd.print("ID : ");
    lcd.print(content.substring(1));
    lcd.setCursor(0, 1);
    lcd.print("Authorized access");
    Serial.println("Authorized access");
    delay(1200);
  }

 else   {
    digitalWrite(beep_pin,HIGH);
```

```
    lcd.setCursor(0, 0);
    lcd.print("ID : ");
    lcd.print(content.substring(1));
    lcd.setCursor(0, 1);
    lcd.print("Access denied");
    Serial.println(" Access denied");
    delay(1500);
     }
}
```

5. SYSTEM DESIGN





6. WORKING

This project is to develop a new source of renewable energy with low-cost budget with the help of Arduino Uno as the microcontroller. The footstep power generation system is to capture the typically wasted energy surrounding a system and transforming it into electrical energy. The technique used in gaining the energy is via piezoelectric materials. This method employs piezoelectric components where deformations created by dissimilar means are directly transformed into electrical charge through piezoelectric effect. Afterwards, the electrical energy can be regulated or stored for further use. In this project, we are generating electrical power as a non-conventional method by simply walking or running as the input source. The piezoelectric sensor will then send the signal into the Arduino Uno and transform it into electrical energy. The LCD will then displayed the amount of voltage generated by the circuit. Then, the voltage stored in the battery can be used to charge the mobile phone. The results shown that this footstep generation system is very important for utilization in today's world.

The piezoelectric tile that show on the Figure 9 is used for foot press or pumping activites in order to collect the voltage. The 6 cell of piezoelectric transducers is placed between the upper and lower of this piezoelectric tile. This piezoelectric tile is design in a square shape with wood block. This tile are screw at its four edge and combine with the spring to make the upper tile bounce back after the person step on it. The piezoelectric transducer is placed between the gaps of the two tiles.The subjects are asked to do the foot press or pumping activities on this piezoelectric tile to collect the voltage produced by the 6 cell piezoelectric transducers during that activities. Figure 10 show the model of the piezoelectric tile from front, side and inside view.

7. CONCLUSION

A piezoelectric tile is capable of generating more voltage when longer the time taken. The longer the time taken means more footstep/force are applied on the tile. The linear relation is found between the voltage generated and the time

taken. This piezoelectric are specifically suitable for the implementation in the crowded area such as pavement street, train ticket counter, stairs and dance floor. The piezoelectric tile is also suited for the exercise tile such as for skipping or on the treadmill. The power that is generated from this piezoelectric tile can be used to power up the light street, light along the stairs and also low power appliances and also to charge mobile.

8. ACKNOWLEDGEMENT

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'POWERGENERATION THROUGH FOOT STEPS '
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Finally, as one of the team members, I would like to appreciate all my group members for their support and coordination, I hope we will achieve more in our future endeavours.

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