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FOOTSTEP POWER GENERATION USING ARDUINO

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ABSTRACT:
This paper presents a novel approach to harvesting renewable energy from human footsteps using piezoelectric sensors and an Arduino-based monitoring system. Mechanical pressure from footsteps is converted into electrical energy via 35mm piezoelectric discs, rectified through a bridge circuit (1N4007 diodes, 10µF capacitor), and stored in 18650 lithium-ion cells. An Arduino UNO processes the generated voltage, displaying real-time data on an LCD I2C display. The system achieves an average output of 3.2V per 50kg load, demonstrating feasibility for low-power applications in crowded areas.

Keywords:
Piezoelectric energy harvesting, Arduino, Renewable energy, Footstep power, Sustainable technology

I.INTRODUCTION

The rapid depletion of conventional energy resources and growing environmental concerns have necessitated the exploration of alternative energy solutions. Among renewable energy technologies, human motion-based energy harvesting has emerged as a promising approach, particularly for urban environments with high pedestrian traffic. This paper presents an innovative footstep power generation system that converts mechanical energy from human footsteps into usable electricity through piezoelectric transduction, offering a sustainable solution for low-power applications in public spaces. Piezoelectric materials, which generate electric charge in response to mechanical stress, provide an efficient means of energy conversion. When integrated into walking surfaces, these materials can harness the otherwise wasted energy from foot traffic. However, existing piezoelectric energy harvesting systems face challenges such as low power output, inefficient energy storage, and lack of real-time monitoring. To address these limitations, this study introduces a prototype system combining.

II. RELATED WORK

1. Footstep power generation for clean and green energy
2. Smart footstep energy harvesting system
3. Prototype model using piezoelectric sensors
4. Advanced footstep power generation using RFID
5. Eco walk – harvesting energy with every step
6. Advanced footstep power generation system for mobile charging
7. Motion sensing and power generation
8. Piezoelectric energy harvesting
9. Smart grid integration
10. Arduino based smart flooring for renewable energy
11. Human motion energy harvesting

III.PROPOSED METHODOLOGY

The system efficiently converts footstep energy into usable electricity through an optimized arrangement of 35mm piezoelectric sensors mounted on a durable 5mm acrylic platform. When subjected to mechanical pressure, these sensors generate AC voltage that undergoes conditioning through a full-wave bridge rectifier (utilizing 1N4007 diodes and a 10µF smoothing capacitor) to produce stable DC output. A voltage regulation stage ensures consistent power delivery to the energy storage system, which consists of a rechargeable 18650 Li-ion battery managed by a BC547 transistor-based charge controller to prevent overcharging. For real-time monitoring and data visualization, an Arduino UNO microcontroller interfaces with an I2C LCD display, programmed to show

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instantaneous voltage, accumulated energy, and battery status. The piezoelectric discs are strategically wired in parallel to enhance current output, while the entire system's performance is rigorously evaluated by applying controlled loads (50-100kg) to measure voltage response, conversion efficiency, and long-term durability. Additional features include a energy storage capacitor and optional GSM module integration for remote monitoring, making the system adaptable for various high-traffic applications such as smart walkways and public spaces.

IV. BLOCK DIAGRAM

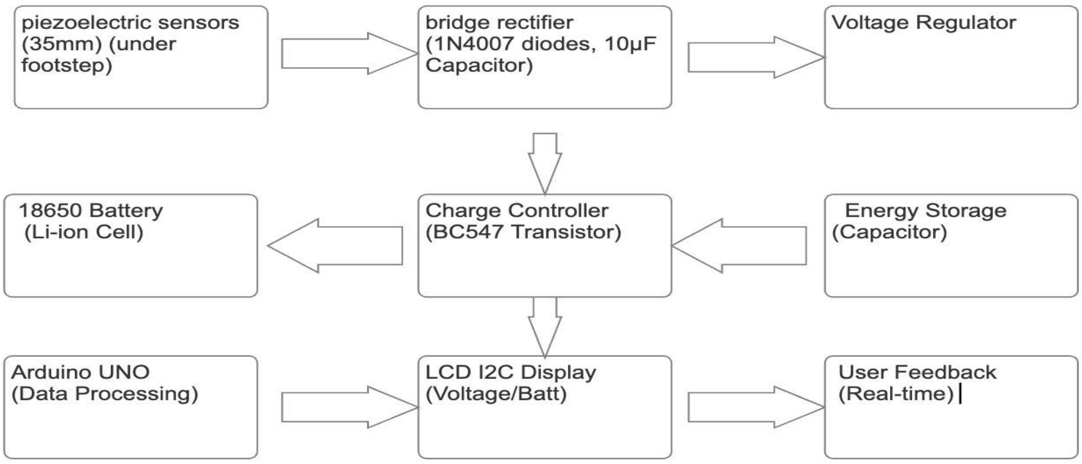

Figure 1 Block diagram

V.COMPONENTS

Major components used:
Piezoelectric Sensors: Capture kinetic energy from footsteps..
18650 Li-ion Battery: Stores the generated energy for later use.
Arduino: Controls the system, monitors the battery, and displays the data.
LCD Display: Shows real-time data on step count and voltage
Software used – ARDUINO IDE for programming

Figure 2 Arduino Uno **I.Arduino uno :**

The Arduino Uno is a versatile and widely popular microcontroller board based on the ATmega328P microchip, designed for a broad range of electronic projects and automation tasks. It features 14 digital input/output pins, six of which can be configured as PWM outputs for tasks like controlling motors or generating analog signals, and six analog input pins, allowing it to read data from sensors or other input devices. At the heart of the Arduino Uno is a 16 MHz quartz crystal oscillator, which ensures precise timing for the board's operations. It also comes equipped with a USB connection for programming and communication, a power jack for external power supply, an In-Circuit Serial Programming (ICSP) header for advanced users, and a reset button to restart the board. The Arduino Uno is programmed using the Arduino IDE (Integrated Development Environment), which employs a simplified version of the C/C++ programming language, making it highly accessible to beginners while still powerful enough for advanced users. The board can be powered either through a USB connection or via an external

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power source, such as a battery or adapter, with a voltage range of 7-12V. The Arduino Uno serves as the central processing unit that manages and controls the entire system.

II. Piezoelectric sensors:

Figure 3 Piezoelectric sensors

Piezoelectric sensors are that change mechanical energy into electrical energy, including vibrations, pressure, and acceleration. They are constructed of piezoelectric materials, which, when under mechanical stress, produce an electrical charge. They are crucial parts of many kinds of sensors and electronic systems because they provide a special and adaptable way to transform mechanical energy into electrical signals. Piezoelectric sensors are preferred in some applications because of their high sensitivity, accuracy, and fast response times. They are also rugged and reliable, able to withstand high temperature and harsh environments. Furthermore, because they generate their own electrical signal, they do not require an external power source, making them suitable for remote or portable applications. However, piezoelectric sensors do have some limitations. For example, they may be affected by temperature variations or environmental factors such as humidity. Additionally, their sensitivity may decrease over time due to fatigue or stress, which can affect their accuracy. Working of a Piezoelectric sensor : sensors are devices that transform vibration, acceleration, pressure, and other mechanical energies into electrical energies. They are constructed of piezoelectric materials, which when stressed mechanically produce an electrical charge. Of applications, including in industrial, automotive, medical, and consumer electronics. For example they can be used in pressure sensors for measuring fluid and gas pressures in pipelines, as well as in accelerometers for measuring vibrations and shock in machinery and vehicles.

III.18650 lithium-ion cells:

Figure 4 Lithium ion cells

Lithium-ion cells are used to store the electrical energy generated by the piezoelectric sensors as people walk over them.These cells are ideal for this project due to their high energy density, reliable performance, and cost-effectiveness. The energy generated from the footsteps is often not consistent enough to power devices directly, so the 18650 cells store this energy, ensuring a steady power supply to devices such as the Arduino and other connected components. Once charged, the stored energy in the cells can power the Arduino and any small devices like LEDs or sensors. The 18650 cells are rechargeable, making them an eco-friendly and cost-efficient option for long-term use. Additionally, multiple cells can be connected in parallel or series to increase the capacity and voltage output, allowing for greater energy storage to power more devices. With their compact size and high capacity, the 18650 cells play a vital role in ensuring the sustainability and functionality of the footstep power generation system, making it possible to harness and store human-generated energy for practical use.

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IV.LCD 12c display:

Figure 5 LCD 12c display

The LCD 12c display serves as an essential component for real-time monitoring and user interaction. It provides an intuitive and straightforward way to visualize the system's performance by displaying key information such as the amount of energy being generated from the footsteps. The I2C interface of the LCD display simplifies the wiring process by requiring only two pins (SDA and SCL) for communication with the Arduino, leaving other pins available for additional components. The LCD can show real-time data such as the voltage being generated, the energy stored in the battery, or the current status of the system, such as whether it is generating power or idle. This immediate feedback helps users understand how much energy is being produced and stored at any given moment. Additionally, during the testing and debugging phases, the LCD becomes a valuable tool for developers to monitor sensor readings and diagnose any issues. Its compact size and ease of use make it a great choice for this project, allowing the system to display important data clearly without occupying much space. The display can also provide status messages such as "Power Generating," "Battery Charging," or "System Idle," enhancing the user experience by keeping them informed about the system's ongoing processes. Overall, the LCD I2C display plays a crucial role in making the project more interactive, accessible, and functional.

VI.ARDUINO CODE

```
#include <Wire.h>
#include
<LiquidCrystal_I2C.h>
// Constants //required
variables int prev = 0,
stepCount = 0; unsigned
long previousMillis = 0;
const long interval =
1000; unsigned long
currentMillis;
float v, vout, vin; //variabls for
calculaHng voltage
// IniHalize the LCD, set the LCD address to 0x27 for a 16 chars and 2 line display
LiquidCrystal_I2C lcd(0x27, 16, 2);
Void setup() {
// IniHalize serial communicaHon
```

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```
Serial.begin(9600);
pinMode(8,OUTPUT);//led indicaHon
// IniHalize the LCD
lcd.init();
lcd.backlight();
// Print a message to the LCD

lcd.print("FOOT STEP POWER");
lcd.setCursor(0, 1); lcd.print("
GENERATOR"); delay(2000);
lcd.clear(); lcd.setCursor(0, 0);
lcd.print("STEP COUNT:");
lcd.setCursor(0, 1);
lcd.print("VOLTAGE:");
}
void loop() {
v = analogRead(A0); //calculaHng
Hme currentMillis = millis();
if (v != 0 and (prev == 0)) {
stepCount += 1; // calculaHng
steps digitalWrite(8,
HIGH); //led indicaHon
lcd.setCursor(12,
0); lcd.print(stepCount);
} else { if (currentMillis -
previousMillis >= 100) {
previousMillis = currentMillis; //Hme
in milliseconds digitalWrite(8, LOW);
}
}
prev = v; lcd.setCursor(9, 1);
//calculaHon of voltage vout =
(v * 5.00) / 1024.00;
vin = (vout /
0.040909)*100;
lcd.print(vin);
lcd.print("mV
"); delay(200);
```

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VII.RESULTS AND OBSERVATIONS

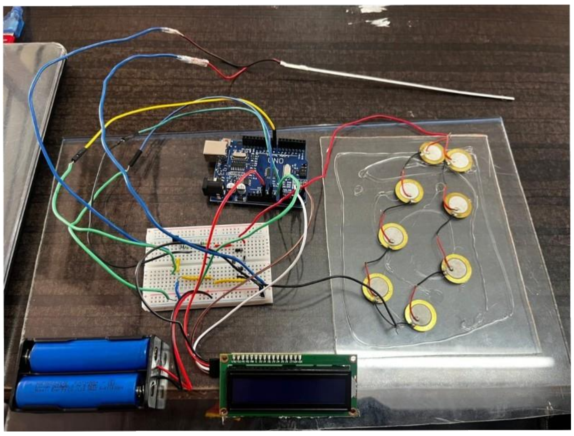

Figure 6 Final model

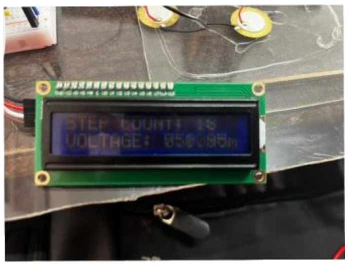

Figure 7 Voltage displayed on display

1) Energy generation
2) Energy conversion and rectification
3) Energy storage
4) Realtime monitoring
5) System stability and efficiency
6) Practical usability

VI.ADVANTAGES

1) Renewable energy source
2) Cost effective energy
3) Scalability
4) Energy storage capability
5) Compact and portable design
6) Eco-friendly and sustainable
7) Applicable in remote locations

VIII.FUTURE SCOPE AND CONCLUSION

The proposed footstep power generation system demonstrates a viable, eco-friendly solution for harvesting wasted kinetic energy in high-traffic areas, with potential applications in smart cities, public spaces, and IoT devices. Future enhancements could include integrating supercapacitors for rapid energy storage, implementing machine learning to predict peak energy generation times, and scaling the system for grid connectivity. Additionally, GSM/IoT modules could enable real-time remote monitoring and fault detection. While current limitations include modest power output and sensor durability, ongoing advancements in piezoelectric materials and power electronics promise higher efficiency and longevity. This project underscores the feasibility of human-motion energy harvesting as a sustainable supplement to conventional power sources, contributing to greener urban

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infrastructure. With further optimization, such systems could play a pivotal role in decentralized renewable energy networks, reducing reliance on fossil fuels and minimizing carbon footprints.

IX.REFERENCES

1) Chu, Steven, and Arun Majumdar. "Opportunitie and challenges for a sustainable energy future." nature 488.7411 (2012): 294-303.
2) "Smartprivacy for the smart grid: embedding privacy into the design of electricityconservation." Identity in the Information Society 3.2 (2010): 275-294.
3) Willems, P. A., G. A. Cavagna, and N. C. Heglund. "External, internal and total work in human locomotion." Journal of Experimental Biology 198.2 (1995): 379-393.
4) Madhushree, M., Utkarsh Kumar Rawat, And K. Internal Guide. Design And Fabrication Of Footstep Power Generation By Crankshaft Mechanism. 2017.
5) Arduino, Store Arduino. "Arduino." Arduino LLC (2015).
6) Teikari, Petteri, et al. "An inexpensive Arduino based LED stimulator system for vision research." Journal of neuroscience methods 211.2 (2012): 227-236.
7) Latha, N. Anju, B. Rama Murthy, and K. Bharat Kumar. "Distance sensing with ultrasonic sensorand Arduino." International Journal of Advance Research, Ideas and Innovations in Technology 2.5 (2016): 1-5.
8) Pisenti, Neal Carden. Isotope Shift Spectroscopy of Ultracold Strontium. Diss. University of Maryland, College Park, 2019.
9) Rupitsch, Stefan Johann. "Measurement of Physical Quantities and Process Measurement Technology." Piezoelectric Sensors and Actuators.Springer, Berlin, Heidelberg, 2019. 407-509.