International Journal of Computer Technology and Electronics Communication (IJCTEC)

| ISSN: 2320-0081 | www.ijctece.com ||A Peer-Reviewed, Refereed and Bimonthly Journal |

|| Volume 9, Issue 3, May- June 2026 ||

DOI: 10.15680/IJCTECE.2026.0903002

Smart IoT Based Pedestrian Power Generator using Dc Motor

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Publication History: Received: 03.04.2026; Revised: 01.05.2026; Accepted: 04.05.2026; Published: 08.05.2026.

ABSTRACT: This project is about creating a smart system that can generate electricity from human walking. When a person steps on a steel plate with a spring, the pressure moves a DC motor. The motor changes the mechanical energy of walking into electrical energy. Jumper wires connect the motor to an Arduino board, which controls the system. The generated power is stored in a lithium battery. The Arduino board helps in monitoring and sending data, making the system part of the Internet of Things (IoT). The main idea is to use simple human activity walking to produce clean energy. This energy can be used for small devices or stored for later use. The system is low-cost, eco-friendly, and useful in crowded places like bus stops, railway stations, and shopping malls where many people walk every day. The concept of smart cities, where human activity is harnessed to power streetlights, charging stations, or small-scale electronic devices. IoT-based pedestrian power generator represents a step toward sustainable urban infrastructure, combining mechanical energy conversion with intelligent monitoring to create a reliable and eco-friendly energy source. The outcome is a reliable, decentralized, and environmentally responsible energy source that aligns with global efforts to combat climate change and enhance energy efficiency. Future enhancements may include advanced energy management algorithms, wireless data transmission, and integration with smart grids, thereby expanding the scope and impact of pedestrian-powered energy systems. In addition, the system can be enhanced by integrating multiple footstep units to increase overall power generation efficiency in high-traffic areas. Overall, the project demonstrates a practical and innovative method for utilizing human movement as a renewable energy resource in smart city environments.

KEYWORDS: Spring, DC Motor, Jumper Wire, Arduino Board, LCD Display, Lithium Battery, DC - DC Buck Converter.

I. INTRODUCTION

The Internet of Things (**IOT**) refers to a network of physical devices that are embedded with sensors, software, and communication technologies, enabling them to collect, exchange, and process data over the internet. These devices can monitor real-time conditions, communicate with other systems, and perform intelligent actions with minimal human intervention. IoT plays a crucial role in modern smart systems by enabling automation, remote monitoring, and efficient resource management. In energy-related applications, IoT helps in tracking power generation, energy consumption, and system performance in real time. Data collected from sensors is transmitted to cloud platforms where it can be analyzed and visualized using web or mobile applications. In the IoT Based Smart Pedestrian Power Generator Using DC Motor, IoT technology is used to monitor electrical parameters such as voltage, current, and battery status. This allows real-time observation of power generation from pedestrian movement and improves system efficiency, reliability, and maintenance. By integrating IoT, the system becomes intelligent, scalable, and suitable for smart city and sustainable energy applications.

II. LITERATURE SURVEY

In 2025, Siddartha Reddy et al. focused on generating electrical energy from human footsteps using piezoelectric sensors along with GPS tracking. The system converted mechanical pressure into electrical energy and stored it in batteries while also providing location tracking. Although the system offered dual functionality and real-time monitoring, it faced challenges such as power management complexity, mechanical wear, and limited power output.

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In 2025, Glory Ram et al. developed an IoT-based smart footstep power generation and monitoring system. The system utilized various approaches such as piezoelectric and mechanical mechanisms to generate electricity and store it for low-power applications. IoT integration enabled real-time monitoring and data analysis. However, the system suffered from low energy generation, high installation cost, and dependency on pedestrian traffic.

In 2025, Prajakta Vijay Nikam et al. proposed an advanced IoT-based footstep power generation system. The system converted mechanical energy into electrical energy using sensors and integrated IoT for monitoring and control. It improved energy efficiency and system reliability, but limitations included low power output, mechanical wear and tear, and dependency on internet connectivity.

In 2025, Saundane Bharati et al. introduced a footstep power generation system using piezoelectric sensors integrated with IoT technology. The system enabled renewable energy generation and real-time monitoring. Although the system was eco-friendly and scalable, it faced issues such as low power generation, environmental sensitivity, and security concerns due to IoT integration.

In 2025, Kritesh A. Chandra et al. presented a comprehensive review of various footstep energy harvesting systems, including piezoelectric, electromagnetic, and triboelectric technologies. The study analyzed different working principles and applications of these systems. Despite their potential, these systems generally produce low power output and face challenges such as mechanical complexity, material durability issues, and difficulty in real-world implementation.

Many researchers have worked on developing systems that generate energy from human footsteps and integrate IoT for monitoring. Some systems focus on energy generation using piezoelectric sensors, while others use mechanical methods such as DC motors. These systems help in utilizing renewable energy and supporting smart applications.

Some research works incorporate IoT technology to monitor parameters such as voltage, current, and power output in real time. This allows users to access data remotely through mobile or web applications. However, most of these systems mainly display data and do not provide advanced analysis or intelligent control.

Other studies focus on improving energy efficiency and storage mechanisms. While these systems enhance performance, they still face limitations such as low output power and dependency on continuous pedestrian movement.

From the existing studies, it is clear that most systems focus on only one aspect such as energy generation or monitoring. Very few systems integrate efficient energy generation, IoT monitoring, and intelligent control into a single platform.

Therefore, the proposed system aims to overcome these limitations by integrating efficient energy generation using a DC motor with IoT-based real-time monitoring and improved energy management to provide a complete smart solution.

III. PROBLEM STATEMENT

The effective utilization of human mechanical energy for sustainable power generation remains a significant challenge despite advancements in renewable energy technologies. Existing pedestrian energy harvesting systems, particularly those based on piezoelectric mechanisms, suffer from low power output, limited scalability, and inefficient energy conversion. Moreover, most conventional systems operate as standalone units without real-time monitoring, data analytics, or intelligent control, which reduces their efficiency and practical applicability in real-world environments. The absence of integrated monitoring systems further limits the ability to analyze key performance parameters such as voltage generation, energy storage efficiency, and usage patterns. Therefore, there is a need to develop an efficient and scalable pedestrian power generation system that enhances energy harvesting performance while integrating Internet of Things (IoT) technology for real-time monitoring, data analysis, and remote accessibility, thereby enabling intelligent energy management and supporting sustainable smart city applications.

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IV. RESEARCH & METHODOLOGY

The proposed system is designed to generate electrical energy from pedestrian movement using a DC motor–based mechanism integrated with IoT technology for real-time monitoring . When a person steps on the platform, mechanical energy is produced and transferred through a spring and mechanical linkage system, converting linear motion into rotational motion. This rotational motion drives a DC motor, which operates as a generator and converts mechanical energy into electrical energy based on electromagnetic induction. The generated electrical output is passed through a rectifier and voltage regulation circuit to obtain a stable DC supply, which is then stored in a rechargeable battery for later use. Sensors are used to measure key electrical parameters such as voltage and current, and the collected data is processed using an Arduino microcontroller. The processed data is displayed locally on an LCD and simultaneously transmitted to a cloud platform using an IoT communication module such as ESP8266. This enables real-time monitoring, data logging, and remote access through mobile or web applications. The system ensures efficient energy harvesting, storage, and utilization while providing intelligent monitoring and analysis, making it suitable for smart city and sustainable energy applications.

SYSTEM ARCHITECTURE

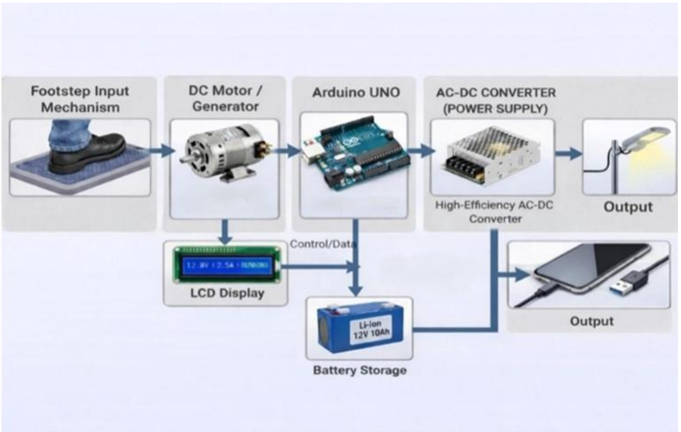

Fig.1.System Architecture for IoT Smart Pedestrian Power Generator using DC Motor

The fig.1 shows to Proposed IoT Based Smart Pedestrian Power Generator using DC Motor follows a modular system architecture that integrates mechanical energy harvesting, embedded processing, IoT communication, and cloud-based monitoring. The architecture is divided into four main layers: Input and Sensing Layer, Processing Layer, Communication Layer, and Application Layer.In the Input and Sensing Layer, mechanical energy generated from pedestrian footsteps is converted into electrical energy using a DC motor. Voltage and current sensors continuously measure the generated output, while a battery level monitoring unit tracks the stored energy status. These sensors provide real-time electrical parameters required for system monitoring. The sensor data is sent to the Arduino microcontroller, which acts as the main processing unit. It collects voltage, current, and power output readings, processes the signals, and prepares the data for IoT transmission.The Processing Layer consists of an Arduino microcontroller that collects sensor readings and performs initial data processing. The controller filters noise, calculates power output values, and manages device operations. This layer ensures accurate measurement and stable control of the energy harvesting system. The cloud infrastructure stores system data, performs analytics, and maintains secure communication through encryption mechanisms. The interface supports remote monitoring, data visualization, and alert notifications. Finally, the Application Layer provides a mobile or web-based dashboard where users can view real-time voltage, current, and power generation values. This layered architecture improves scalability, reliability, and efficiency, making the system suitable for smart city environments such as railway stations, malls, and public walkways

1. Energy Generation Module
This module consists of the mechanical footstep platform and DC motor arrangement. When pedestrians step on the platform, mechanical force is transferred through springs and linkages to rotate the DC motor. rectifier and voltage regulator are used to stabilize the generated output before it is supplied to the storage unit.

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Generated Voltage (DC Generator):

$$\boxed{E = k\phi\omega}$$

E= Generated EMF (Voltage) , k= Machine constant , ϕ= Magnetic flux , ω= Angular speed (rad/s)

Electrical Power Generated:

$$\boxed{P = VI}$$

P= Power (Watts), V= Voltage (Volts), I= Current (Amps)

2. Power Conditioning & Storage Module

The power conditioning module ensures that the electrical energy generated from the DC motor is stable and suitable for storage and usage. Since the output from the DC motor may fluctuate depending on pedestrian movement, a rectifier circuit is used to convert the generated voltage into a consistent DC output. The processed energy is stored in a rechargeable battery, which acts as an energy buffer and provides continuous power supply even when pedestrian activity is low.

Battery Charging Equation:

Q = I × t

$$\boxed{Q = I \times t}$$

Q= Charge (Coulombs or Ah)

3. Processing and Control Module

The Arduino functions as the main processing unit of the system. It collects data from all sensors, processes the readings, and calculates power output values. The processing unit also handles timing operations, data filtering, and error detection to improve system reliability. It acts as the central control unit of the system, responsible for acquiring sensor data, processing inputs, and managing system operations.

Energy Generated:

$$\boxed{E = P \times t}$$

E= Energy (Joules or Wh), t= Time

Force to Torque Relation (Footstep Input):

$$\boxed{T = F \times r}$$

F= Force from footstep, r = Radius of shaft

Angular Speed Conversion:

.

N= Speed in RPM

$$\boxed{\begin{matrix}\omega \\ 2\pi N\end{matrix}}$$

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V. RESULT

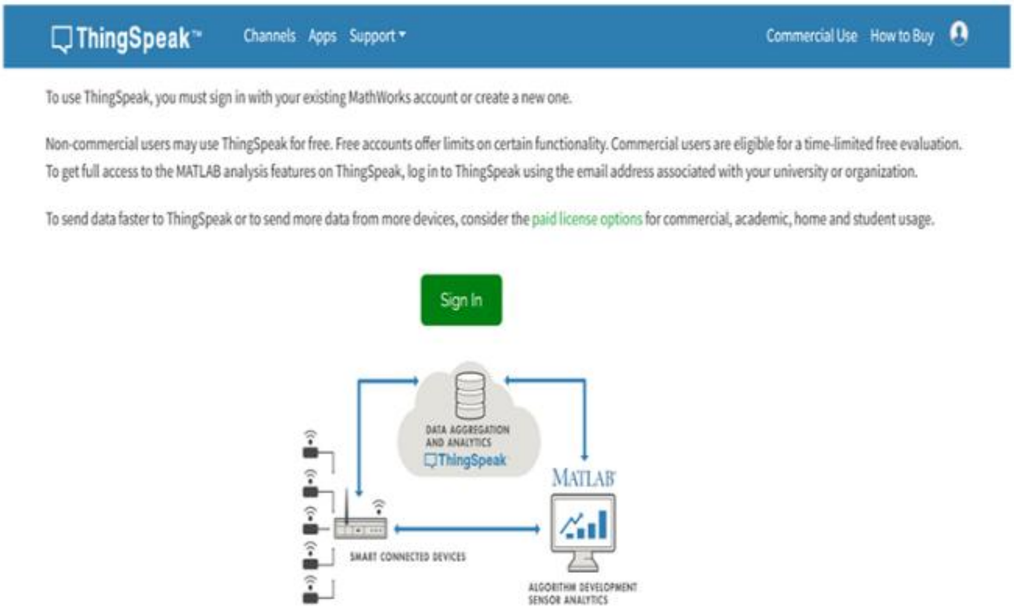

Fig.2.Thinkspeak Web Page

The fig.2 image shows that smart devices (like sensors or IoT modules) collect data and send it to the ThingSpeak cloud platform through the internet. ThingSpeak stores the data and uses tools like MATLAB to analyze it, allowing users to view graphs, monitor performance, and understand system behavior in real time.

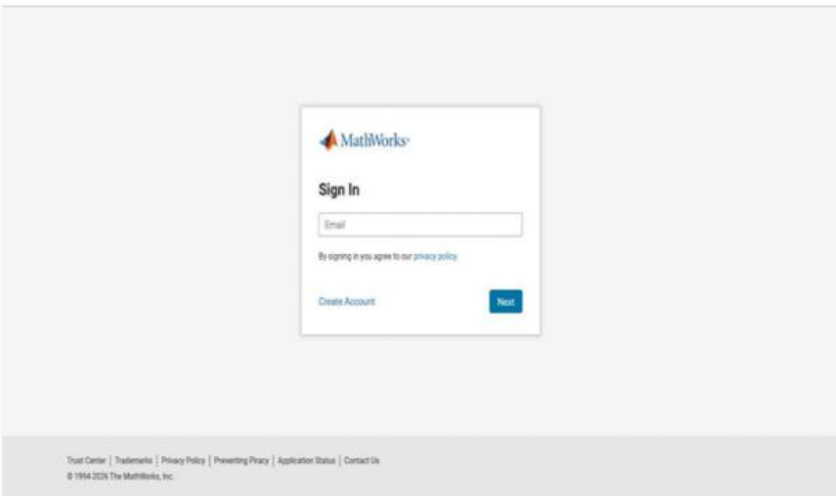

Fig.3.Login page

The fig.3 shows the MathWorks login page where users enter their email to sign in and access services like ThingSpeak. If the user doesn't have an account, they can create a new one; after login, they can use MATLAB and IoT features for data analysis and monitoring.

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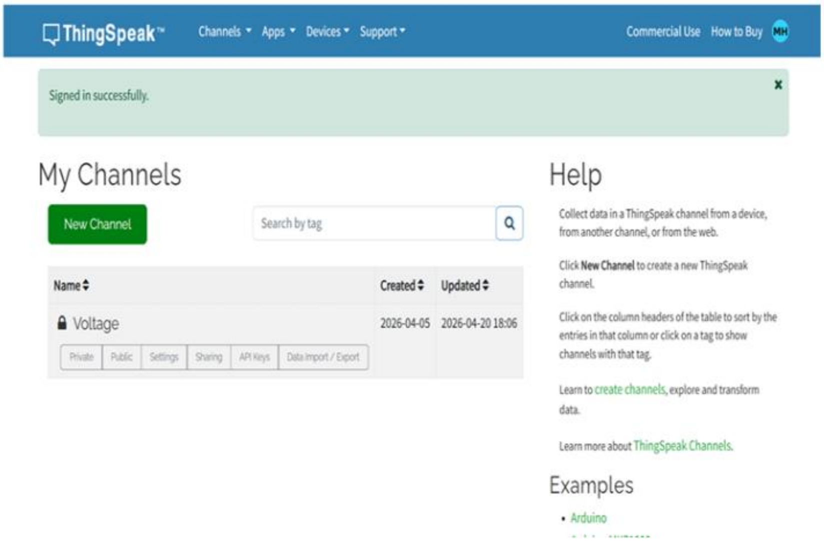

Fig.4.ThingSpeak Dashboard Page

The fig.4 shows the ThingSpeak dashboard where users can create and manage channels to store sensor data (like voltage). The created channel ("Voltage") is used to collect, store, and analyze real-time data from IoT devices for monitoring system performance.

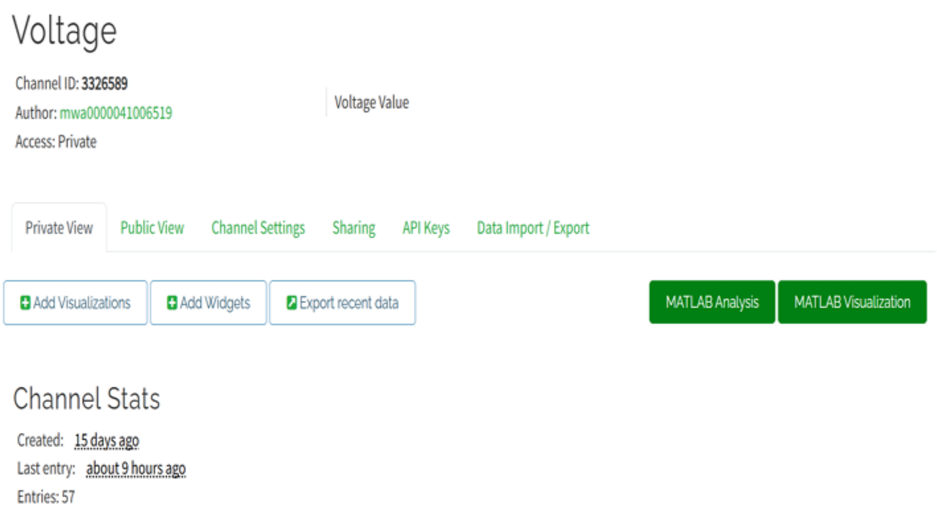

Fig.5.ThingSpeak Channel Data View (Voltage Monitoring)

The fig.5 shows details of the "Voltage" channel, including channel ID, access type, and number of data entries collected from the IoT system. The options like MATLAB Analysis and Visualization allow users to analyze voltage data and view it in graphical form for better understanding of system performance.

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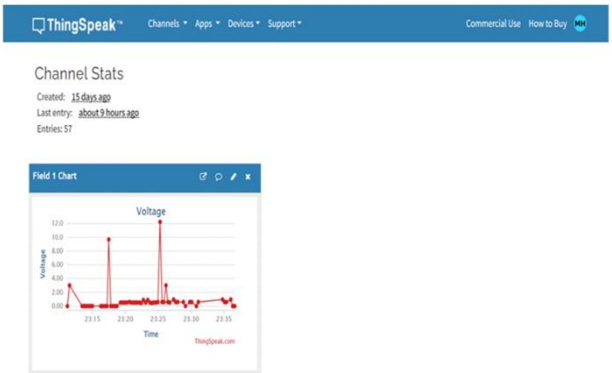

Fig.6.Real-Time Voltage Monitoring Graph

The fig.6 image shows that smart devices (like sensors or IoT modules) collect data and send it to the ThingSpeak cloud platform through the internet.ThingSpeak stores the data and uses tools like MATLAB to analyze it, allowing users to view graphs, monitor performance, and understand system behavior in real time.

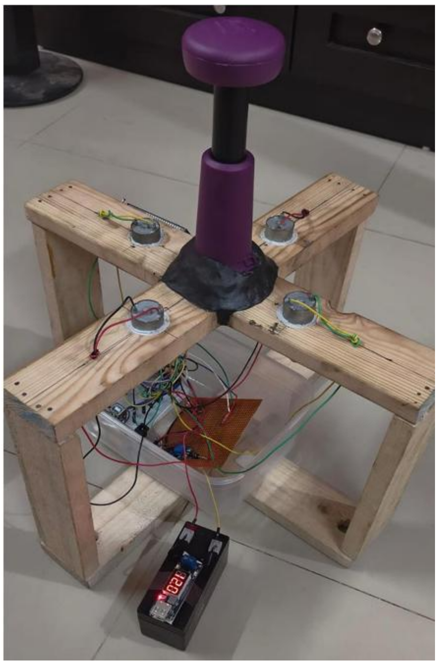

Fig.7.Prototype of IoT Based Smart Pedestrian Power Generator

The fig.7 image shows a prototype of a pedestrian power generation system where mechanical energy from footsteps is converted into electrical energy. When a person presses the central platform, the force is transferred through the mechanical structure to generate motion, which is then converted into electricity using a generator and stored in a battery, as indicated by the connected wiring and circuit components. Additionally, the setup includes electronic circuits and a digital display module that monitor and display the generated voltage, allowing real-time observation of the system's performance and energy output.

VI. CONCLUSION

The IoT Based Smart Pedestrian Power Generator Using DC Motor successfully demonstrates an innovative method of generating electrical energy from human footsteps. The system efficiently converts mechanical energy into electrical energy using a DC motor and stores it for future use. By integrating IoT technology, the system enables real-time

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monitoring of voltage, current, and power output through cloud platforms. The proposed system offers an eco-friendly and sustainable solution for energy generation, especially in high pedestrian traffic areas such as railway stations, shopping malls, and public walkways. It improves energy utilization by combining mechanical energy harvesting with smart monitoring and control. The system also ensures reliability, scalability, and cost-effectiveness compared to traditional energy harvesting methods. Overall, the project contributes to the development of smart city infrastructure by promoting renewable energy usage and efficient energy management.

VII. FUTURE ENHANCEMENT

The proposed IoT Based Smart Pedestrian Power Generator Using DC Motor can be further improved in several ways to enhance its performance and usability. The system can be upgraded by improving the mechanical design and using high-efficiency DC motors to generate more electrical energy from pedestrian movement. Advanced energy storage devices such as supercapacitors or high-capacity batteries can be implemented to improve energy storage efficiency and reliability. Integration with smart grid technology can enable better distribution and utilization of the generated power. Additionally, the system can be enhanced by incorporating advanced IoT features such as real-time analytics, remote control, and predictive maintenance. Developing a dedicated mobile application will allow users to monitor system performance easily from anywhere. Artificial Intelligence can also be integrated to analyze pedestrian patterns and optimize energy generation automatically. Furthermore, using durable materials can improve the lifespan of mechanical components and reduce maintenance requirements. The system can also be combined with other renewable energy sources like solar power to increase overall energy generation and make it more efficient for large-scale smart city applications.

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