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EMPOWERING PATHS: THE POTENTIAL OF FOOTSTEP-GENERATED POWER

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Abstract: In this research, "EMPOWERING PATHS: THE POTENTIAL OF FOOTSTEP-GENERATED POWER," piezoelectric materials are strategically placed in flooring or walkway surfaces to harness the energy created by footsteps. Since these materials can convert mechanical stress from feet into electrical energy, they can be employed as a component of larger grids or to power low-energy gadgets. Scalability, adaptability to various circumstances, and seamless connection with the current infrastructure are advantages. This technology offers a sustainable solution to cities' energy needs and opens the door to further research and development, leading to a more ecologically friendly future.

Keywords: Electrical, Internet Of Things, piezoelectric plates, power generation.

I. INTRODUCTION

The global energy demand and growing environmental concerns have spurred interest in the quest for renewable energy sources. On a step- power generation with human kinetic energy has emerged as a practical and innovative method. This section conducts a comprehensive analysis of the literature, looking at the many technologies, uses, challenges, and advancements in this field. By combining current knowledge, it offers a comprehensive analysis of footstep generation of electricity and highlights its potential as a key component of ecologically friendly energy research.

1.1 FOOTSTEP POWER GENERATION:

The global energy demand and growing environmental concerns have spurred interest in the quest for renewable energy sources. On a step- power generation with human kinetic energy has emerged as a practical and innovative method. This section conducts a comprehensive analysis of the literature, looking at the many technologies, uses, challenges, and advancements in this field. By combining current knowledge, it offers a comprehensive analysis of footstep generation of electricity and highlights its potential as a key component of ecologically friendly energy research.

1.2 REVIEW:

India is currently facing several energy-related challenges. A brief discussion of these issues should be included, with a focus on the need for decentralized and sustainable energy solutions as India's energy needs continue to rise. At present Status of Kinetic Energy Harvesting Technologies in India. To examine projects or initiatives pertaining to renewable energy, particularly those that take human kinetic energy into consideration. Review the present state of kinetic energy harvesting technologies deployed or studied in India. Initiatives for Footstep Power generating in India: Locate and evaluate any completed or ongoing initiatives pertaining to India's footstep power generating. Emphasize the principal discoveries, obstacles encountered, and insights gained from these endeavours.

1.3 PROBLEM DESCRIPTION:

To support sustainable energy solutions, design and create a dependable and effective system for footstep power generation. The idea is to develop a system that may be used in busy places like shopping centres, public parks, or transportation hubs to harvest and transform the mechanical energy that people walk into electrical power that can be used.

1.4 GOAL:

Create a footstep power generation system prototype with a high conversion efficiency of energy. Make that the system is robust, dependable, and able to survive a range of environmental circumstances. Give top priority to a user-friendly design that blends in seamlessly with public areas and doesn't impede normal pedestrian traffic.

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1.5PERSPECTIVE:

Step-by-step power generation has enormous potential for use in a number of contexts, such as educational institutions, movie theatres, retail centres, temples, and other structures. A filter built into the system efficiently eliminates AC components from the sensor's output voltage. When it comes to AC voltage, this filter is an open circuit; when it comes to DC voltage, it is a short circuit.

II. SYSTEM SPECIFICATION

2.1 HARDWARE REQUIREMENTS:

- Arduino UNO
- Piezoelectric Plates (Sensor)
- Lithium ion battery
- LED
- LCD
- Charging port

2.2 SOFTWARE REQUIRMENTS:

- Object system - Windows 10
- IDE – Arduino

III. PROJECT DESCRIPTION

3.1 BLOCK DIAGRAM:

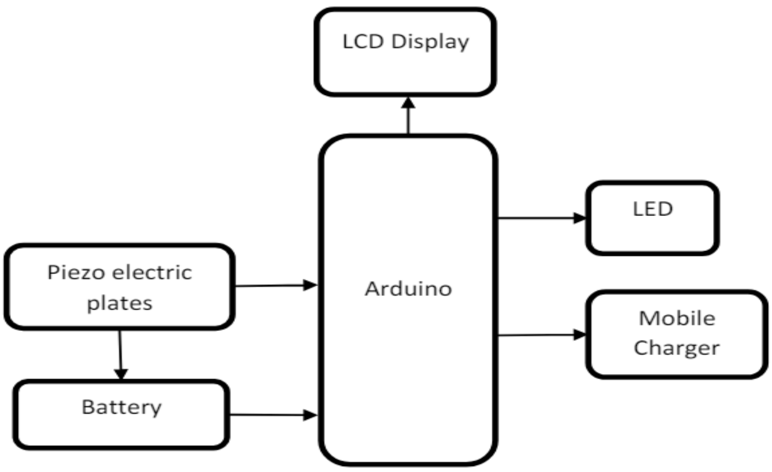

Figure 3.1-Block diagram

3.2 BLOCK EXPLANATION:

3.2.1 ARDUINO UNO:

With its 16 MHz ATmega328P microcontroller, the Arduino Uno is a popular open-source microcontroller board. With six analog input pins, fourteen digital input/output pins, and an easy-to-use USB connection, it offers a convenient foundation for creating a range of electronics projects. Due to its ease of use and integration with the Arduino IDE, the board is suitable for both novice and seasoned developers. Its compatibility for many shields increases its adaptability and makes it simple to expand its capabilities. The Arduino Uno is a well-liked educational tool because of its ease of use in teaching programming and electronics. Its vibrant community also guarantees an abundance of resources for learners.

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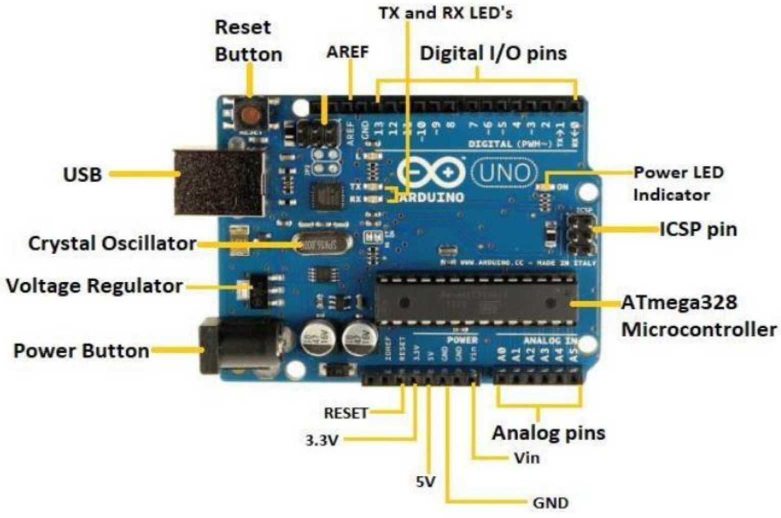

Figure 3.2.1-Arduino Uno

As the central component of the Arduino ecosystem, the Arduino Uno has grown to be indispensable for both hobbyists and experts in the field of electronics. The Uno allows for flexibility in project design because it has an integrated voltage regulator and may be charged by either an external power supply or USB.

Sensors, actuators, and other components may be interfaced with ease because to its analog and digital ports, and the Arduino IDE makes writing easier with an intuitive interface. Because it is open-source, users are able to explore the nuances of its design and add to the large collection of community-driven applications and libraries. A lasting and adaptable instrument in the world of microcontrollers, the Arduino Uno can be used for embedded systems development, home automation, or prototyping.

3.2.2 BOARD ARCHITECTURE:

Every single Arduino board needs a way to connect to a power source. An Arduino Uno (like this one) with a barrel jack on the end can be powered by a USB connection from your computer or a wall power supply. In the above illustration, the connection via USB is identified (1), and the cylindrical jack is shown (2). In addition, you will use the USB connection to put code onto the board that comes with Arduino. For further details on how to program with Arduino, see our Installation and Programming Arduino tutorial. Pins: AREF-19, Digital, Analog, PWM, GND, 3.3V, and 5V

By connecting wires with Arduino pins, you can build a circuit (usually with the help of a prototype along with some wire). Typically, GND (3): abbreviation for "Ground." The Arduino has multiple GND pins that you can utilize for grounding your circuit.

• 5V (4) & 3.3 volts (5): The 5V pin, as you might expect, provides 5 volts electrical power, while the 3.3V pin provides 3.3 volts. The majority of the basic parts that are used for the Arduino gladly operate on 3.3 or 5 volts.

• Analog (6): The section of pins on the UNO that are labeled "Analog In" (A0 through A5) are Digital In pins. These pins have the ability to read and transform signals from analog sensors, such as temperature sensors. it into a readable digital value.

• Digital (7): The digital pins that are used (0 to 13 on the UNO) are located across the remaining analog pins. Digital output, such as illuminating an LED, and digital input, such as determining whether a button is pressed, are both possible with these pins.

• PWM (8): Some of the pins that are digital (3, 5, 6, 9, 10, and eleven on the Arduino) may have had the tilde's (~) next to them. In addition to functioning as regular digital pins, these pins can be utilized for pulse-width modulation, or

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PWM. For the time being, consider these pins as having the ability to replicate analog output (e.g., dimming an LED in and out). We have a lesson on PWM.

• AREF (9): Relative Reference is the acronym. For the most part, you may ignore this pin. Occasionally, it is employed to establish an external reference voltage (ranging from 0 to 5 volts) as the maximum value for the analog input pins.

3.2.3 RESET BUTTON:

The Arduino's reset button (10) is the same as the one on the original Nintendo. By briefly attaching the reset signal pin to ground, pressing it will bring back any running program on the Arduino. This can be quite useful if you want to test the source code on multiple occasions but it doesn't repeat. However, in contrast to the original Nintendo, problems are usually not fixed by blow on the Arduino.

3.2.4 POWER LED INDICATOR:

On the electronics board, there is somewhat Light next to the letter "ON" (11) and just below and to the correct side of the term "UNO." This LED should come on each time you plug the circuit board into a power source. In the event that this light is off, there's probably a problem.

3.3 PIEZOELECTRIC PLATE SENSORS:

A piezoelectric plate sensor is a type of sensor that utilizes the piezoelectric effect to convert mechanical stress or vibrations into electrical signals. The piezoelectric effect refers to the ability of certain materials, like certain ceramics or crystals, to generate an electric charge in response to applied mechanical stress. Here's a description of a typical piezoelectric plate sensor.

3.3.1 STRUCTURE:

A piezoelectric plate sensor is typically a thin and flat plate made of a piezoelectric material. Common materials used include lead zirconate titanate (PZT) ceramics or polyvinylidene fluoride (PVDF) polymers. The sensor may have electrodes attached to its surfaces to facilitate the collection of generated electric charges.

3.3.2 WORKING PRINCIPLE:

When the piezoelectric plate is subjected to mechanical stress or vibrations, it undergoes deformation, causing a change in the arrangement of its atoms or molecules. This change in structure generates an electric charge across the material. The magnitude of the generated charge is proportional to the applied mechanical stress or the rate of deformation.

3.3.3 SENSITIVITY:

Piezoelectric plate sensors are known for their high sensitivity and responsiveness to dynamic mechanical events. They can detect a wide range of frequencies, from low frequency vibrations to high-frequency impacts.

Figure 3.3 -Piezoelectric plate sensors

3.3.4 PIN DESCRIPTION:

Positive Terminal (+):

This terminal is the positive electrode of the piezoelectric plate. When mechanical stress or pressure is applied to the plate, it generates a positive voltage at this terminal relative to the negative terminal.

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Negative Terminal (-):

This terminal is the negative electrode of the piezoelectric plate. It serves as the reference point for the generated voltage when the plate experiences mechanical stress. The voltage at this terminal is lower than the voltage at the positive terminal when stress is applied.

3.3.5 SPECIFICATION:

- Weight 2 grams
- Diameter 35 mm
- Thickness 0.5 mm
- Resonance Frequency 4.6 Khz +/- 0.5 Khz
- Resonance Impedance 200 Ohms
- Capacitance 20nF +/- 30% at 1 Khz
- Operating Temperature -20...+70 C
- Maximum Voltage Generate 6.2V

3.4 LI-ION BATTERY (LITHIUM ION):

These batteries are commonly used in various electronic devices, such as laptops, power tools, flashlights, and even some electric vehicles. Due to their high energy density and standardized size, they are popular choices for portable applications requiring rechargeable power sources.

Figure 3.4 -Lithium ion

3.4.1 PIN DESCRIPTION:

Positive Terminal (+):

This is the terminal where the positive voltage of the battery is provided. It's usually the flat or raised end of the battery. This terminal is often referred to as the "cathode."

Negative Terminal (-):

This is the terminal where the negative voltage of the battery is received. It's typically the flat end of the battery, opposite to the positive terminal. This terminal is often referred to as the "anode."

3.4.2 SPECIFICATIONS:

- Battery Type Lithium-ion (Li-ion) Model 18650
- Nominal Voltage 3.6 to 3.7
- Volts (V) - 24 –
- Capacity 2500 mAh
- Discharge Current 10-15A
- Charging Voltage 4.2V when fully charged.
- Chemical Formula ($LiCoO_2$) / ($LiFePO_4$)
- Cycle Life 300 – 500 cycles

3.5 LIGHT EMITTING DIODE, OR LED:

A semiconductor material, usually a compound semiconductor composed of elements from Group III and Group V of the periodic table, is used to build LEDs. Gallium arsenide (GaAs), gallium phosphate (GaP), or indium gallium nitride (InGaN) is examples of common materials. Two electrodes are positioned between the semiconductor materials.

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3.5.1 OPERATIONAL CONCEPT:

The semiconductor material moves electrons from the n-type (negative) area to the p-type (positive) region when a voltage is applied across it by connecting it to a power source. Photons, or light, are produced as these electrons recombine with holes, or vacant electron sites, in the p-type region. The light's emission color is determined by the bandwidth of the semiconductor material's energy.

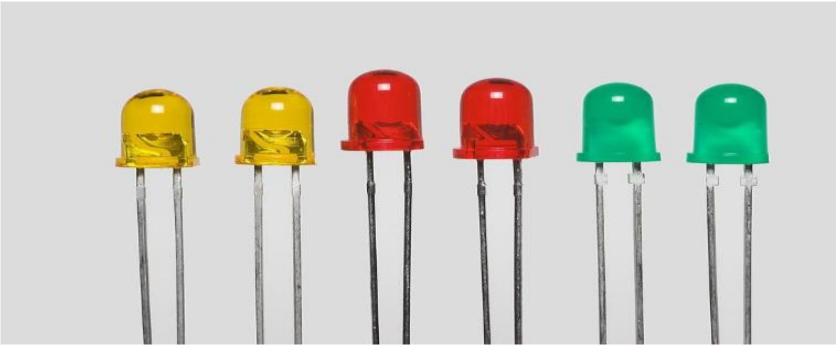

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Figure 3.5 -Light Emitting Diode

3.6 LCD:

A 16x2 LCD (Liquid Crystal Display) is a common type of alphanumeric display module that can display two lines of text, with each line containing up to 16 characters. These displays are widely used in various electronics projects, devices, and applications

For displaying information to users.

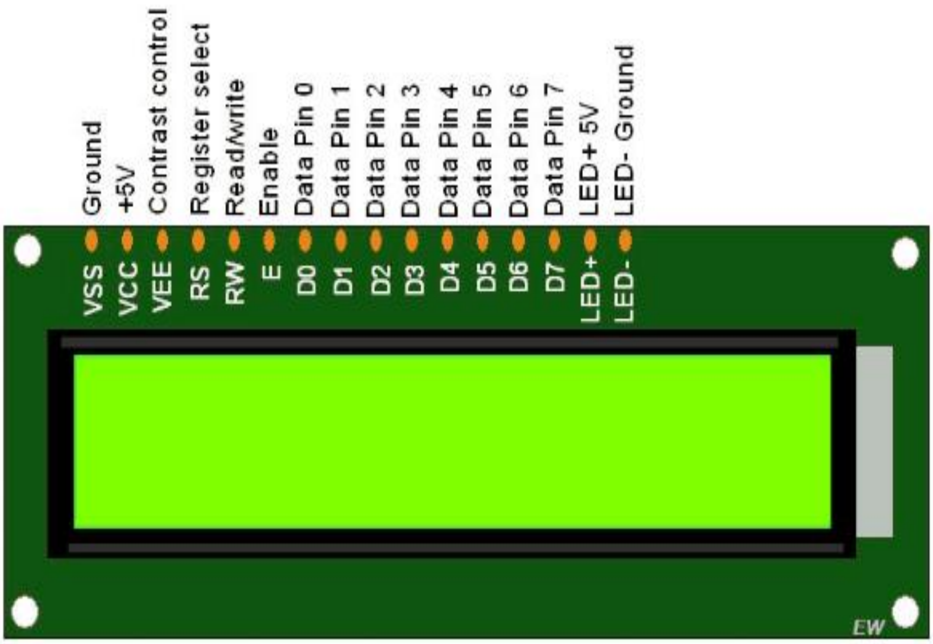

Figure 3.6 -Liquid Crystal Display

3.6.1 WORKING PRINCIPLE:

An LCD's ability to manipulate light is derived from the liquid crystal layer. The molecular alignment of a liquid crystal varies in response to an applied electric field, which modifies the polarization of light that passes through certain regions. The LCD can produce images because of this deliberate light manipulation.

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3.7 MOBILE CHARGING:

Using PIC16F677, design the external circuit connection in accordance with the block diagram.The piezo electric crystal provides the PIC's input. A socket input is provided as the output of the PIC's fifteenth pin. The socket provides a 5 volt output that can be utilized to charge a mobile device.

3.8 CIRCUIT DIAGRAM:

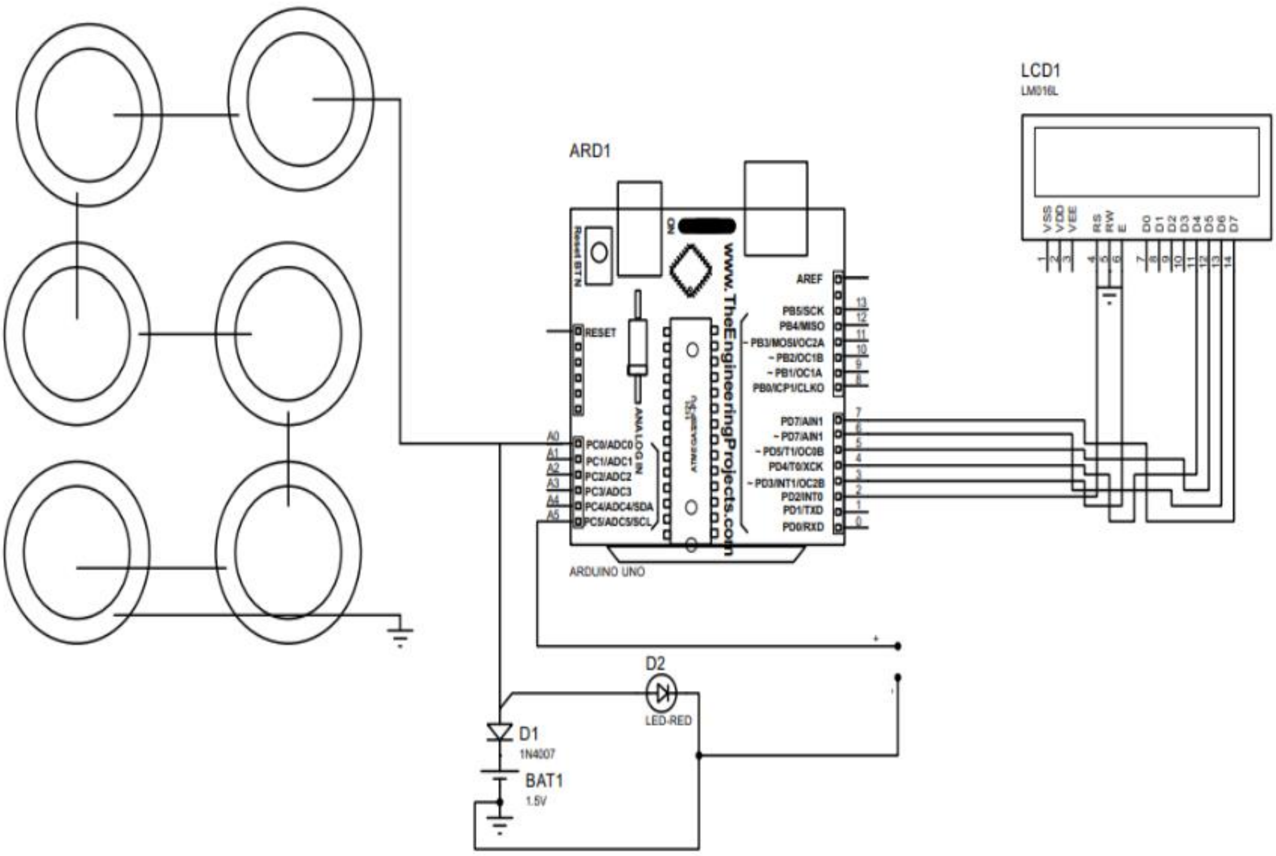

Figure 3.7-Circuit Diagram

IV. IMPLEMENTATION AND RESULT ANALYSIS

4.1 STEPS TO CONNECT:

Connect piezoelectric sensor with arduino:

- Connect the sensor's positive (signal) wire to the Arduino's analog input port (A0, for instance).
- Connect the negative (ground) wire of the sensor to the Arduino's GND pin.
- Depending on the output voltage range of the sensor, you may need to apply a voltage divide to bring the current inside the Arduino's permitted input range, which varies between 0 and 5 volts.
- One example of this is constructing a resistor-based voltage divider circuit.

Connect LED to arduino:

- One end of the resistor should be connected to the LED's cathode, or shorter leg. The other end should be connected to a digital pin on the Arduino, such as pin 13.
- Attach the LED's anode, or longer leg, to the Arduino's 5V pin.
- If you haven't already connected the LED's cathode, or shorter leg, to a digital pin on the Arduino that goes LOW (0V), do so now for a complete circuit.

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Connect LCD to arduino:
- Use jumper wires to connect the Arduino to the LCD.
- Attach the VDD pin to +5V and the RW and VSS pins to ground.
- Attach the potentiometer's center pin to the V0 pin.
- Attach the data, RS, and E pins to the appropriate digital pins on the Arduino.

V. RESULT ANALYSIS

ance. First and first, it is important to assess the energy production, which calls for a thorough examination of the electricity, voltage, and flow generated by walking. Power density, which is defined as power per steps or unit area, indicates how well the system scales and adjusts to various traffic patterns and environments. Efficiency studies make sure that the electricity is used with as little waste as possible by analyzing how well fuel is transformed and pointing out potential improvement areas. The user observations and interactions are the main components of the investigation, offering valuable insights into the practicality and acceptance of footstep electrical power across a range of demographics. Furthermore, the The robustness and dependability of the system are rigorously inspected to evaluate its performance in varying environmental conditions and throughout extended. To provide a consistent and reliable power supply, the effectiveness of integration with batteries in the storage and distribution of extra energy is assessed.

Second, a cost-benefit analysis is necessary to evaluate the economic viability of footstep power generation. This means that the system's lifetime earnings from investments, ongoing maintenance expenses, and initial setup fees must all be carefully examined. Research on how a system affects the environment assess its sustainability by considering factors such as material use, disposal methods, and carbon footprint. Scalability evaluations look at how well footstep power production works in a range of settings, such as public spaces and commercial buildings, to determine whether it can be widely adopted. Regulatory safety and compliance standards must be taken into account for the equipment in order to ensure user safety and meet legal criteria. To maximize both the system's overall efficiency and its role in sustainable energy practices and dependability, constant observation, and system enhancement depending on evaluations of the outcomes are crucial.

5.1 PROBLEM FORMULATION & SOLVING:
- The use of electronics equipment has expanded as technology has advanced.
- The conventional techniques of generating power are becoming inadequate.
- It presented an additional issue: insufficient power.
- An alternative way of power generation is required.
- Simultaneously, energy is squandered in several forms, with human mobility being one of them.

5.2 ADVANTAGES:
- Power generation is as simple as walking on a step.
- It doesn't require fuel input.
- It has a non-conventional system.
- It has no moving parts and a long service life.
- It is compact and extremely sensitive.
- It is self-generating and doesn't require external power.

5.3 DISADVANTAGES:
- Exclusive to that particular area.
- The setup has a high initial cost.
- Temperature fluctuations impact output.
- If crystal is overstressed, it can break easily.

VI. CONCLUSION

In conclusion, the advancement of step taken power generation presents a workable route toward the utilization of ecologically acceptable energy sources. According to the analysis of the findings, it can convert human motion into electricity, offering an environmentally friendly alternative that can be applied in a range of situations. The efficiency, user-engagement, and dependability of footstep power producing devices have been proven, highlighting their versatility and viability for insertion within public spaces, commercial structures, and other contexts.

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The advantages—such as lower emissions of carbon and consumers acceptance—indicate that step electrical power generation has a lot of possibilities as a novel and practical solution for effectively and environmentally achieving energy demands, yet there continue to be issues to be determined regarding savings, scalability, and regulatory compliance. For the reason this Collaboration, technological advancements, and continuous research are required for this to occur. The advantages—such as reduced emissions of carbon and consumers acceptance—indicate that step electricity production has a great deal of promise as a novel and practical solution for effectively and economically meeting energy demands, even though there still exist issues to be settled regarding affordability, scalability, and regulation compliance. To fully utilize footstep electric power as a sustainable energy option, continued research, technological advancements, and collaborative efforts are needed.

6.1. FUTURE ENHANCEMENT:

Future advancements in footstep generator systems could focus on improving energy collection methods, such as piezoelectric material efficiency and exploring novel energy conversion strategies. Additionally, by integrating smart grid technologies, the transportation of captured energy may be maximized and matched to current demand. Energy storage developments can provide a more consistent power supply and reduce intermittent power outages by creating batteries with higher capacity and longer lifespans. As malleable and wearable technologies develop, materials that gather energy and incorporate them into shoes or wearable devices present an intriguing future. These materials have the potential to capture energy from a greater range of human motions. Foot traffic patterns could be used to optimize energy harvesting with the use of machine learning techniques. resulting in a more adaptable and responsive system. The future viability and sustainability of footstep power generation will depend on initiatives to lower prices, increase public awareness, and engage worldwide.

VII. SCREEN SHOTS

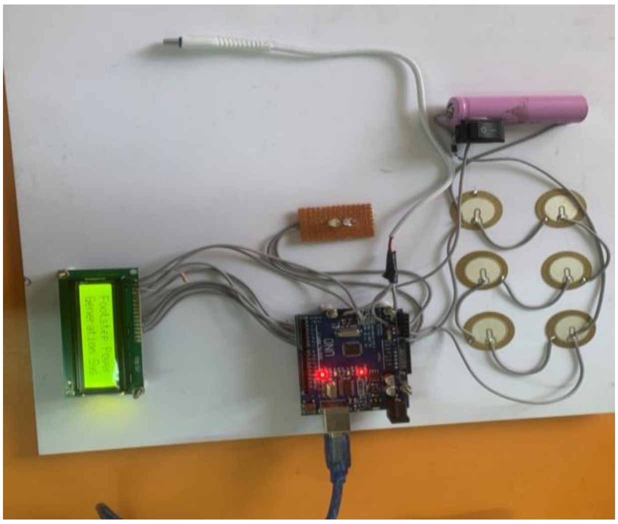

Figure 7.1 – Footstep power generation

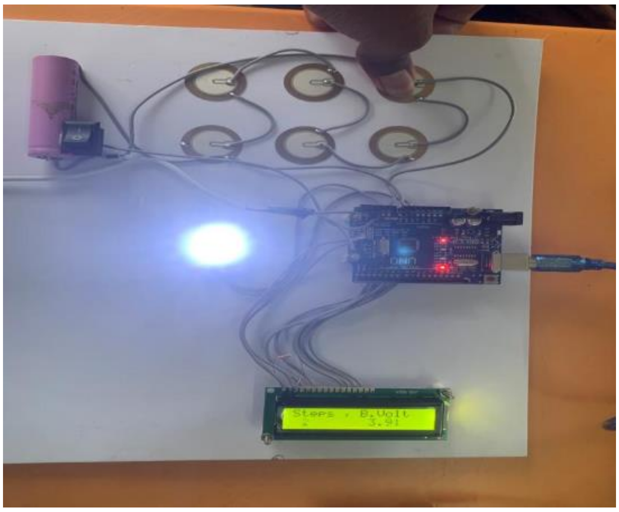

Figure 7.2 – Giving pressure to sensor

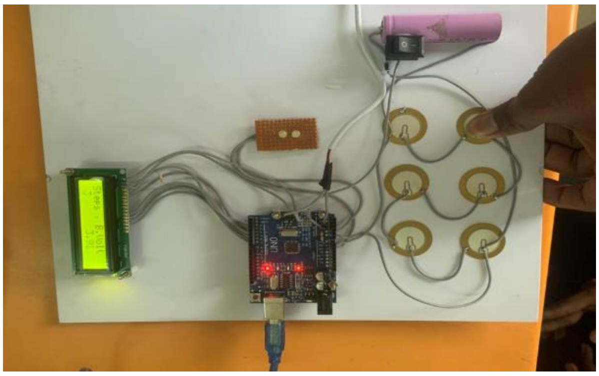

Figure 7.3 – Charging to battery

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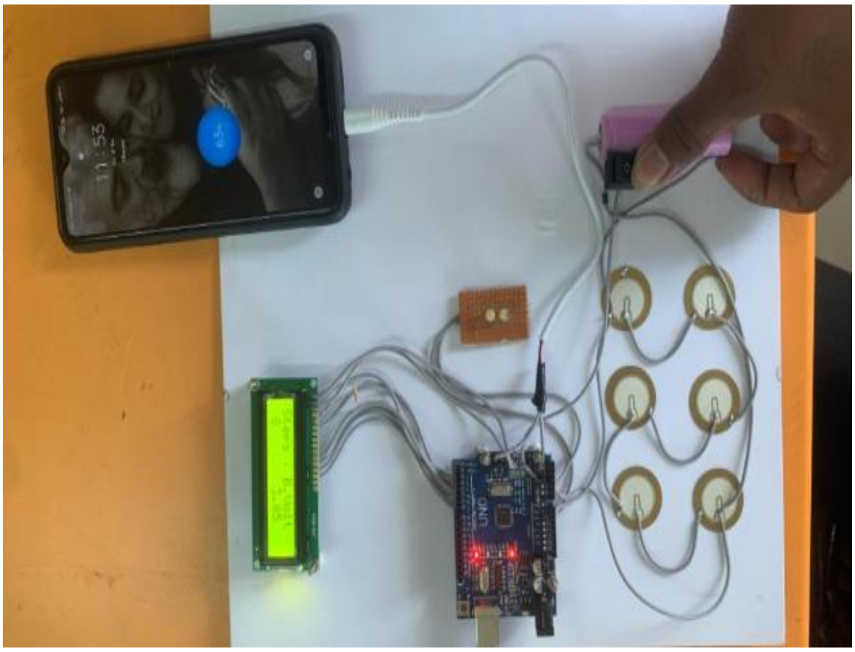

Figure 7.4 – Charging to mobile

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