POWER GENERATING DANCING MAT

A Mini Project Report

Submitted to the APJ Abdul Kalam Technological University

in partial fulfillment of requirements for the award of degree

Bachelor of Technology

in

Electronics and Communication Engineering

by

AADITH S (NSS22EC002)
AKHILA A (NSS22EC021)
BHARATH B CHANDRAN (NSS22EC048)
GEETHIKA V (NSS22EC050)

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

NSS COLLEGE OF ENGINEERING PALAKKAD

April 2025

DEPT. OF ELECTRONICS & COMMUNICATION ENGINEERING
NSS COLLEGE OF ENGINEERING PALAKKAD
2025 - 26

CERTIFICATE

This is to certify that the report entitled **Power Generating Dancing Mat** submitted by **Aadith S** (NSS22EC002), **Akhila A** (NSS22EC021), **Bharath B Chandran** (NSS22EC048) & **Geethika V** (NSS22EC050) to the APJ Abdul Kalam Technological University in partial fulfillment of the B.Tech. degree in Electronics and Communication Engineering is a bonafide record of the project work carried out by them under our guidance and supervision. This report in any form has not been submitted to any other University or Institute for any purpose.

Dr.Lija Arun
(Project Guide)
Assistant Professor
Dept. of ECE
NSS College of Engineering
Palakkad

Prof.Vinod G
(Project Coordinator)
Associate Professor
Dept. of ECE
NSS College of Engineering
Palakkad

Dr.Sreeleja N Unnithan
(Head of Department)
Associate Professor
Dept. of ECE
College of Engineering
Palakkad

DECLARATION

We hereby declare that the project report **Power Generating Dancing Mat** , submitted for partial fulfillment of the requirements for the award of the degree of Bachelor of Technology of the APJ Abdul Kalam Technological University, Kerala, is a bonafide work done by us under the supervision of **Dr.Lija Arun**.

This submission represents our ideas in our own words and where ideas or words of others have been included, we have adequately and accurately cited and referenced the original sources.

We also declare that we have adhered to the ethics of academic honesty and integrity and have not misrepresented or fabricated any data, idea, fact, or source in our submission. We understand that any violation of the above will be a cause for disciplinary action by the institute and/or the University and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been obtained. This report has not been previously submitted as the basis for the award of any degree, diploma, or similar title of any other University.

Aadith S
Akhila A
Bharath B Chandran
Geethika V

Palakkad
01-04-2025

Abstract

The project **Power Generating Dancing Mat** aims to develop a piezoelectric-based power-generating dance mat that converts mechanical energy from dancing movements into electrical energy. Man has needed and used energy at an increasing rate for the sustenance and well-being since time immemorial. Due to this a lot of energy resources have been exhausted and wasted. Proposal for the utilization of waste energy of foot power with human locomotion is very much relevant and important for highly populated countries like India where the railway station, temples etc., are overcrowded all round the clock. When the flooring is engineered with piezo electric technology, the electrical energy produced by the pressure is captured by floor sensors and converted to an electrical charge by piezo transducers, then stored and used as a power source. And this power source has many applications as in agriculture, home application and street lighting and as energy source for sensors in remote locations.

Acknowledgement

We take this opportunity to express my deepest sense of gratitude and sincere thanks to everyone who helped us to complete this work successfully. We express our sincere thanks to **Dr.Sreeleja N Unnithan**, Head of Department, Electronics and Communication Engineering, NSS College of Engineering Palakkad for providing us with all the necessary facilities and support.

We would like to express my sincere gratitude to the **Prof.Vinod G**,Associate Professor, Electronics and Communication Engineering, NSS College of Engineering Palakkad for the support and co-operation.

We would like to place on record my sincere gratitude to our project guide **Dr.Lija Arun**, Assistant Professor, Electronics and Communication Engineering, NSS College of Engineering Palakkad for the guidance and mentorship throughout this work.

Finally, I thank my family and friends who contributed to the successful fulfillment of this seminar work.

Aadith S
Akhila A
Bharath B Chandran
Geethika V

Contents

List of Figures

Chapter 1

Introduction

1.1 Overview

DanceVolt is an innovative energy-harvesting system that generates electricity from human movement, specifically through dancing. The project integrates piezoelectric sensors, an Arduino-based processing unit, and an energy storage system to convert mechanical energy into usable electrical power.
The system is divided into three main components:

1. Energy-Generating Mat – Embedded with piezoelectric sensors to capture mechanical pressure and convert it into electrical energy.

2. Main Circuit Unit – Uses an Arduino microcontroller to process sensor data and display real-time energy output on an LCD screen.

3. Energy Storage and Inverter System – Stores the generated electricity in a battery and allows controlled power usage via a switch-controlled inverter.

1.2 Problem Statement

In today's world, energy consumption continues to rise, leading to increased dependency on non-renewable sources and contributing to environmental degradation. While various renewable energy sources like solar and wind exist, they often require significant space, infrastructure, and favorable environmental conditions to be efficient.

At the same time, human movement, particularly in activities like dancing, fitness routines, and crowded public spaces, generates significant mechanical energy that is typically wasted. The challenge is to harness this untapped kinetic energy efficiently and convert it into usable electrical power in a compact, cost-effective, and scalable manner. Key issues addressed by this project:

1. Wasted Kinetic Energy: Current public and recreational spaces do not utilize the mechanical energy generated by movement.

2. Energy Scarcity and Sustainability: The growing energy demand requires alternative solutions that reduce dependency on fossil fuels.

3. Portable and Scalable Energy Solutions: There is a need for small-scale, self-sufficient energy systems that can be implemented in various locations, including dance floors, gyms, and public walkways.

4. User Engagement in Green Energy: Encouraging public participation in sustainable energy generation through an interactive and engaging platform.

1.3 Objectives

1. To design and develop an energy-generating mat embedded with piezoelectric sensors that efficiently convert mechanical pressure into electrical energy.

2. To implement an Arduino-based control system that processes sensor data and displays real-time energy generation on an LCD screen.

3. To integrate an energy storage and inverter system that stores generated electricity and allows controlled power utilization via a switch.

4. To analyze the efficiency and output of the system, ensuring optimal energy conversion and minimal losses.

5. To promote sustainability and awareness by providing an interactive way to engage people in green energy generation through movement.

6. To explore potential applications of the technology in various settings, such as dance studios, gyms, public walkways, and smart cities.

1.4 Key Features

- Real-time energy generation and display.
- Efficient power storage and controlled distribution.
- Sustainable and eco-friendly approach to energy harvesting.
- Potential applications in dance studios, fitness centers, and entertainment venues.

Chapter 2

Literature Review

Power generation using footsteps, also known as piezoelectric energy har vesting, is an innovative technology that aims to harness the kinetic energy generated by human footsteps and convert it into usable electrical energy. Self powered sensors and wireless sensor networks, Smart buildings and infrastruc ture, wearable electronics and mobile devices can be revolutionized by means of piezoelectric harvesting. For example,power can be generated by mount ing piezoelectric sensors in a shoe system, which can also be used for medical sensory purposes(Meler et al., 2014).In addition, GPS tracking systems can be added to this model which provides the precise location of that person wear ing the shoes(Prasad et al., 2019). Keeping in mind the need for Maximiz ing energy conversion efficiency, mitigation of environmental factors affecting performance,Cost-effectiveness and sustainability challenges, several modifica tions can be made to this technology. AN instance of the same is the storage and reuse of energy in rechargeable batteries produced by the piezoelectric sen sors, which can then be used to light up the streetlights.An LCD can be used to show the voltage up to which the batteries are charged(Sarala et al., 2020). We can make use of these kinds of technology to harness the dense population in many developing and developed countries to form a source of sustainable and environment friendly power generation as well as strive for its integration with renewable energy sources and effective large-scale implementation(Kamboj et al., 2017).

Chapter 3

System Development

3.1 Hardware Components

- **Piezoelectric Sensors**

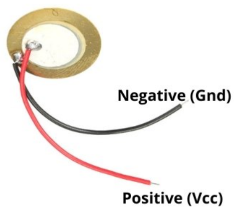

Figure 3.1: Piezoelectric Sensor

Working Principle:

- Piezoelectric sensors generate electrical voltage when subjected to mechanical stress (such as foot pressure).
- The piezoelectric effect causes certain materials (e.g., quartz or PZT - lead zirconate titanate) to produce an electric charge when deformed.
- The generated voltage is proportional to the applied force, making it ideal for energy harvesting in movement-based applications.

Placement Strategy:

- Sensors are embedded beneath the mat's surface to capture foot pressure effectively.
- They are arranged in a grid pattern to ensure even energy distribution across the mat.

– Optimal placement density is determined to maximize power output without excessive overlap.

- **ESP32 Microcontroller**

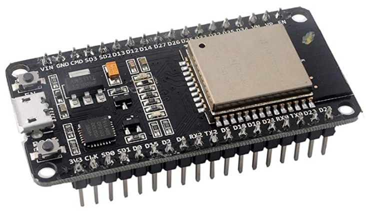

Figure 3.2: ESP32 WiFi Microcontroller

Role of Arduino:

– ESP32 microcontroller serves as the brain of the system, handling signal processing and data visualization.

– It receives voltage pulses from the piezoelectric sensors and converts them into digital signals.

– The microcontroller calculates the total energy generated based on the input from multiple sensors.

Display Integration:

– The processed energy data is sent to an LCD display, allowing users to see real-time power generation.

– The Microcontroller program ensures smooth operation, including:

– Filtering out noise from sensor readings.

– Averaging voltage levels to ensure accurate energy calculations.

– Updating the LCD in real time as users interact with the mat.

- **LCD Display**

Figure 3.3: LCD Display

The LCD provides a visual representation of energy generation, enhancing user engagement.

Displays real-time values such as:

  - Voltage generated per step
  - Total energy output over time
  - Battery charge status

- **Energy Storage and Inverter System**

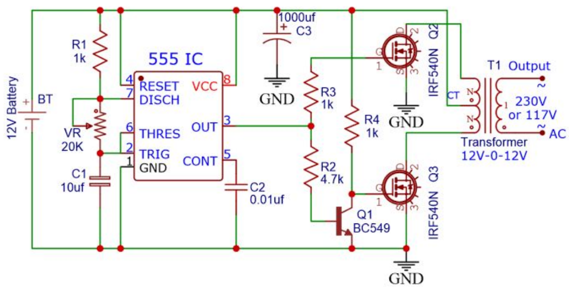

Figure 3.4: Inverter System Circuit

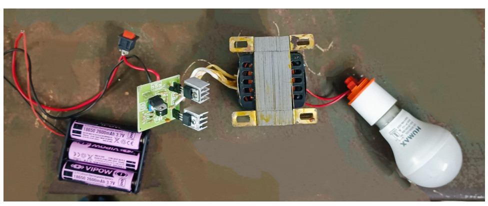

Figure 3.5: Inverter System

Energy Storage :

- The generated electrical energy is stored in a rechargeable battery for future use.
- A charge controller regulates the input voltage to prevent battery overcharging and damage.
- The stored energy remains in DC form until required.

Inverter System:

- Converts DC power to AC power when needed for standard electrical appliances.
- The system ensures efficient energy conversion with minimal losses.

- **Switching Mechanism**

Figure 3.6: Manual Switch

- A manual switch allows users to activate or deactivate power output.
- The switch controls the inverter system, ensuring power is only used when needed.

- **Voltage Booster**

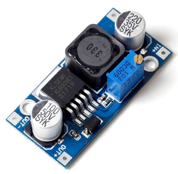

Figure 3.7: Voltage Booster Module

Step-up Low Voltage:

- Piezoelectric sensors typically generate low AC voltage.
- Increases this voltage to a usable level(e.g.,5V,12V,or more).

Chapter 4

Working Principle

4.1 Block Diagram

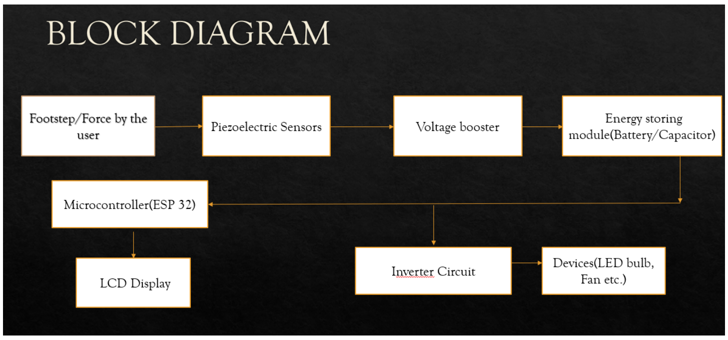

Figure 4.1: System Architecture of Power Generating Dancing Mat

4.2 Energy Conversion Process

Piezoelectric Effect:

- When a person steps or dances on the mat, the embedded piezoelectric sensors experience mechanical stress.
- Due to the piezoelectric effect, these sensors generate an electrical charge proportional to the applied force.
- The produced voltage is in the form of small AC pulses, which are then collected and processed.

Energy Enhancement:

- Since a single piezo sensor generates only a small amount of electricity, multiple sensors are connected in an array to increase energy output.

- The generated AC voltage is then passed through a rectifier circuit to convert it into a usable DC form.
- A voltage regulation circuit ensures a steady voltage level before sending it for further processing.

4.3 Sensor Data Acquisition and Processing

Signal Conditioning:

- The raw voltage from the piezo sensors is unstable and requires processing before use.
- A signal conditioning circuit smooths the voltage fluctuations and removes unwanted noise.

Microcontroller Processing : The conditioned voltage signals are fed into the Arduino microcontroller for real-time data processing.

The Arduino performs the following tasks:

- Analog-to-Digital Conversion (ADC): Converts the sensor voltage into digital values.
- Energy Calculation: Computes total power generated based on sensor inputs.
- Data Display: Sends the calculated values to the LCD screen for real-time monitoring.

4.4 Storage and Power Distribution

Energy Storage:

- The processed electrical energy is directed to a rechargeable battery for later use.
- A charge controller ensures optimal battery charging, preventing overcharging or deep discharge.

Power Distribution:

- When needed, the stored DC power is converted to AC power using an inverter circuit.
- A switching mechanism allows users to control energy output efficiently.
- The system ensures stable power supply to connected loads, such as small electronic devices.

Chapter 5

Arduino IDE Code

```
#include <Wire.h>
#include <LiquidCrystal_I2C.h>
int i=0;
const int piezoPin = 27;
const int threshold = 40;
long totalSteps = 0;
float voltage = 0.0;

LiquidCrystal_I2C lcd(0x27, 16, 2);

void setup() {
  Serial.begin(9600);
  pinMode(piezoPin, INPUT);

  lcd.init();
  lcd.backlight();
  lcd.clear();



}

void loop() {
  int sensorValue = analogRead(piezoPin);

  if (sensorValue > threshold) {
    totalSteps++;
    delay(200);
  }
voltage=0;

  voltage= sensorValue*0.547;

```

```
  Serial.print(totalSteps);
  Serial.print(",");
  Serial.println(voltage);
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("Steps:");
  lcd.setCursor(7, 0);
  lcd.print(totalSteps);
  lcd.setCursor(0, 1);
  lcd.print("Voltage:");
  lcd.setCursor(9, 1);
  lcd.print(voltage);
  lcd.print("V");

  delay(1000);

}
```
Listing 5.1: Piezoelectric Energy Conservation Program

Chapter 6

Circuit Implementation

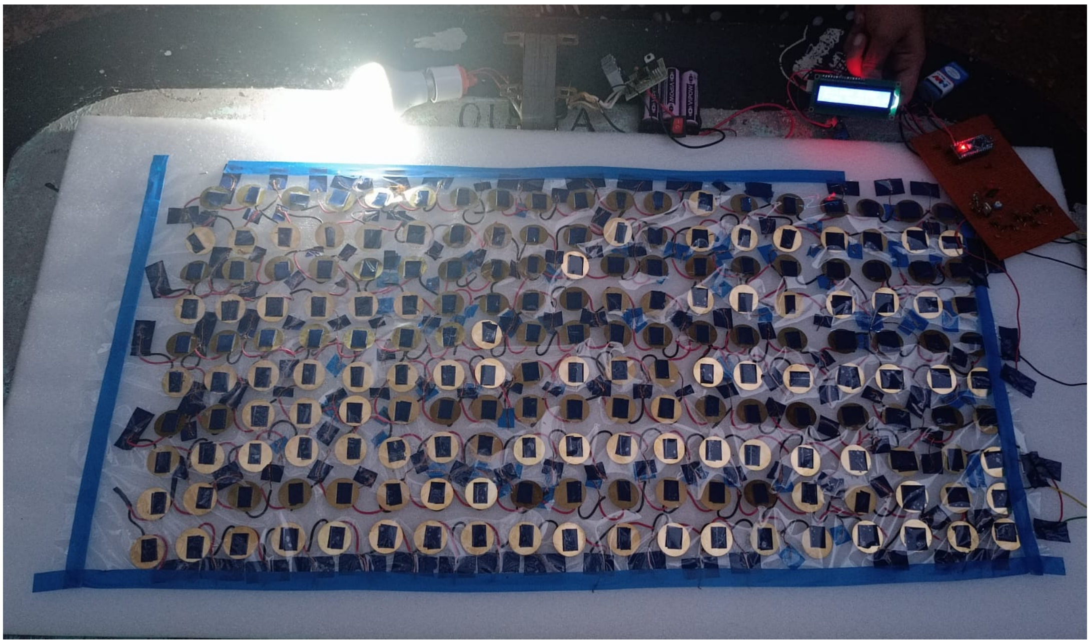

Figure 6.1: Implemented Circuit

The DanceVolt energy-harvesting system is implemented using a matrix of piezoelectric sensors that generate electricity from foot pressure. The circuit is designed to efficiently convert, store, and utilize the generated energy.

Implementation Steps:

1. **Piezoelectric Sensor Array Setup:**
   - Multiple piezoelectric discs are connected in a series-parallel arrangement to maximize power generation.
   - Each sensor produces an AC voltage when mechanical pressure is applied.
2. **Rectification and Storage:**

- The AC voltage from the sensors is passed through bridge rectifiers to convert it into DC.
- A capacitor bank is used for energy storage and voltage stabilization.
- The stored energy is fed into a rechargeable battery or supercapacitor for continuous operation.

3. **Microcontroller and Display Module:**

   - A microcontroller (e.g., Arduino) reads voltage levels from the energy storage unit using an ADC (Analog to Digital Converter).
   - The LCD display shows real-time voltage or power output generated by the system.

4. **Power Utilization:**

   - The stored energy is used to power LED bulbs or small appliances via a DC-DC converter to regulate the output voltage.
   - A switch controls the power flow to the load.

5. **Testing and Optimization:**

   - The system is tested by applying different pressures to observe energy output.
   - Additional components, like boost converters, can be integrated to improve efficiency.

Chapter 7

Results and Discussion

From the implemented circuit, one reached to the following observations.

- Theoretical value of voltage a Single PZT= 5-6V
- Capacity of backup battery= 11.1V
- Capacity after recharging due to operations of the circuit= 8.77V
- Percentage charged= 79
- Time taken for battery to fully charge= 4hr 45mins
- Total capacity of battery= 3000 mAh
- Charge in battery in 1 hr= 21.6 (Approx)

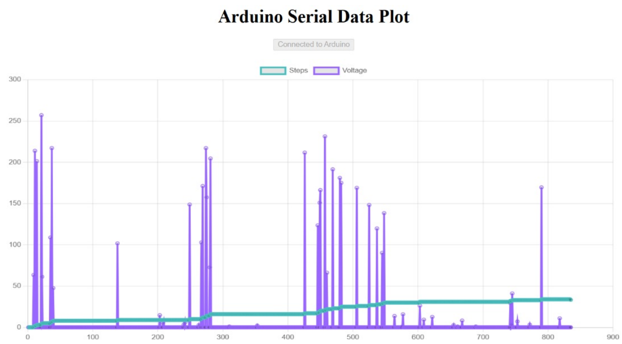

Figure 7.1: Voltage vs Step Count Serial Data Plot

From above, we can conclude that a single Piezo-electric Transducer is capable of providing minimum 3.6V voltage and a series connection of 3 such PZT was successful in generating a voltage of more than 10V.Therefore, the project to generate power using foot-steps has been accomplished.

Chapter 8

Conclusion and Future Scope

8.1 Conclusion

The Power Generating system successfully demonstrates energy harvesting using piezoelectric transducers. The project validates the feasibility of converting dance movements into usable electrical energy.

8.2 Future Scope of the Project

The DanceVolt project focuses on developing a sustainable energy-harvesting system that converts human movement into electrical power using piezoelectric sensors, an Arduino-based processing unit, and an energy storage system. The scope of this project includes design, development, implementation, and performance analysis of the system, with potential applications in various public and commercial spaces.

1. Design and Development:

    - Creation of an energy-generating mat embedded with piezoelectric sensors to capture mechanical energy.
    - Implementation of a main circuit that processes sensor output and displays real-time data on an LCD screen using an Arduino.
    - Integration of an energy storage and inverter system for power management and controlled energy usage via a switch.

2. Functionality and Performance Analysis:

    - Measurement of energy conversion efficiency and power output per step/movement.
    - Evaluation of storage capacity and inverter efficiency for reliable power supply.

- Testing system durability under varying loads and usage conditions.

3. Potential Applications:
   - Dance studios, fitness centers, and gyms – Utilizing kinetic energy from workouts and dance routines.
   - Public walkways and event spaces – Implementing large-scale versions for energy harvesting in high-footfall areas.
   - Smart city projects – Integrating with urban infrastructure to contribute to sustainable energy solutions.

4. Scalability and Future Enhancements:
   - Expanding the system for larger areas with increased power output.
   - Enhancing energy storage capacity for prolonged usage.
   - Potential IoT integration for smart monitoring and remote data analysis.

Chapter 9

References

[**1**] Rich Meler, Nicholas Kelly, Omri Almog, Patrick Chiang, *A piezoelectric energy-harvesting shoe system for podiatric sensing*, 2014.

[**2**] P Rajendra Prasad, Avala Bhanuja, L Bhavani, N Bhoomika, Bindu Srinivas, *Power Generation Through Footsteps Using Piezoelectric Sensors Along with GPS Tracking*, 2019.

[**3**] T Sarala, Shivashankar, M Poornima, H D Lekhana, *Generation And Utilization Of Electricity Using Footsteps As A Source Of Energy*, 2020.

[**4**] Akshat Kamboj, Altamash Haque, Ayush Kumar, V.K. Sharma, Arun Kumar, *Design Of footstep power generator using piezoelectric sensors*, 2017.

[**5**] R.J.M. Vullers, R.V. Schaijk, I. Doms, C.V. Hoof, and R. Mertens, *"Micropower energy harvesting"* Solid State Electron, vol. 53, no. 7, pp. 684-693, 2009.

[**6**] P.D. Mitcheson, E.M Yeatman, G.K. Rao, A.S Holmes, and T.C. Green, *"Human and machine motion for wireless electronic devices"* Proc. IEEE vol. 96, no. 9, pp. 1457-1486, Sep. 2008.

[**7**] M. Ferrari, V. Ferrari, D. Marioli, and A. Taroni, *"Modeling, fabrication and performance measurements of a piezoelectric energy convertor for power harvesting in autonomous micro system"*, IEEE Trans. Instrum Meas, vol. 55, no. 6, pp. 2096-2101, Dec. 2006.