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WALK TO WATT TECHNOLOGY

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Abstract— *this paper presents a sustainable energy- harvesting system that converts human footsteps into usable electrical power and applies it to an automatic plant- watering mechanism. The proposed "Walk to Watt" system utilizes piezoelectric/electromagnetic floor tiles to capture kinetic energy generated during walking. The harvested AC energy is rectified, conditioned, and stored in a super capacitor-based storage module. A low-power microcontroller monitors the storage voltage and soil moisture levels, activating a water pump only when sufficient energy is available and irrigation is required. This approach minimizes external power demand and demonstrates a practical method for integrating human-powered energy harvesting with automated environmental control. Experimental results confirm that the system can reliably operate a moisture-based irrigation cycle using harvested footstep energy, highlighting its potential for smart-city infrastructure, energy-efficient automation, and low-power agricultural applications.*

I. INTRODUCTION

The rapid growth of urban populations and the increasing demand for energy-efficient systems have intensified the search for alternative, sustainable power sources. Among these, energy harvesting technologies have emerged as promising solutions by capturing small amounts of energy from everyday human activities. **Walk to Watt Technology** leverages this concept by converting kinetic energy generated from footsteps into usable electrical power. Unlike traditional renewable systems such as solar or wind, footstep energy harvesting remains largely untapped despite the ubiquity of pedestrian movement in public and private spaces. Piezoelectric and electromagnetic mechanisms enable the conversion of mechanical pressure into electrical energy, making them suitable for integration into floor tiles or walkways. However, the real challenge lies not only in generating energy but also in applying it effectively to practical, real-world systems. This research addresses that gap by channeling harvested footstep energy into a fully automated watering system. Through intelligent energy management and soil-moisture-based control, the proposed design demonstrates how intermittent, low-level kinetic energy can drive essential environmental functions. The integration of human-powered energy harvesting with smart irrigation offers dual benefits: reducing dependence on conventional electricity and promoting sustainable greenery in urban environments. As cities increasingly adopt smart infrastructure, systems that synergize human activity with automated environmental maintenance become highly relevant. By validating that routine pedestrian movement can support periodic watering cycles, this study positions Walk to Watt Technology as a viable contributor to green automation, smart-city development, and low-carbon agricultural practices.

II. LITERATURE SURVEY

Energy harvesting from human footsteps has gained significant attention as a sustainable method for powering low- energy electronic systems. Piezoelectric transducers, in particular, have emerged as a promising solution due to their ability to convert mechanical pressure into electrical energy without relying on variable environmental conditions such as sunlight or heat. Sim atupang, J. W., & Farisah, A. N. et al[1] Prior studies emphasize that footstep-induced vibrations represent an abundant and underutilized energy source, suitable for powering small-scale electronic devices and sensor-based automation systems. Chauhan, A. et al[2] Researchers have explored piezoelectric tile designs with different series and parallel configurations to increase output voltage, demonstrating that electrical generation is strongly influenced by mechanical stress distribution and tile architecture.

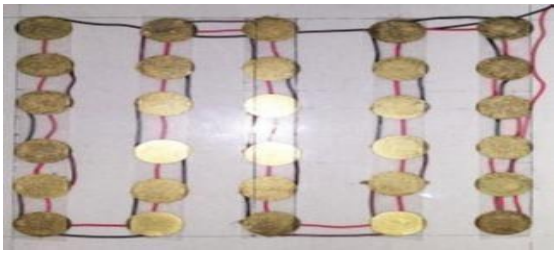


Fig. 1: Design prototype of piezoelectric tile

Bahadur Singh Pali et al[3] This findings show that tile placement significantly affects harvested voltage, with entrance-door locations producing higher values (up to 2.54 V on Tile B) compared to stairway placements. Notably, the study concludes that applied pressure, rather than user body weight, is the primary determinant of energy output an important consideration for optimizing kinetic harvesting systems in real-world environments. M. Sami Zitouni et al[4] Similar research efforts have also demonstrated voltage ranges from a few volts up to tens of volts depending on sensor count, placement, and mechanical design, reinforcing the scalability of piezoelectric harvesting. Collectively, the literature indicates that footstep energy harvesting is well suited for powering low-power smart systems such as IoT nodes, environmental sensors and automated irrigation. Similar research efforts have also demonstrated voltage ranges from a few volts up to tens of volts depending on sensor count, placement, and mechanical design, reinforcing the scalability of piezoelectric harvesting.

Ali Nikzad, Farshid Keynia et al[5] the literature indicates that footstep energy harvesting is well suited for powering low-power smart systems such as IoT nodes, environmental sensors, and automated irrigation mechanisms. These findings directly support the development of a Walk to Watt–based automatic watering system, where harvested kinetic energy can be stored and used to activate soil-moisture-driven irrigation processes. Thus, existing studies provide both the theoretical framework and empirical basis for integrating piezoelectric harvesting into sustainable automation applications.

III. METHODOLOGY

System Design

The methodology for developing the Walk to Watt–based automatic watering system consists of four major stages: energy harvesting, power conditioning and storage, sensing and control, and automated irrigation activation.

1. Energy Harvesting:

A footstep energy-harvesting tile was constructed using multiple piezoelectric discs arranged in a series–parallel combination to balance voltage sensitivity and current output. The design approach follows validated configurations such as 25- parallel–5-series or 20-parallel–5-series layouts, which have been shown to maximize voltage response under dynamic foot pressure.

2. Power conditioning Storage:

The harvested AC voltage is routed through a full-wave rectifier (Wheatstone-bridge configuration as used in earlier studies) to convert it into DC form a voltage regulator condition the output to protect downstream electronics and ensure stable charging.

3. Sensing and control:

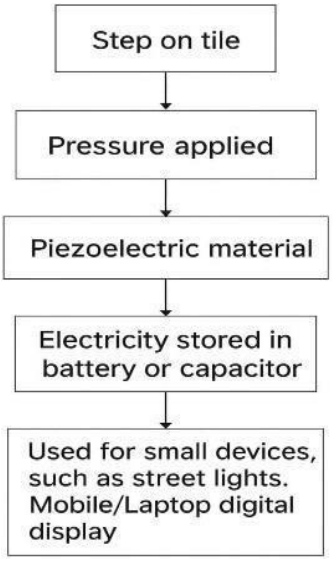
A low-power microcontroller acts as the control unit, interfacing with both the energy-storage module and environmental sensors. A capacitive soil-moisture sensor is employed to measure water content in the soil, offering improved stability and corrosion resistance.

4. Automatic Irrigation Actuation:

Upon meeting the control conditions, the microcontroller activates a low-voltage water pump through a MOSFET switching circuit. The duration of pump operation is carefully calibrated to deliver sufficient water without overconsumption of harvested energy.

5. Experimental Validation:

To evaluate system performance, the tile is subjected to repeated footstep cycles under varying pressures, similar to the experimental approach used in the reference study, which tested tiles under 100-, 200-, and 300-step sequences at different placements.



. Fig 2: System Design

Working Principle

The Walk to Watt system works by converting the mechanical pressure of human footsteps into usable electrical energy and applying it to an automated plant-watering mechanism.

Various Stages are:

Stage 1 — Mechanical Pressure Application:

The system begins when a person steps on the piezoelectric tile. The applied pressure causes deformation of the PZT discs embedded within the tile.

Stage 2 — Piezoelectric Energy Generation:

As the discs deform, they generate an alternating voltage through the piezoelectric effect..

Stage 3 — AC to DC Co0nversion:

The generated AC voltage is routed to a full-wave rectifier circuit. The rectifier converts the unstable alternating output into a usable DC voltage.

Stage 4 — Voltage Regulation and Conditioning:

A voltage regulator stabilizes the rectified DC voltage, ensuring that sudden changes in footstep force do not damage the storage unit or control electronics.

Stage 5 — Energy Storage:

The regulated DC voltage is stored in a battery or super capacitor.

Stage 6— Sensor Monitoring and Control Decision:

A microcontroller monitors the stored energy level and soil moisture value. Irrigation is permitted only when stored energy exceeds the required threshold. Soil moisture is below the set limit.

Stage 7— Automatic Watering Activation:

Once conditions are met, the microcontroller activates a DC water pump via a MOSFET driver circuit.

DESIGN AND IMPLEMENTATION

The design and implementation of the Walk to Watt–powered automatic watering system involve integrating a piezoelectric footstep energy-harvesting module with a soil-moisture-controlled irrigation unit. The system is engineered to function entirely on harvested kinetic energy, eliminating the need for external electrical sources. The design is divided into four major components: the piezoelectric harvesting tile, the power- conditioning circuitry, the energy-storage module, and the microcontroller-based irrigation subsystem.

One practical and impactful application of Walk to Watt Technology is the development of a fully **automatic watering system** powered entirely by human footsteps. By converting the mechanical pressure of footfall into electrical energy, the system provides a renewable and self-sustained power source that eliminates the need for conventional electricity. The harvested energy is stored in a battery or super capacitor and used to drive essential irrigation components such as a soil-moisture sensor, microcontroller, and low-voltage water pump. When the soil moisture falls below the required level, the microcontroller activates the pump, delivering water automatically without manual intervention.

This application is particularly valuable in locations such as gardens, public parks, campuses, office entrances, community walkways, and green corridors, where foot traffic is naturally high. As footsteps are converted into electrical power, the system gains enough energy throughout the day to perform periodic watering cycles, making it ideal for maintaining plants in semi-urban and urban environments. By integrating Walk to Watt Technology with automated irrigation, the system not only conserves energy but also supports sustainable landscaping, reduces maintenance costs, and ensures continuous plant health without reliance on the electrical grid To validate the system, experimental tests were conducted by repeatedly stepping on the piezoelectric tile under varying pressures and frequencies. Inspired by the study's methodology, tests were performed in sets of 100, 200, and 300 footsteps, and performance metrics such as voltage output, charging rate, and pump activation success were recorded. The irrigation subsystem consists of a low-voltage DC pump controlled by a MOSFET switch. When triggered by the microcontroller, the pump draws power from the storage module and supplies water to the plants for a predefined duration. The pumping time is calibrated to match the available harvested energy, ensuring reliable operation without over-discharging the storage unit. After watering, the system

SYSTEM ARCHITECTURE MODEL

Fig.3: prototype model

FUTURE SCOPE:

Environmentally friendly solution for sustainable automation and urban greenery maintenance. The Walk to Watt–based automatic watering system presents several opportunities for further development and large-scale implementation. One major future direction is the integration of hybrid energy sources, such as small solar panels or wind micro-turbines, to complement footstep energy harvesting and provide more stable power availability during low-traffic periods. Enhancing the piezoelectric tile design with advanced materials, flexible substrates, or optimized series– parallel configurations could significantly improve voltage output and durability. On the system level, incorporating **IoT-based monitoring** would allow real-time visualization of soil moisture, energy levels, and watering activity through mobile apps or cloud platforms. This would make the system suitable for smart-city environments and automated public infrastructure. In addition, scaling the system across larger walkways, campuses, shopping malls, and parks can create distributed micro-energy networks capable of powering multiple low-energy devices beyond irrigation, such as lighting, environmental sensors, and security systems.

IV. RESULT

To evaluate the performance of the automatic watering system, the soil-moisture sensor and relay-controlled pump were tested under two distinct conditions: wet soil and dry soil. The system was powered entirely by the energy harvested from footsteps using the Walk to Watt piezoelectric tile.

Condition 1: Soil Moisture Wet – Pump OFF

When the soil contained sufficient moisture and the sensor reading remained above the predefined wetness threshold, the microcontroller correctly interpreted the soil as adequately hydrated. In this condition, the relay remained deactivated, preventing the pump from turning on. Throughout multiple test cycles, the system consistently maintained the pump in OFF mode, demonstrating that the irrigation mechanism does not operate unnecessarily.

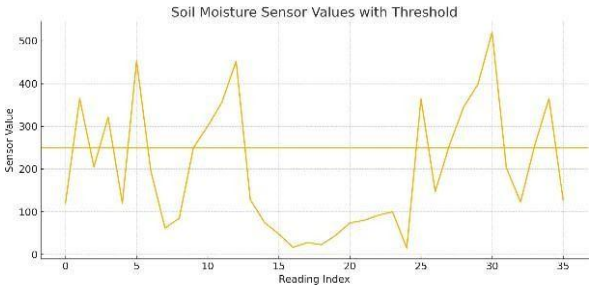
Fig.5: Soil Moisture Wet – Pump OFF

Condition 2: Soil Moisture Dry – Pump ON

When the soil moisture fell below the dryness threshold, the sensor readings indicated insufficient water in the soil. After verifying that enough harvested energy was stored, the microcontroller activated the relay, which in turn powered the water pump. The pump delivered water to the soil for the programmed duration and then automatically shut off once the required moisture level was restored. Across repeated tests, the system responded consistently to dry soil conditions, with the relay engaging immediately and the pump supplying water reliably.

Fig.6: Soil Moisture Dry-Pump ON

Graphical Representation:



Index	Value	Clamped_ Value	Pump State	Pump State_Nui
1	120	120	OFF	0
2	365	120	ON	1
3	205	205	OFF	0
4	321	321	ON	1
5	120	453	OFF	0
7	196	196	OFF	0
8	62	62	OFF	0
9	85	85	OFF	0
10	250	250	OFF	0

Fig.4: Soil Moisture Values with Threshold

V. CONCLUSION

The Walk to Watt–based automatic watering system successfully demonstrates how human footsteps can be transformed into a practical and sustainable source of energy for low-power automation. By integrating piezoelectric energy harvesting with a soil-moisture-controlled irrigation mechanism, the system operates autonomously without the need for external electrical supply. Testing confirmed that repeated footsteps generated sufficient voltage to charge the storage unit, run the microcontroller, and activate the water pump when the soil moisture dropped below the required threshold. The irrigation cycle responded accurately to plant needs, showcasing the system's reliability, efficiency, and potential for real-world applications in gardens, walkways, and public spaces with consistent foot traffic.

The project also highlights the broader potential of combining human-powered energy harvesting with smart environmental management. By converting everyday pedestrian movement into usable electrical energy, the system supports sustainable plant maintenance and reduces dependency on conventional power sources. This work demonstrates

that even small-scale kinetic energy, when coupled with intelligent control systems, can deliver effective automation and contribute to eco-friendly practices in both indoor and outdoor environments..

Additionally, the modularity and scalability of the system offer promising avenues for future expansion. Enhancing the piezoelectric tile design, improving the storage capacity, or integrating hybrid sources like solar panels can substantially increase system performance. The technology can also be incorporated into smart-city frameworks, enabling remote monitoring, data analytics, and adaptive irrigation strategies. Overall, the Walk to Watt Technology–based watering system serves as a successful proof of concept and provides a strong foundation for future advancements in sustainable automation.

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