**MINI PROJECT REPORT**

**Microcontrollers Lab (ICE 2242)**

**Fourth Semester B.Tech. Electronics & Instrumentation**

**Fourth Semester B.Tech. Cyber-Physical systems**

**Footstep Power Generation**

**using**

**Piezo-Electric crystals**

*Submitted by*

**Name: Jimit Desai Name: Nagbhushan Pai**

Reg. No: 220961144 Reg. No: 220961152

Section: A Section: A

Roll No.: 44 Roll No.: 39

**DEPARTMENT OF INSTRUMENTATION AND CONTROL ENGINEERING**

**MANIPAL INSTITUTE OF TECHNOLOGY**

Manipal Academy of Higher Education

MANIPAL – 576104, KARNATAKA, INDIA

**Table of Contents**

| Sl. No | Content | Page No |
| --- | --- | --- |
| 1. | Introduction | 3 |
| 2. | Statement of problem | 3 |
| 3. | Block diagram | 4 |
| 4. | Components Required | 5 |
| 5. | Methodology | 5-8 |
| 6. | Results | 9 |
| 7. | Conclusion & Future Scope | 9-10 |
| 8. | References | 10 |

### Introduction

Utilization of power turns to be necessary for every work in today's world. To comfort our daily routines the devices are used in large numbers. The benefits of roadway energy harvesting systems are potentially excellent. Energy harvesting is defined as capturing minute amounts of energy from one or more of the surrounding energy resources. To generate the power through footsteps as a source of renewable energy sources that we can obtain while walking on a certain arrangement like stepping foot on piezoelectric tiles. an advanced footstep power generation system proposed here uses the piezoelectric sensors. To generate a voltage from footstep the piezo sensors are mounted below the platform. To generate maximum output voltage the sensors are placed in such an arrangement. This is then forwarded to our monitoring circuitry. The circuit is the microcontroller based monitoring circuit that allows users to monitor the charges and voltage a connected battery to it and this power source has many applications. It also displays the charge generated by our footstep and displays it on an LCD. Thus we charge a battery using power from footsteps, display it on LCD using a microcontroller circuit and allow for powering load (fan) in our case. Our project model cost is effective and easy to implement and also it is green and not harmful to the environment.

### Statement of Problem

This project is used to generate voltage using footstep force. The proposed system works as a medium to generate power using force. This project is very useful in public places like bus stands, theatres, railway stations, shopping malls, etc. So, these systems are placed in public places where people walk and they have to travel on this system to get through the entrance or exists. Then, these systems may generate voltage on each and every step of a foot. For this purpose, piezoelectric sensor is used in order to measure force, pressure and acceleration by its change into electric signals. This system uses voltmeter for measuring output, led lights, weight measurement system and a battery for better demonstration of the system.

### Block diagram

A diagram of a power supply system

Description automatically generated

**Rechargeable Battery :**  A 9-12V od rechargeable battery is used to supply power to load . The battery gets recharged by the voltage generated due to piezo crystals.

**Atmega328p**: This represents the Atmega328p board, which is the main controller in the system.

**ESP8266 Module**: This module is connected to the microcontroller via Software Serial communication (pins 2 and 3). It handles the Wi-Fi communication with the Thing Speak server.

**Voltage Sensor**: This represents the voltage sensor connected to pin A0 of the Atmega328p. It measures the voltage value.

**Wi-Fi Connection**: The ESP32 module establishes a Wi-Fi connection to the specified SSID and password provided in the code.

**Thing Speak API**: The code sends HTTP GET requests to the Thing Speak server API endpoint (**api.thingspeak.com/update**) with the provided API key and field data.

**Data Transmission**: The Arduino sends data to the ESP32 module, which then sends it over Wi-Fi to the Thing Speak server.

**Thing Speak Server**: This represents the Thing Speak cloud server, which receives the data sent by the Arduino.

**Data Logging**: Thing Speak logs the received data into the specified fields of the corresponding Thing Speak channel.

**Response Handling**: The code processes the HTTP response received from the Thing Speak server and prints it to the serial monitor for debugging purposes.

Overall, the block diagram illustrates how the Atmega328p, ESP8266 module, voltage sensor, and Thing Speak server interact to collect and log data remotely over Wi-Fi.

### Components Required

Atmega328p Microcontroller

1 9v battery(Power Supply)

1 9V rechargeable battery

Piezo disks

Voltage sensor

Relay Module

Fan(Load)

LCD(16\*2 display)

16MHZ clock

2 22pf capacitors

4 diodes

1 0.1uf capacitor

1 10 uf capacitor

Jumper Wires

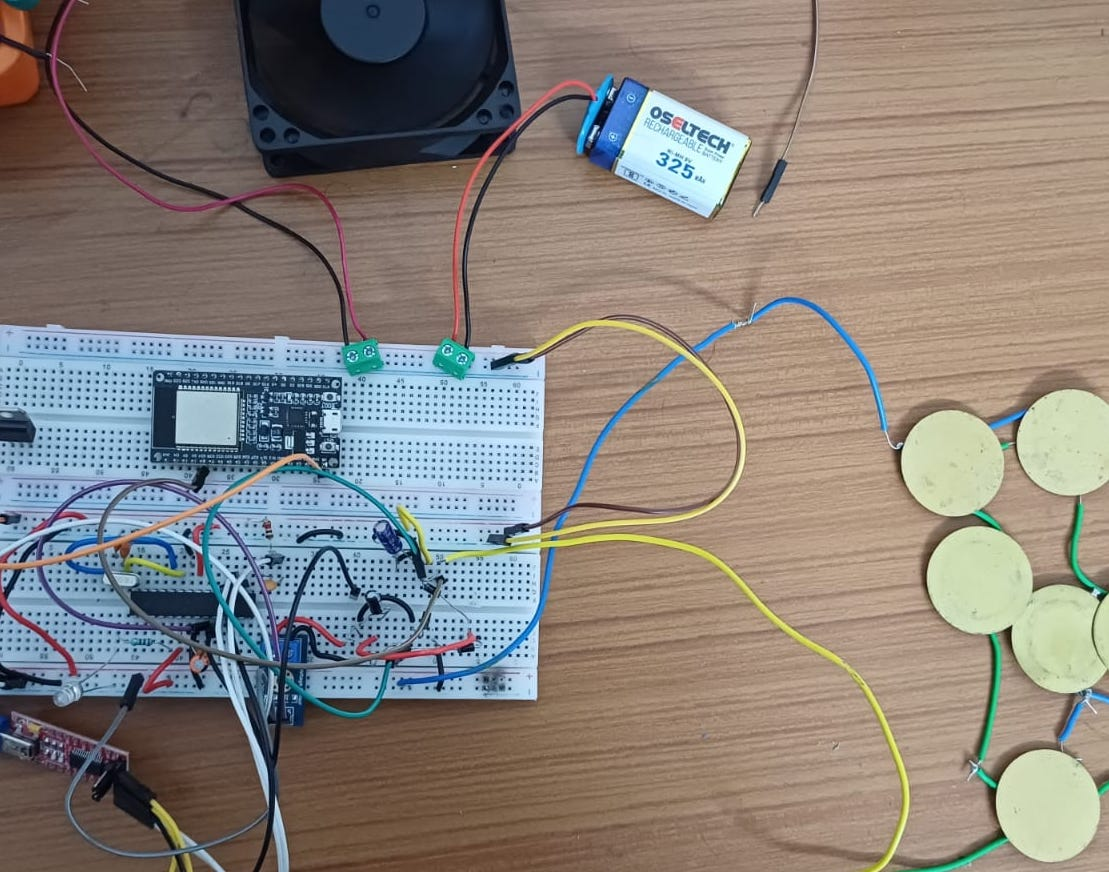
Leds

### Methodology

The entire system could be divided into 3 sub-systems.

1. Microcontroller unit
2. Piezo transducer unit
3. IOT unit

Designed system is shown below:



Footstep-Power Generation System

1. MICROCONTROLLER UNIT:

It essentially consists of Atmega328p chip which works on 16KHZ clock frequency . 2 22pf of capacitors are connected across the outputs of the crystal. 1 10kohms of resistor is connected across RESET pin of atmega328p to switch it to reset mode every time it is power up. Capacitor across the input terminal is placed to filter the noise .5V power supply is provided to microcontroller chip. We are powering MC using a FTDI cable.

A circuit board with wires and wires

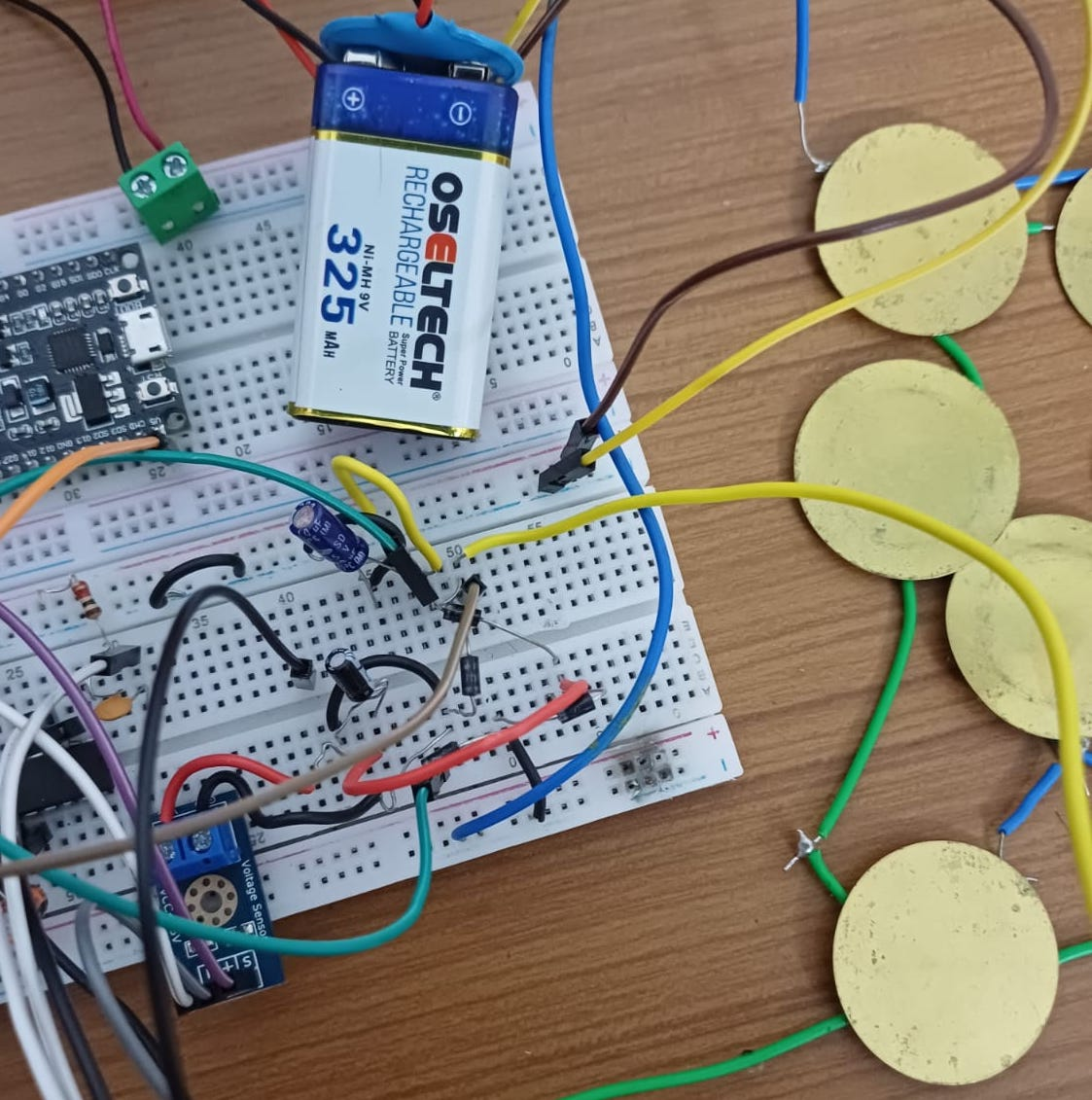
Description automatically generated

**Microcontroller unit**

1. PIEZO TRANDUCER UNIT:

This unit consists of :

7 Piezo-electric crystals connected in parallel. Rectifier circuitry to convert the data into pulsating DC . The pulsated output is then connected to 0.1uF capacitor to further filter out ac component . The data is then fed to Voltage Sensor which helps atmega328p read the piezo data properly. Additionally , a 9V rechargeable battery is connected across capacitor . The Piezo crystals are responsible for charging it . A fan is connected to this battery .. Our microcontroller is programmed to read the battery level .



**Piezo-sensor unit**

1. IOT UNIT:

We have used ESP32 module to send data to THINK SPEAK website for data analysis. The ESP32 takes data from microcontroller serially and then transmits it to cloud .Tx and Rx pin of ESP module is connecrted to Rx and TX pin of atmega328p microcontroller. Microcontroller and Esp module share common power supply and ground.

A close up of a circuit board

Description automatically generated

ESP32 unit

*Code*

#include <SoftwareSerial.h>

SoftwareSerial espSerial(2, 3); // RX, TX

// WiFi credentials

const char\* ssid = "your\_wifi\_ssid";

const char\* password = "your\_wifi\_password";

// ThingSpeak settings

const char\* server = "api.thingspeak.com";

const String apiKey = "your\_thingspeak\_api\_key";

const String field1Name = "steps";

const String field2Name = "voltage";

// Define the pin for the voltage sensor

const int voltageSensorPin = A0;

int step = 0;

int ref\_volt = 0;

int count = 0;

float sensor\_avg = 0.00;

float voltage = 0.00;

float voltage\_sum = 0.00;

void setup() {

Serial.begin(9600);

espSerial.begin(9600); // ESP8266 baud rate

// Connect to Wi-Fi

sendCommand("AT+RST\r\n", 2000);

sendCommand("AT+CWMODE=1\r\n", 1000); // Station mode

sendCommand("AT+CWJAP=\"" + String(ssid) + "\",\"" + String(password) + "\"\r\n", 5000);

}

void loop() {

unsigned long startTime = millis();

unsigned long duration = 5000; // 5 seconds

int sensorSum = 0;

while (millis() - startTime < duration) {

// Read the voltage from the sensor

int sensorValue = analogRead(voltageSensorPin);

sensorSum += sensorValue;

count++;

delay(100); // Adjust delay if needed for stability

}

// Calculate the average sensor value

sensor\_avg = (float)sensorSum / count;

// Set the reference voltage if it's the first iteration

ref\_volt = analogRead(voltageSensorPin);

voltage = (float)(abs(sensor\_avg - ref\_volt)) \* 5.0;

//diff=float((sensor\_avg - ref\_volt));

if(sensor\_avg>0.1) {

step++;

if(voltage>2.5) {

voltage=2.5;

}

}

// Send data to ThingSpeak

String url = "GET /update?api\_key=" + apiKey +

"&" + field1Name + "=" + String(step) +

"&" + field2Name + "=" + String(voltage) +

" HTTP/1.1\r\nHost: " + server + "\r\n\r\n";

sendCommand("AT+CIPSTART=\"TCP\",\"" + String(server) + "\",80\r\n", 2000);

sendCommand("AT+CIPSEND=" + String(url.length() + 2) + "\r\n", 2000);

sendCommand(url, 2000);

delay(10000); // Send data every 10 seconds

}

String sendCommand(String command, const int timeout) {

String response = "";

espSerial.print(command);

long int time = millis();

while ((time + timeout) > millis()) {

while (espSerial.available()) {

char c = espSerial.read();

response += c;

}

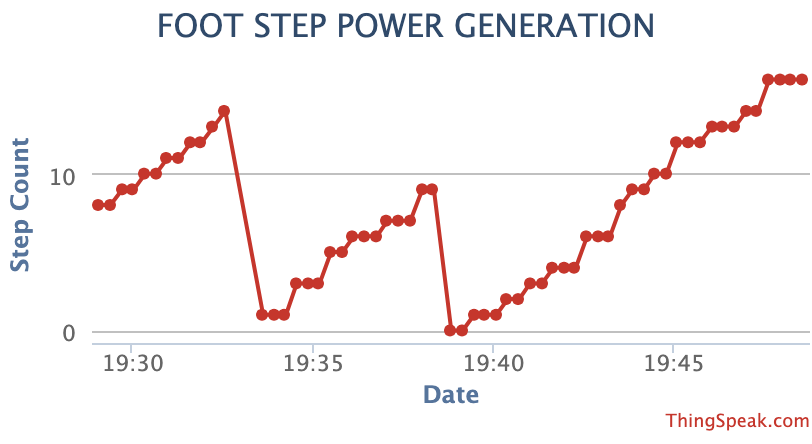
}

Serial.print(response);

return response;

}

*Results*



(a)

A graph showing a number of steps

Description automatically generated with medium confidence

(b)

As per our aim we are trying to find out the voltage generated by piezo sensors. Fig (a) and (b) helps us conclude our goal. Fig (a) is about steps counted by the microcontroller as per the programme fed .So we can observer that whenever there is a spike in Fig(b) our step count is increasing . Also the sudden drop in (a) is because microcontroller was in power off mode durinh that period . We have observed that when a person walks on our piezo crystal plat he/she is generating anywhere around 0.4-1 V . This is evident from Fig(b).

We also observed that when small force is applied piezo plate gives output in the range 0.5-0.17V. On an average each step of a person corresponds to 0.54V of voltage generation.

### Conclusion & Future Scope

Piezo based Footsteps Power Generator is a risk-free electricity generation system. Much of the energy that is wasted when people are moving is well utilized and transformed to electrical energy which can be used in schools and other institutions. This method of power generation is cost effective when used continually. Basically, the cost efficiency is realized in the long term. This method of power generation can be installed in areas such as malls, schools, colleges, at the railway stations or any other areas where people movement is intensive. The production of electricity using this method is environmental conservative because power is produces without polluting the environment. Also, the power that is wasted by human while working is utilized by this system to produce electricity. Therefore, the system ensures maximum utilization of available energy. The energy source is renewable and is available continuously. Therefore, the method is very convenient than other methods of power generation. The power generated by this system can be used in the rural areas. The method is also very eco-friendly; the production does not require fuelling, that produce smoke and other pollutants. The tests that have been done so far have confirmed that the system is best because being provides affordable energy solution to people. Although the method seems advantageous in most aspects, the amount of power that can be generated by this system may not be used in places where mass electricity is needed. Therefore, the system can only generate power for lighting and powering simple electricity gadgets. However, more improvement can be done to increase its production such as coming up with a method of stepping up the generated power.

### **References:**

<https://www.sciencedirect.com/science/article/pii/S2214785320363562#f0005>

<https://nevonprojects.com/footstep-power-generation-system/>