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Power Generation Using Human Foot Steps

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Abstract

This research paper presents the design, fabrication, and optimization of a footstep power generation system capable of converting human kinetic energy into usable electricity. The system employs a rack and pinion mechanism to transform the linear motion of footsteps into rotary motion. Spur gears are integrated to amplify rotational speed and torque, thereby enhancing energy conversion efficiency. The mechanical energy generated is converted into electrical energy using low-RPM dynamo, which is then stabilized and stored in a battery for off-grid applications. This innovative approach combines traditional mechanical components with modern energy harvesting techniques, offering a durable and cost-effective alternative to piezoelectric systems. Performance metrics, including voltage output, energy storage capacity, and gear ratio efficiency, are evaluated through rigorous testing. The system generates 3V per footstep, effectively powering four 1.5V LED lights. Designed for scalability, this system demonstrates potential for deployment in high-traffic areas such as schools, transit hubs, and malls, effectively harnessing wasted kinetic energy. By addressing challenges such as material durability, energy loss, and precise gear alignment, the paper highlights the viability of mechanical energy harvesting as a practical and sustainable renewable energy solution.

Keywords: *Footstep power generation, kinetic energy, rack and pinion mechanism, spur gears, low-RPM dynamo, renewable energy.*

1.Introduction

Energy is one of the most essential resources in modern society, yet its generation often depends on non-renewable and environmentally harmful methods. As the global population grows, so does the demand for sustainable and renewable energy solutions. Human motion, an abundant yet underutilized source of kinetic energy, presents an innovative opportunity for power generation. Footstep power generation is a concept that harnesses the energy produced by human footsteps and converts it into usable electrical energy. By integrating mechanical and electrical systems, this approach offers a practical method for energy harvesting, especially in high-traffic areas such as schools, transit hubs, and public spaces. This project focuses on developing a robust and cost-effective footstep power generation system utilizing a rack and pinion mechanism combined with spur gears to optimize energy conversion. This introduction provides the foundation for exploring the project's objectives, methodology, and significance in addressing energy sustainability challenges.

BLOCK DIAGRAM

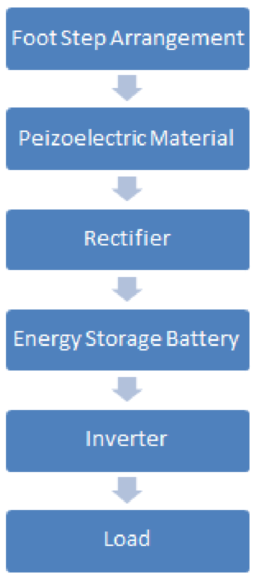

Fig.1: Block Diagram of foot step power generation

2. WORKING PRINCIPLE:

The working principle of the footstep power generation system is based on converting mechanical energy from human footsteps into electrical energy. When a person steps on the system, the applied force moves the upper plate downward, causing a rack and pinion mechanism to convert the linear motion into rotary motion. Spur gears then amplify the rotational speed, which drives a low RPM dynamo. The dynamo converts this mechanical energy into electrical energy, which is then regulated and stored in a battery. This stored energy can be used to power small electrical devices, such as LED lights.

• Mechanical Energy Conversion: When a person steps on the system, the applied force causes the upper plate to move downward.

• rack and pinion mechanism: The downward motion activates a rack and pinion mechanism converts linear motion into rotary motion

• Spur gears amplify the rotational speed, increasing torque and ensuring efficient energy transfer.

• Energy Conversion with Dynamo: The rotary motion drives a low RPM dynamo, converting the mechanical energy into electrical energy.

• Energy Regulation and Storage: The generated electrical energy is regulated and stored in a battery for later use.

• Power Output: The stored energy can be used to power small electrical devices, such as LED lights or other low-power applications.

This system efficiently captures and converts kinetic energy from footsteps into usable electrical energy, offering a sustainable solution for powering small devices.

3. Literature-Review:

Footstep power generation has emerged as a promising unconventional energy harvesting technique that converts mechanical energy from human walking into electrical energy using piezoelectric, electromagnetic, or hybrid mechanisms. Early work by V. Jose Ananth Vino [1] demonstrated the feasibility of using piezoelectric sensors to generate electricity under mechanical stress, particularly for low-power applications. Afzal and Hafeez [2] further emphasized the potential of simple mechanical systems to convert human motion into usable electrical energy, highlighting the need for improved efficiency for real-world deployment. Subsequent studies explored scalable and practical implementations. Shiraz Afzal and Farrukh Hafeez [3] proposed a power-generating floor system incorporating a gear and flywheel mechanism to drive a dynamo, with the capability of large-scale power generation when deployed in multiple units. Similarly, Vipin Kumar Yadav et al. [4] developed a DC generator-based system using gears, springs, and bearings, demonstrating a simple and environmentally friendly approach to energy conversion. Later research focused on optimizing system design and application in public environments. Dhimar et al. [5] introduced a multi-sensor platform to capture energy from pedestrian movement in crowded areas, suggesting its potential for urban energy generation. Md. Azhar et al. [6] and Bhosale et al. [7] utilized rack-and-pinion mechanisms to convert linear footstep motion into rotational motion for electricity generation, emphasizing mechanical efficiency and independence from external power sources. Munaswamy et al. [8] proposed a movable platform-based system with energy storage capability for low-power applications such as LED lighting. Additionally, Joydev Ghosh et al. [9] explored electromagnetic induction using rotating magnets and coils, achieving improved voltage and current output suitable for small electrical devices and battery charging. Ramesh Raja R and Sherin Mathew [10] explored the potential of staircase-based energy harvesting, demonstrating that significant mechanical energy from daily human movement on stairs can be captured and converted into electrical energy for applications such as building lighting. Gupta and Verma [11] extended this concept to urban infrastructure, emphasizing the integration of kinetic energy harvesting systems into sidewalks, pedestrian crossings, and walkways to support sustainable development. Patel and Sharma [12] provided a comprehensive review of footstep energy harvesting techniques, including piezoelectric, electromagnetic, and mechanical systems, highlighting their suitability for low-power applications in high-footfall areas such as railway stations and shopping malls. Kumar and Singh [13] focused on improving system efficiency through the optimization of mechanical components such as springs, gears, and rack-and-pinion mechanisms, demonstrating enhanced energy conversion performance. Similarly, Singh and Sharma [14] investigated piezoelectric transducer-based systems embedded in floors, showing their effectiveness in generating and storing electrical energy for small-scale applications and their potential role in smart infrastructure. Patil, Kulkarni, and Deshmukh [15] conducted an experimental study using multiple piezoelectric sensors arranged beneath a spring-supported movable plate, demonstrating that increased pressure and optimized sensor arrangement significantly enhance power output. Reddy and Das [16] explored a dynamo-based system where mechanical energy from footsteps drives a generator through linkages, showing it as an effective alternative to piezoelectric approaches. Sharma and Raj [17] investigated the scalability of such systems, concluding that large-scale deployment in high-footfall areas can generate substantial energy. Similarly, Olawale and Ibrahim [18] developed a piezoelectric-based platform that converts mechanical pressure into electrical energy, which is rectified and stored for low-power applications such as LEDs and sensors, emphasizing its suitability for crowded public environments. Further advancements include Hanumantha Rao et al. [19], who demonstrated a compact prototype with multiple piezoelectric sensors and explored integration into everyday infrastructure such as walkways and wearable systems. V. Jeevan Kumar et al. [20] proposed a piezoelectric tile-based system with rectification, battery storage, and IoT-enabled monitoring, highlighting improvements in energy management and system efficiency.

Overall, these studies demonstrate the feasibility, adaptability, and potential of footstep power generation systems. However, challenges such as low efficiency, scalability, and cost effectiveness remain critical barriers to large-scale implementation.

4. Methodology Overview

The project involves the integration of mechanical and electrical components to achieve energy conversion. The linear motion of footsteps is converted into rotary motion using rack and pinion mechanism. Spur gears are employed to enhance torque and speed, while a dynamo converts the mechanical energy into electrical energy. The output is regulated and stored in a battery for later use. The system undergoes rigorous testing to assess its performance under different conditions.

4.1 Fabrication-and-Assembly The system was fabricated using durable materials to ensure longevity and reliability. The rack and pinion mechanism was constructed from high strength steel, while the spur gears were precision-engineered to minimize energy loss. The low-RPM dynamo was selected for its efficiency in converting mechanical energy into electrical energy at low rotational speeds. The entire system was assembled with careful attention to gear alignment and mechanical stability.

Fig. 2: fabricated foot step power generator

5. Performance Evaluation

The system was subjected to rigorous testing to evaluate

its performance. Key metrics included:

- **Voltage Output**: The system generates 3V per footstep, sufficient to power four 1.5V LED lights.

- **Energy Storage Capacity**: Assessed by monitoring the battery charge over time.
- **Gear Ratio Efficiency**: Calculated based on the rotational speed and torque output.

5.1 Analysis

Let us consider,

Height of foot step=80 Kg (Approximately) 12 cm

∴ Work done=Force x Distance

Here, Force= Weight of the Body
= 80 Kg x 9.81
= 784.8 N
Distance traveled by the body = Height of the foot step
= 12 cm

= 0.12 m
∴ Output power= Work done/Sec
= (7848 × 0.12)/60
= 1.56 Watts
(For One pushing force)
Watt = volt x current
Motor max output current is 250mA
Therefore,
Watt = volt x 0.25
By this we get voltage = 1.56/0.25
=2.08 volts approx.
This may vary according to how fast the force is applied.
Now, let us calculate with the specifications of motor
* Motor specs:-Output Voltage: 12V

Speed: 200 RPM
Max. No Load Current: 60mA
Max. Load Current: 250mA
Total motor power = V_{out} x I_{out}
= 12v x 0.25A
= 6 watt
200 rpm = 6 watt
Each watt = 6/200
= 3 volt

Hence, in one revolution of the motor 3volts will be generated.

However, with this much power produced, it cannot be tapped fully. For the above purpose, we have selected to generate electricity by permanent magnet type D.C generator and store it by 12V lead-acid battery cell. The results demonstrated that the system was capable of generating sufficient electricity to power small off-grid applications, with potential for scalability in high-traffic environments.

6. Problem Definition

The following issues highlight the need for
a footstep power generation system:

• **Wasted Kinetic Energy**: High traffic areas such as railway stations, schools, malls, and airports generate significant kinetic energy from footsteps, which is currently unutilized.

• **Limitations of Existing Renewable Systems**: Solar and wind energy solutions are not always feasible in indoor or dense
urban environments.

• **High Costs of Advanced Technologies**: Piezoelectric energy harvesting systems are expensive to manufacture and difficult to implement on a large scale.

• **Energy Demand and Sustainability**: The growing demand for electricity and the depletion of fossil fuel reserves
necessitate the exploration of alternative and sustainable energy sources.

• **Lack of Scalable Solutions**: Current energy harvesting technologies are often not designed for scalability and widespread deployment in high-traffic areas.

7.Challenges-and-Solutions

Several challenges were encountered during the design and fabrication process, including material durability, energy loss, and precise gear alignment. These challenges were addressed through the use of high strength materials, precision engineering, and careful assembly techniques.

8. Result

In one revolution of the motor, 3V is generated. However, due to losses and inefficiencies, the full potential of this power cannot be utilized directly. To optimize power generation and storage, we have selected a permanent magnet DC generator for electricity generation. The generated voltage will be efficiently regulated and stored in a 12V lead-acid battery, ensuring a stable and reliable power supply for further applications

9.Conclusion

The design and fabrication of a footstep power generation system using a rack and pinion mechanism, spur gears, and a low-RPM dynamo has been successfully demonstrated. The system offers a durable and cost-effective alternative to piezoelectric systems, with potential for deployment in high-traffic areas. By harnessing wasted kinetic energy, this system contributes to the development of practical and sustainable renewable energy solutions.

10. References

[1]. **Vino, V. J. A., & Kumar, S. (2011)**. *Power generation using footstep*. International Journal of Engineering Trends and Technology (IJETT), 2(2), 25–27.

[2]. **Afzal, M., & Hafeez, S. (2014).** *Electric power generation using footstep*. International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, 3(4), 8765–8770.

[3]. **Shiraz Afzal & Farrukh hafeez (2014)**. Power generation using footstep. *International Journal of Advancements in Research & Technology*, 3(4).

[4]. **Vipin Kumar Yadav et al. (2014).** Power generation using foot step. *International Journal of Engineering Trends and Technology (IJETT)*, 1(2)

[5]. **Dhimar, H., Patel, B., & Parmar, P. (2017).** *Footstep power generation system*. International Journal of Innovative Research in Science, Engineering and Technology, 6(5), 8756–8760.

[6]. **Md.Azhar et al** (2017). *Footstep power generation using piezoelectric sensors*. International Journal of Engineering Research & Technology (IJERT), 6(4), 102–105

[7]. **Bhosale, A., Patil, P., & Jadhav, S. (2017).** *Footstep power generation using piezoelectric sensors*. International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, 6(3), 1980–1984.

[8]. **Munaswamy, M., Kumar, R., & Reddy, P. (2018).** *Footstep power generation using piezoelectric sensors*. International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering, 6(5), 34–38.

[9]. **Ghosh, J., Das, S., & Roy, A. (2018).** *Footstep power generation using piezoelectric sensors*. International Journal of Engineering Research & Technology (IJERT), 7(3), 589–592.

[10]. **Raja, R. R., & Mathew, S. (2018).** *Footstep power generation system using piezoelectric sensors*. International Journal of Engineering Science and Computing, 8(4), 16742–16745.

[11]. **Gupta, S., & Verma, R. (2019)**. *Footstep power generation system using piezoelectric sensors*. International Journal of Scientific Research in Engineering and Management, 3(6), 1–5.

[12]. **Patel, R., & Sharma, P. (2020)**. *Footstep power generation using piezoelectric sensors*. International Journal of Engineering Research & Technology (IJERT), 9(5), 1234–1238.

[13]. **Kumar, A., & Singh, R. (2021).** *Design and development of footstep power generation system using piezoelectric sensors*. International Journal of Engineering Research & Technology (IJERT), 10(6), 456–460

[14]. **Singh, V., & Sharma, A. (2021).** *Footstep power generation system using piezoelectric sensors*. International Journal of Innovative Technology and Exploring Engineering, 10(7), 112–116.

[15]. **Patil, S., Kulkarni, A., & Deshmukh, R. (2022).** *Design and development of a footstep power generation system using piezoelectric sensors*. International Journal of Scientific Research in Engineering and Management, 6(2), 1–6.

[16]. **Reddy, P., & Das, S. (2022).** *Footstep power generation using piezoelectric sensors for sustainable energy*. International Journal of Engineering Research & Technology (IJERT), 11(4), 512–516.

[17]. **Sharma, P., & Raj, A. (2023)**. *Design and analysis of footstep power generation system using piezoelectric sensors*. International Journal of Engineering Research & Technology (IJERT), 12(2), 215–219.

[18]. **Olawale, A., & Ibrahim, M. (2023).** *Design and implementation of a footstep power generation system using piezoelectric sensors*. International Journal of Engineering Research and Applications (IJERA), 13(3), 45–50.

[19]. **Rao, K. R. H., Saurav, S., Raj, P., Kumar, S., & Tamanna. (2024).** *Footstep power generation*. International Journal of Recent Advances in Multidisciplinary Topics, 5(5), 94–95.

[20]. **Kumar, V. J., Reddy, S., Kumar, P., & Rao, M. (2025).** *Design and development of a footstep power generation system using piezoelectric sensors*. International Journal of Innovative Research in Engineering and Technology, 12(1), 45–50