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ENERGY in EVERY STEP: An IOT based Arduino-Powered Smart Footstep Power Generator

Dr.Rashmi R
Associate Professor, Dept, of CSE
Vemana Institute of Technology, Bengaluru, India
rashmi.r@vemanait.edu.in
https://orcid.org/0000-0001-8641-8042
C.Naveen Kumar Reddy,Anil B N,Ashok A V,Chethan Kumar S
Student, Department of CSE
Vemana Institute of Technology, Bengaluru, India
chinnathimmanagarinaveen@gmail.com, anilbnani589@gmail.com
ashokav2004ven@gmail.com, chethanchethan4321@gmail.com

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Abstract: The Smart Footstep Power Generator is an innovative system designed to harvest energy from human footsteps using piezoelectric sensors. As individuals walk over the embedded tiles, mechanical pressure is converted into electrical energy, which is then stored in a battery for later use. This system is especially useful in crowded areas such as railway stations, airports, or shopping malls where foot traffic is high, ensuring continuous energy generation. The generated energy can power small devices like LED lights or sensors, contributing to sustainable and green energy initiatives. This project not only promotes renewable energy but also encourages awareness about energy conservation through practical implementation this project also integrates a microcontroller-based system to efficiently manage power storage and distribution. The Arduino microcontroller monitors voltage levels and ensures optimal charging of the battery, while an LCD display provides real-time updates on voltage output and energy generation. This intelligent interface adds educational and practical value to the system, making it suitable for implementation in smart city infrastructure. Furthermore, the design is scalable, low-cost, and easy to maintain, making it ideal for both urban and rural settings. By transforming everyday movement into a valuable energy source, the Smart Footstep Power Generator exemplifies the potential of combining technology and sustainability. An Arduino microcontroller manages the entire process, controlling the flow of energy and sometimes displaying the power generation through an LED. This setup can be used in areas with heavy foot traffic, such as walk ways or smart buildings, to power small devices like lights or sensors.
Keywords: piezoelectric, renewable energy, footstep power, energy harvesting, green technology.

I. INTRODUCTION

A Smart Footstep Power Generator using Arduino is a simple and eco-friendly system that converts the energy from footsteps into electrical power. The system works by using piezoelectric sensors, which generate electricity when pressure is applied, like when someone steps on them. The electricity produced is typically alternating current (AC), so it's converted to direct current (DC) using a rectifier. The generated power is then stored in a battery or capacitor for later use. An Arduino microcontroller manages the entire process, controlling the flow of energy and sometimes displaying the power generation through an LED. This setup can be used in areas with heavy foot traffic, such as walkways or smart buildings, to power small devices like lights or sensors. By harnessing the energy from daily human activity, this project offers a sustainable and low-cost solution for generating clean energy. The Smart Footstep Power Generator project offers a practical method to harness renewable energy through human motion. As people walk over specially designed tiles embedded with piezoelectric materials, the mechanical stress from footsteps is converted into electrical energy. This mechanism relies on the piezo electric effect where specific materials generate.

II. SCOPE

The scope of a Smart Footstep Power Generator using Arduino extends to a wide range of practical applications and benefits, especially in promoting sustainability and harnessing energy from everyday human activity. The technology is especially relevant in urban settings, where foot traffic is abundant, and it offers an innovative way to generate power in an environmentally friendly manner. The scope of the Smart Foot step Power Generator extends far beyond a basic energy-harvesting experiment.

It provides a foundational framework for transforming passive human activity into a usable source of electrical energy. In urban environments with dense populations, such as metro stations, shopping malls, school corridors, and public parks, this technology can be seamlessly integrated into the existing infrastructure to generate supplementary power. The generated energy, although modest in individual output, can cumulatively power LED lighting, sensor-based systems, display screens, or charge portable devices. It not only offsets the energy demand from traditional sources but also encourages the adoption of micro-energy harvesting technologies that align with green building principles and sustainable urban development. From a technological standpoint, the project covers a wide range of disciplines including electronics, embedded systems, energy storage, and renewable energy management. The modular design allows for expansion by simply adding more piezo electric tiles in parallel or series, depending on the required voltage and current output. The inclusion of Arduino adds program ability and control, making the electric charge in response to mechanical stress. To make the generated energy usable, a rectification process is performed using a bridge rectifier, converting alternating current (AC) to direct current (DC). This DC energy is then stored in a rechargeable battery or a super capacitor. The Arduino microcontroller serves as the brain of the system, overseeing data collection from sensors. This setup can be used in areas with heavy foot traffic, such as walkways or smart buildings, to power small devices like lights or sensors. By harnessing the energy from daily human activity, this project offers a sustainable and low-cost solution for generating clean energy. Project not only presents a technological innovation but also invites a shift in mindset encouraging us to see energy not as a distant utility, but as something we generate with every step we take. The global demand for renewable energy sources has driven a significant shift toward decentralized and environment friendly power solutions. Among the various emerging methods of energy harvesting, mechanical-to electrical energy conversion using piezoelectric materials has proven to be both promising and practical. The Smart Footstep Power Generator using Arduino aims to harness the untapped potential of kinetic energy generated by human footsteps, particularly in areas of high pedestrian activity. At its core, this project utilizes piezoelectric sensors, which produce an electrical charge in response to mechanical stress. These sensors are strategically embedded under a platform or flooring surface that converts the force of footfalls into alternating current (AC). Since most electronics and storage units operate on direct current (DC), the circuit includes a rectifier to convert AC to DC. The Arduino microcontroller plays a pivotal role in the operation and monitoring of the system. It processes sensor data, manages voltage regulation, controls load switching, and interfaces with output modules like LED indicators or LCD displays. This integration not only improves user interaction but also allows for scalability and smart functionalities such as real-time feedback, data logging, or even IoT connectivity. In today's urban landscapes, energy wastage is a persistent issue. Every step taken in crowded places like metro stations, shopping malls, schools, or public parks carries with it a form of energy that traditionally goes unutilized. The idea of capturing this otherwise wasted kinetic energy and turning it into a usable power source reflects a transformative approach to energy management. Not only does it reduce dependency on conventional power grids, but it system intelligent and adaptable to various applications such as footfall monitoring, data logging, or load balancing. Furthermore, the scope includes integration with IoT networks for cloud- based data transmission, allowing facility managers or city planners to monitor energy generation in real- time. This opens the door to advanced implementations like adaptive lighting control, predictive maintenance, and user-based interaction systems. In rural or remote areas where access to reliable power is limited, this system can offer a decentralized and sustainable alternative. In educational institutions, the setup can be used as a live demonstration to teach students about the principles of piezoelectricity, circuit design, and sustainable engineering practices. Beyond the technical applications, the project also supports environmental awareness by encouraging individuals to rethink how every day actions like walking can contribute to energy sustainability. Overall, the scope of this project is not just limited to energy generation but expands to education, innovation, sustainability, and infrastructure enhancement across diverse environments.

The Smart Footstep Power Generator embodies a practical application of technology aimed at solving real-world problems. It serves as a bridge between mechanical energy and digital systems, proving that innovation and sustainability can walk hand in hand. With continued research and development, footstep energy systems could one day become standard in building infrastructure. Floors could become interactive energy sources, turning public movement into public benefit. This approach aligns with several UN Sustainable Development Goals, particularly those related to affordable and clean energy, sustainable cities and communities, and climate action. Through continuous improvement, rigorous testing, and user-centric design, the Smart Footstep Power Generator can evolve from a prototype to a commercial product with significant societal impact. The Smart Foot step Power Generator using Arduino aims to harness the untapped potential of kinetic energy generated by human footsteps, particularly in areas of high pedestrian activity. At its core, this project utilizes piezo electric sensors, which produce an electrical charge in response to mechanical stress. These sensors are strategically embedded under a platform or flooring surface that converts the force of footfalls into alternating current (AC). also promotes energy conservation and environmental awareness among the public. Additionally, this project serves as an interdisciplinary platform that integrates concepts from electronics, embedded systems, mechanical engineering, and renewable energy technologies. It is an ideal prototype for educational demonstrations, research applications, and even potential commercialization. The system's cost- effectiveness, simplicity, and portability further enhance its suitability for rural development, emergency response scenarios, and sustainable infrastructure planning. The control logic within the Arduino can also be enhanced to monitor system health, detect faults, or log performance data. With the help of appropriate sensors and programming, the system can diagnose when components fail or need maintenance. A feedback mechanism, such as audio-visual signals, can inform users that energy has been harvested. This kind of reinforcement can make the experience more engaging, especially in public demonstration settings or exhibitions.

In addition to energy storage, real-time energy usage is also available application. The generated power can directly drive low-power devices like LED lights, display screens, or charging ports for small electronics, making the system both functional and illustrative. The integration of advanced sensors such as force-sensitive resistors can help determine the exact pressure applied on each foot step. This data can be used to calibrate energy output and even study pedestrian behaviour. The Smart Footstep Power Generator can also contribute to security and surveillance. If combined with pressure-sensing and RFID modules, the system can detect unauthorized access or monitor crowd movement in sensitive areas. The future of foot step energy lies in hybrid systems. By combining piezoelectric energy harvesting with other sources such as solar or electromagnetic induction, a more stable and efficient power system can be realized. As battery technology continues to evolve, new forms of energy storage like graphene super capacitors or solid-state batteries could further enhance the efficiency and lifespan of footstep-based generators. The materials used in the platform should also be carefully selected for both mechanical strength and environmental friendliness. Recycled plastics, composites, or biodegradable materials can make the entire system more sustainable.

III. OBJECTIVES

The objectives focus on creating a functional, sustainable, and affordable energy generation system using footstep power, with an emphasis on ease of use, environmental impact, and educational potential.

Energy Harvesting from Foot steps: To design and develop a system that captures mechanical energy from footsteps and converts it into electrical energy using piezoelectric sensors.

Integration with Arduino: To utilize an Arduino microcontroller for processing the signals from the piezoelectric sensors, managing the energy flow, and controlling the storage of the generated power.

Power Conversion and Storage: To convert the alternating current (AC) generated by the piezoelectric sensors into direct current (DC) using a rectifier and store the generated energy in a battery or capacitor for later use.

Real-time Monitoring: To implement an LED or other visual indicators that display the power generation process, allowing users to track how much energy is being generated and stored.

Sustainable Energy Solution: To create an eco- friendly, sustainable method of energy generation using natural human movement, reducing the reliance on conventional electricity sources in areas with high foot traffic.

Cost-Effective Power Source: To provide an affordable, low-maintenance solution for powering small electronic devices, sensors, or lights in environments like smart cities, commercial buildings, or public spaces.

Demonstrating Feasibility: To demonstrate the practicality and efficiency of using footstep generated energy in real-world applications, helping raise awareness of renewable energy sources.

Educational Value: To create a project that can be used as a learning tool for students and engineers, showing how energy harvesting technologies and Arduino can be applied to solve real world challenges

IV. IMPLEMENTATION

The software implementation of the Smart Footstep Power Generator is carried out using the Arduino IDE platform. The Arduino Uno is programmed in embedded C/C++ to control the system operations. The program begins by initializing the input pins connected to the sensors and the output pins linked with the LCD and battery monitoring circuit. Once the system is powered, the code continuously reads the analog signals generated from the piezoelectric sensors or pressure mechanism. These analog values are converted into digital form using the inbuilt ADC of the Arduino. The microcontroller then calculates the corresponding voltage level produced by each foot step. The processed data is displayed on the LCD module in real time, showing both instantaneous voltage and cumulative energy stored. In addition, safety conditions such as overvoltage protection are implemented in the code to avoid damage to the storage unit. The logic flow is structured using conditional statements and loops for continuous monitoring. Interrupt routines are applied to ensure accurate measurement of sudden input changes caused by footsteps. The software also maintains a counter to track the total number of steps and their contribution to energy generation. If an IoT module is interfaced, the program further uploads energy data to a cloud server for remote monitoring. By combining signal processing, voltage regulation, and display operations, the Arduino code ensures efficient system control. The modular design of the program makes it easy to upgrade for future applications such as wireless transmission or mobile app integration. Furthermore, the software is designed to be lightweight and optimized for the limited memory and processing capability of the Arduino Uno. Proper delay management and non-blocking code structures are used to ensure smooth execution without missing sensor events. The program periodically calibrates sensor readings to reduce noise and fluctuations caused by uneven foot pressure or environmental variations. Filtering techniques such as averaging of multiple sensor samples are applied to improve the accuracy of voltage measurement.

V. REQUIREMENTS

It defines the essential requirements needed to design, build, and operate the Smart Foot step Power Generator using Arduino. These requirements are categorized into functional, non-functional, hardware, and software components. Each of these plays a critical role in ensuring the smooth execution and reliability of the overall system.

Functional Requirements

- **Energy Generation:** The system must convert mechanical pressure from footsteps into electrical energy using piezoelectric sensors.
- **Energy Storage**: The generated energy must be stored in a rechargeable battery or capacitor system.
- **Voltage Regulation:** The output energy must be regulated to maintain a steady voltage level suitable for device charging or lighting.
- **Data Acquisition:** The Arduino microcontroller should record the energy produced and display real-time values if needed.

- **Sensor Detection:** Piezo sensors should respond effectively to varying footstep pressures.

Non Functional Requirements

- **Efficiency**: The system should convert at least 60–70% of mechanical energy into usable electrical energy under ideal conditions.
- **Reliability**: It must work consistently for users of different weights and footstep intensities. System performance should not vary with usage patterns.
- **Durability**: The hardware especially the piezo sensors should resist wear from repeated mechanical stress. Long-term use should not affect functionality.
- **Cost-Effectiveness:** Components must be low-cost and easy to source from common electronics vendors. The goal is to keep the system affordable for wide adoption.

Software Requirements

- **Arduino IDE:** Main platform to write and upload code to Arduino. It supports C/C++ and serial monitoring.
- **Embedded C/C++:** Programming language used for writing system logic. It controls sensor input and output actions.
- **Serial Monitor:** Tool with in Arduino IDE for viewing real-time data. Useful for testing sensor output and debugging code.
- **Proteus / Multisim (Optional):** Simulation software for testing circuit designs virtually. Helps verify connections before physical setup.
- **Excel/Google Sheets (Optional):** Used to analyze collected energy data and visualize trends. Helps in creating performance charts and reports

Hardware Requirements

- **Piezoelectric Sensors:** These sensors generate voltage when pressed by footsteps. They form the core of the energy harvesting process.
- **Arduino Uno/Nano:** A microcontroller that collects sensor data and manages control logic. It's used for programming and automation.
- **Bridge Rectifier (Diodes):** Converts the AC signal from piezo sensors into DC. Ensures the energy can be stored or used by devices.
- **Voltage Regulator (e.g.7805 IC):** It keeps the output voltage stable to protect connected devices. It prevents power spikes from damaging the circuit.
- **Capacitors:** Store small amounts of energy and smooth voltage fluctuations. Useful for stabilizing short bursts from footsteps.
- **Rechargeable Battery or Power Bank**: Stores the collected electrical energy for later use. Enables powering external devices or loads.
- **LCD Display (Optional):** Displays live information like voltage, step count, or energy output. Helps users monitor system performance easily.

VI. ARCHITECTURE DESIGN

The below Fig1.1shows system architecture shows Smart Footstep Power Generator and it begins with a piezo tile that captures mechanical energy from footsteps. This mechanical pressure is transferred to a piezoelectric transducer, it converts into alternating electrical signal. This output is AC and not directly usable, it is passed through a bridge rectifier, it converts the AC into DC voltage. This rectified voltage is then monitored by a voltage sensor, it plays a dual role and it provides input to an Arduino microcontroller and also determines whether the voltage level is sufficient to charge a battery.

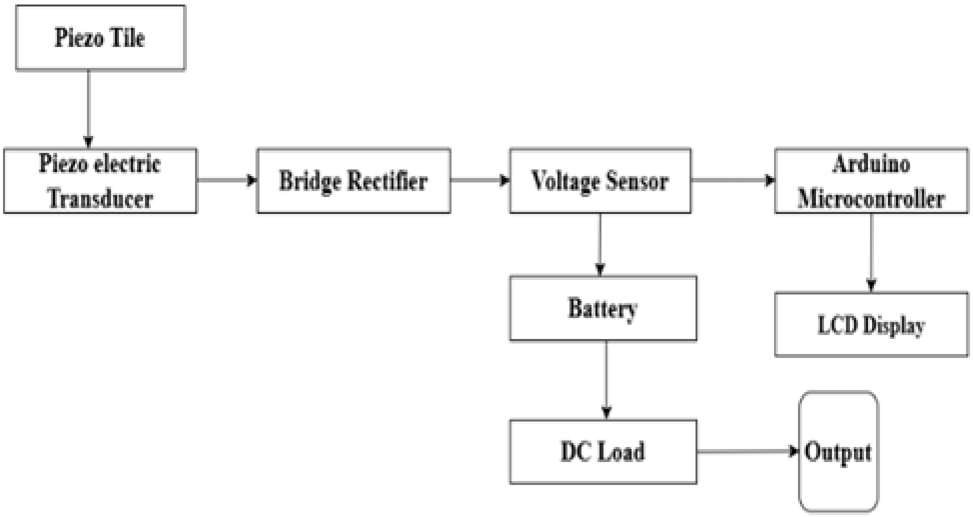

Fig 1.1 Architecture

Simultaneously the Arduino microcontroller receives real-time voltage data from the sensor and displays relevant information like voltage levels or footstep counts on an LCD screen. This integrated design ensures efficient energy conversion, intelligent monitoring, and user-friendly interaction, making the system not only functional but also educational and scalable for larger applications.

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The piezo tile serves as the initial point of energy generation in the system. When a person walks over or applies pressure to the tile, it undergoes mechanical stress. This mechanical stress is then converted into a small amount of electrical energy through the piezoelectric effect, forming the foundation of the system's energy harvesting process. The bridge rectifier takes the alternating current output from the piezo electric transducer and converts it into direct current (DC). This step is crucial because most electronic components, such as batteries and microcontrollers, require DC power to function properly. The rectifier ensures the energy can be effectively stored or used. This output is AC and not directly usable, it is passed through a bridge rectifier, it converts the AC into DC voltage. This voltage sensor is used to measure the level of direct current voltage coming from the rectifier. It plays a key role in monitoring the system's energy output and ensuring the voltage remains within a safe and usable range. The sensor data is sent to the microcontroller for further processing and decision making. The battery is used to store the electrical energy generated from foot pressure. It acts as an energy reserve that can supply power even when no one is stepping on the tiles. This storage capability allows for continuous operation of connected devices, regardless of real-time human activity. The DC load represents any external device or circuit that consumes the stored energy. This could include systems like LED lighting, sensors, or other small electronic devices. The energy harvested from footsteps is put to practical use here, demonstrating the efficiency and utility of the energy conversion process.

VII. COMPARATIVE ANALYSIS

The reviewed studies collectively underscore the viability of footstep energy harvesting as a supplementary power source. While each study presents unique methodologies and applications, common themes emerge. The below table 2.1 represents the Voltage Output Derived from different weights and the force generating from the weights are shown below.

Table1.1 Comparative Analysis

Weight (Kg)	Force (N)	Min Voltage (V)	Max Voltage(V)
10kg	~98N	1.5V	2.5V
20kg	~196N	2.7V	3.9V
40kg	~392N	4V	5.3V
60kg	~588N	9V	12.7V
80kg	~784N	12.3V	15V
100kg	~980N	13.7V	17.6V

As the applied weight increases, the mechanical stress on the piezoelectric sensor grows, resulting in higher voltage output. This behavior validates the sensor's rectified voltage is then monitored by a voltage sensor, it plays a dual role. functionality and confirms the effectiveness of the system across a broad range of user weights. It also underscores the need for appropriate energy regulation and storage mechanisms when dealing with heavier loads.

VIII. CIRCUIT DIAGRAM

The Fig 1.2 explains circuit diagram represents a footstep power generation system using piezoelectric sensors integrated with an Arduino Uno. Multiple piezoelectric sensors are embedded on to an acrylic sheet to harness mechanical pressure from footsteps and convert it into electrical energy.

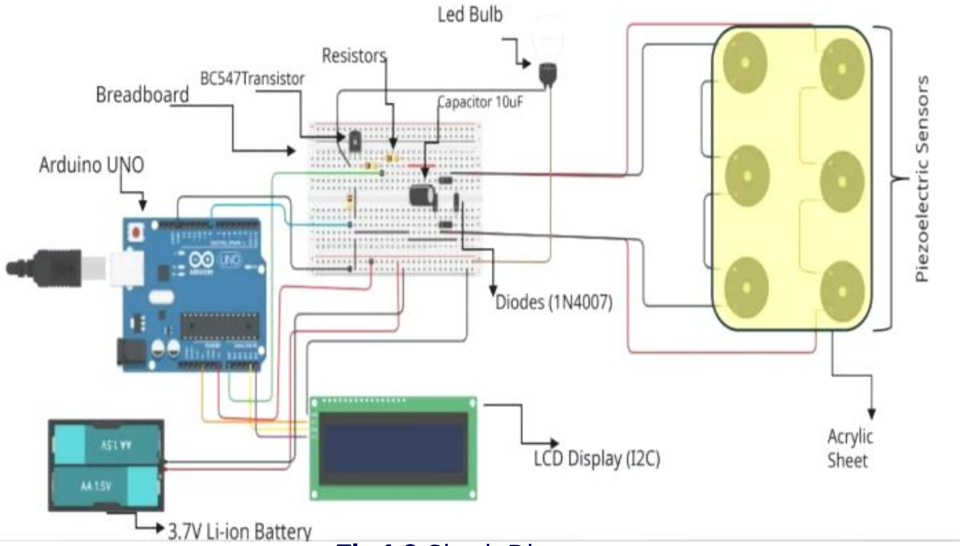

Fig 1.2 Circuit Diagram

These sensors are connected to a bread board circuit that includes key components such as a BC547 transistor, resistors, diodes (1N4007), and a 10μF capacitor, which help in rectifying, filtering, and regulating the generated voltage. The rectified DC output charges a 3.7V Li-ion battery, which then powers an LED bulb as a load indicator. The system also incorporates an LCD display (I2C interface) to show real-time voltage output or system status, controlled by the Arduino Uno. The microcontroller manages data input and output, ensuring accurate monitoring and smooth system functionality. This setup demonstrates how mechanical energy from human steps can be efficiently harvested and utilized for low-power applications.

The Smart Footstep Power Generator system is a renewable energy project designed to convert mechanical energy from human footsteps into usable electrical energy. The circuit utilizes piezoelectric sensors embedded under an acrylic sheet to detect pressure from footsteps. Each foot step applies force on the piezo elements, generating a small alternating voltage. This energy is then captured and routed through a series of electrical components.

IX. TESTING

System testing is conducted to verify that all components of the Smart Footstep Power Generator work together correctly and deliver the expected output. During this phase, the piezoelectric sensors, rectifier circuit, Arduino controller, battery, and LCD display are tested as a complete unit to ensure proper interaction and performance. Multiple footsteps with varying pressure levels are applied to check voltage accuracy, energy storage efficiency, and display responsiveness. Any issues such as unstable readings, wiring faults, or irregular voltage outputs are identified and corrected. This testing process ensures the system is reliable, safe to use, and capable of producing consistent results under real-world conditions. The first phase of testing focuses on verifying the core operational principle of the system: the piezoelectric effect. Each installed piezoelectric sensor is individually tested by applying a known, controlled amount of pressure (simulating a footstep). The primary test confirms that the sensor successfully generates an Alternating Current (AC) voltage output, validating its function as a mechanical-to-electrical transducer. Further tests ensure the voltage amplitude scales predictably with the applied pressure, establishing a calibration curve for different user weights and confirming the uniformity and consistency of all sensors used in the platform. Following the validation of individual sensors, the rectification and filtering stage is tested to confirm efficient conversion of the generated AC signal into a stable Direct Current (DC) output. The bridge rectifier circuit is examined under different foot step frequencies to ensure minimal power loss and consistent voltage smoothing. Capacitors used in the filtering stage are monitored for proper charge and discharge behavior, ensuring that voltage ripples remain within acceptable limits. This phase confirms that the electrical output is suitable for storage and further processing. The Arduino controller testing phase focuses on verifying accurate data acquisition and processing. Analog input pins are checked for correct voltage sampling, and the Analog-to-Digital Converter (ADC) rectification, storage, and display. The system is centered on an Arduino UNO, which handles control logic and communication. A 3.7V lithium- ion battery is used to store the generated electricity. The circuit includes six piezoelectric discs connected in parallel, improving current output while maintaining voltage levels. They are widely used in switching and amplification. The transistor must be oriented correctly on the breadboard. Improper pin placement may result in circuit failure. The LED bulb is selected to match the available voltage and current. It is placed to visually represent system activity. The LED's anode is connected to the transistor's collector, and cathode to ground. The transistor also ensures the battery is not drained unnecessarily. Thus, it optimizes load management and protects components. The code is uploaded via the Arduino IDE on a computer. Functions such as analog Read, digital Write, and delay are used in programming. The microcontroller adds logic and flexibility to the system. It interprets raw voltage data into usable signals. The Arduino's 5V output can also power other low-power components. It communicates with the LCD over I2C using the SDA and SCL pins. The Arduino ensures the circuit is interactive and adaptable. It can be programmed to log data or send it wirelessly. Proper grounding and stable power input are essential for smooth operation. It ensures coordinated behaviour between the piezo system, transistor, and display. It bridges the gap between analog sensing and digital control. The Arduino makes the system smart and responsive. It is the central control hub for the energy harvesting setup. Messages such as “Power On,”“Voltage Detected,” or “Battery Charging” can be displayed. It makes the system user-friendly and informative. The display includes a backlight for readability in low light. The I2C address must be configured correctly in the Arduino code. The LCD is mounted securely on a flat surface for visibility. The display updates in real-time as new data is received. Its integration improves user interaction and diagnostics. Display code uses the LiquidCrystal_I2C library in Arduino IDE. The library provides functions like lcd print() and lcd set Cursor(). It is compact and energy efficient. The display gives immediate confirmation of successful power generation. Resolution is evaluated for precision and repeatability. Multiple test cycles are conducted to ensure that the microcontroller correctly interprets varying voltage levels generated by footsteps. The calculated voltage and step count values are cross-verified using external measuring instruments to confirm computational accuracy. Energy storage testing is performed by observing the charging behavior of the battery or capacitor over extended periods of footstep activity. The system is tested for proper charging thresholds and safe cut-off condition stop revent over charging. Discharge tests are also conducted by powering low-load devices, confirming the usability of stored energy. These tests validate the effectiveness of the storage unit and the protection logic implemented in both hardware and software. The LCD display module undergoes functional testing to ensure real-time and accurate visualization of system parameters. Display readability, refresh rate, and data consistency are evaluated under continuous operation the system is also tested for fault scenarios, such as sensor disconnection or low voltage conditions, to confirm that appropriate warning messages or indicators are shown. Integration testing is carried out by operating the system continuously under simulated real-world conditions, including varying step intensity, frequency, and duration. The system's stability, responsiveness, and power output consistency are closely monitored. Environmental factors such as temperature variations and mechanical vibrations are also considered to assess system robustness. The primary test confirms that the sensor successfully generates an Alternating Current (AC) voltage output, validating its function as a mechanical-to-electrical transducer.

X. ACKNOWLEDGEMENT

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XI. RESULTS

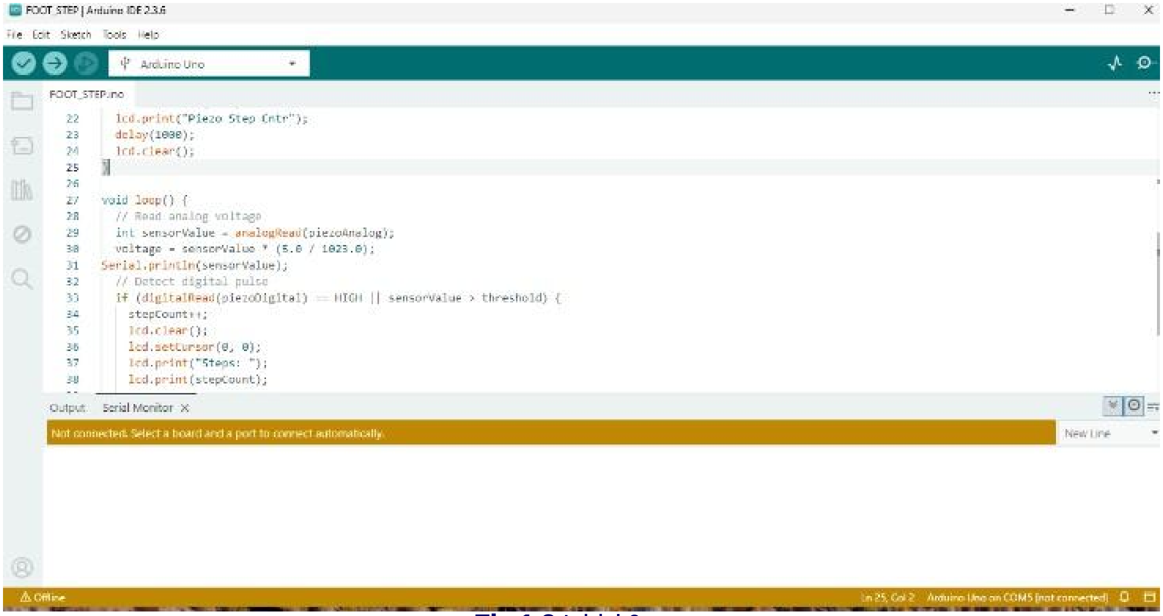

Fig 1.3 Initial Stage

The picture shows the Arduino IDE window with a program written for the Smart Footstep Power Generator project. The code reads voltage values from a sensor connected to the Arduino, converts the analog signal into a readable voltage value, and displays the step count and voltage on an LCD screen. It also prints the same information to the Serial Monitor for debugging and observation. The message at the bottom indicates that the Arduino board is not currently connected to the computer

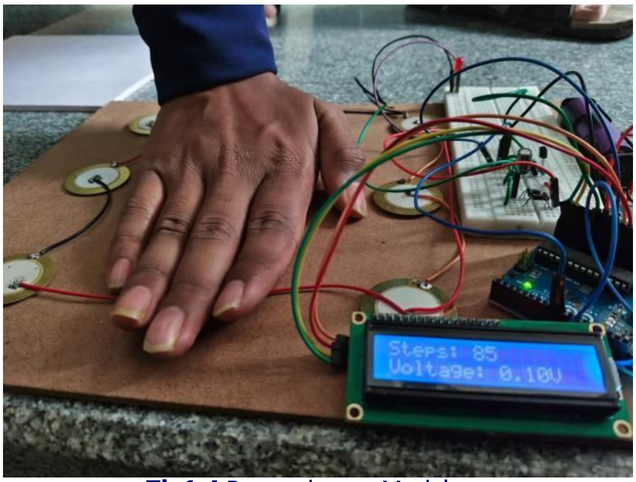

Fig1.4 Pressuring on Model

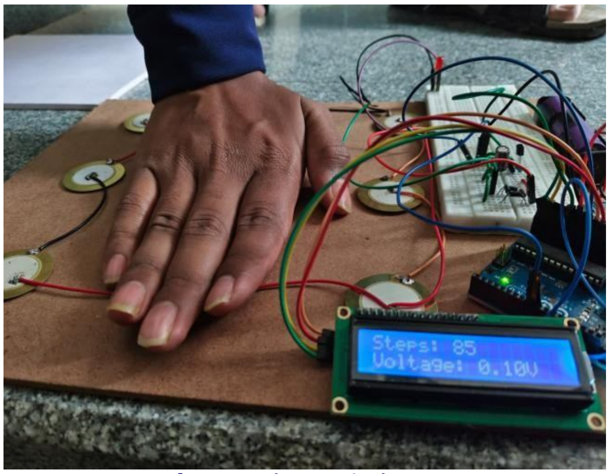

Fig1.5 Voltage Display on LCD

Fig1.6 Step Count on Serial Monitor

The picture shows a Smart Footstep Power Generator proto type in operation. A hand is pressing on piezoelectric sensors mounted on a board, simulating a footstep that generates electrical energy. The sensors are connected through wires to an Arduino controller, which processes the generated voltage. The LCD display clearly shows the number of steps detected and the voltage produced, demonstrating real-time energy generation and monitoring. The figure shows the voltage display of the Smart Foot step Power Generator system in real time. When pressure is applied to the piezoelectric sensors, an electrical voltage is generated and processed by the Arduino controller. The LCD module displays the total number of detected steps along with the corresponding voltage value produced, indicating successful energy generation and measurement. This visual output helps in monitoring system performance and validating the effectiveness of the footstep-based power generation. The figure shows the Arduino IDE with a program running for the Smart Footstep Power Generator system. The code reads input values from the piezo electric sensor, processes the voltage using the Arduino's analog and digital pins, and updates the step count based on detected pressure. The Serial Monitor at the bottom displays real-time step values, confirming that the Arduino is correctly receiving and processing sensor data. This setup helps in testing, debugging, and verifying the system's functionality during operation.

XII. CONCLUSIONS AND FUTURE ENHANCEMENTS

The Smart Foot step Power Generator using Arduino is an innovative and practical solution that utilizes renewable energy principles to convert human movement into electrical energy. As modern society continues to seek clean, sustainable energy sources, this project stands out for its simplicity, lowcost, and real-world relevance. Throughout this project, we designed a prototype that effectively harvests energy from piezoelectric sensors embedded under a platform. Key Future Enhancements [1]. Enhanced Energy Harvesting and Efficiency Hybrid Energy System: Integrate a secondary, complementary energy source, such as small solar panels placed on the platform's edges or a small electromagnetic generator to harvest energy from the low-frequency movement.[2] IoT Integration and Smart Monitoring Cloud-Based Monitoring (IoT): Upgrade the Arduino Uno to a Wi-Fi enabled microcontroller (like the Node MCU or ESP32). This enables the system to transmit real-time data on voltage generated, battery status, and foot traffic count to a cloud platform. The Smart Foot step Power Generator using Arduino presents an effective approach to harnessing renewable energy by converting everyday human movement into usable electrical power. As the demand for sustainable and eco-friendly energy solutions continues to rise, this project demonstrates a practical method of energy harvesting that is both economical and easy to implement. The developed prototype successfully captures mechanical pressure through piezoelectric sensors embedded beneath a walking platform and converts it into electrical energy, which is then monitored and stored efficiently. The system proves that even small, repetitive human actions can contribute to energy generation when properly utilized. One of the major strengths of this project lies in its scalability and adaptability for real-world environments such as railway stations, shopping malls, educational institutions, and public walkways. TheArduino-based control unit ensures accurate data processing, real-time monitoring, and safe energy storage, making the system reliable for continuous operation.

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