Khulna University of Engineering & Technology

FOOTSTEPS TO POWER : SUSTAINABLE CAMPUS MOVEMENT

TEAM TRIPLE CONNECT

Presented By:

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Project Inspiration

🌍 **Real-World Inspiration:**
Smart cities are already using **piezoelectric floor tiles** in places like airports, malls, and train stations to convert footsteps into electrical energy. This innovation blends sustainability with everyday human activity—turning movement into micro power.

🚨**Problem Spark**
Despite high foot traffic, most university campuses (like KUET) let this kinetic energy go to waste. In a world racing toward green solutions, this untapped energy source is a missed opportunity.

🎯 **Our Mission**
To simulate this energy-harvesting concept using affordable components—Arduino + Force Sensor—creating a smart, educational prototype that mirrors the logic of real-world piezo systems for future campus integration.

Project Overview

What We Build ?

We developed a smart energy-harvesting simulation system that mimics piezoelectric floor tiles using Arduino and a Force Sensor in Tinkercad. The Force Sensor acts as a placeholder to simulate the behavior of a piezoelectric sensor, due to hardware limitations in the simulation environment. It models how footsteps can trigger energy feedback in real-time.

How It Works ?

👣 Footstep pressure is applied.

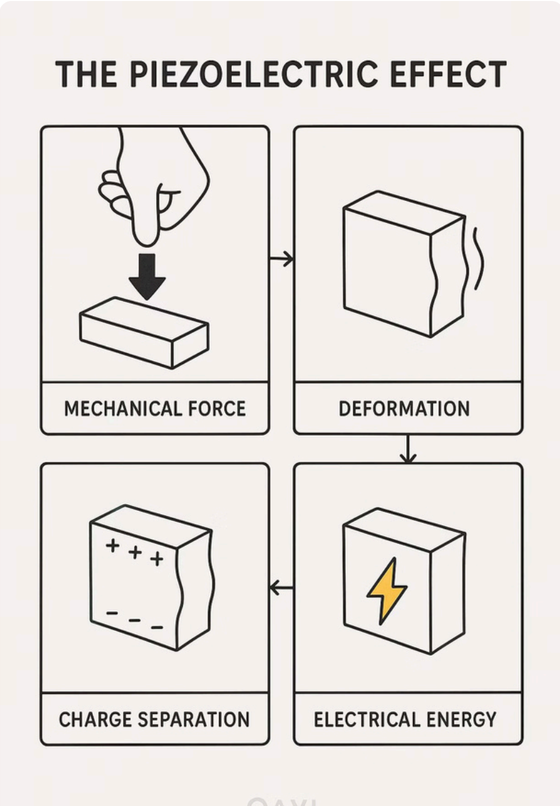
⚡ Force Sensor detects the pressure .
(simulating a **piezoelectric sensor**)

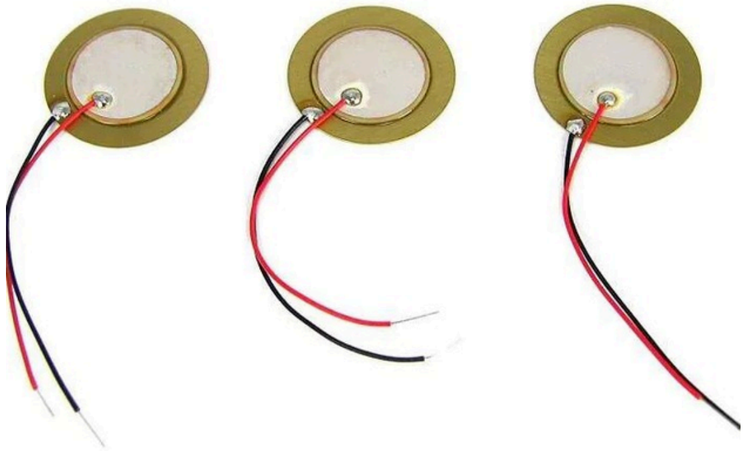
🔦 RGB LED lights up.

📊 LCD Display shows simulated energy values.

What is piezoelectric effect ?

The piezoelectric effect is the phenomenon where certain materials generate an electric charge when subjected to mechanical stress (such as squeezing, pressing, or twisting). This effect occurs due to a displacement in the centers of positive and negative charges within the crystal lattice of these materials, which leads to an external electric field or voltage





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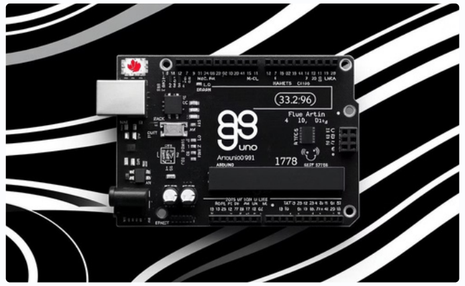
Key Components



Arduino Uno

The brain of the system, processing sensor input and controlling outputs.

Force Sensor (FSR)

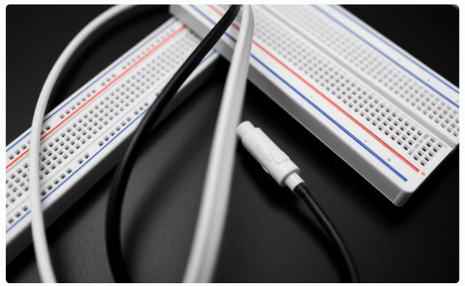
Detects the pressure applied by a footstep.

RGB LED

Provides visual feedback on simulated energy levels.

LCD (16x2)

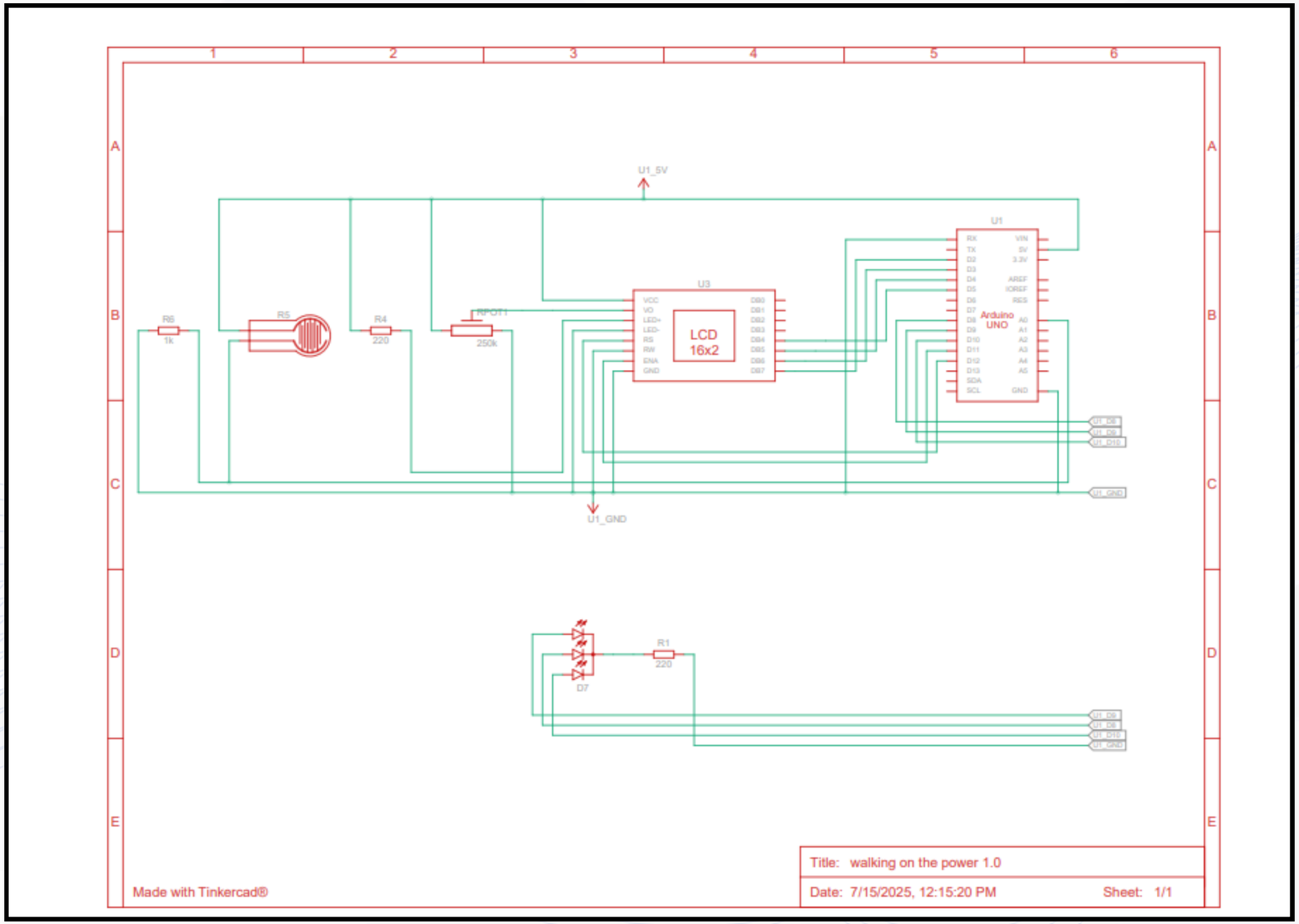
Displays real-time step count and total energy accumulated.



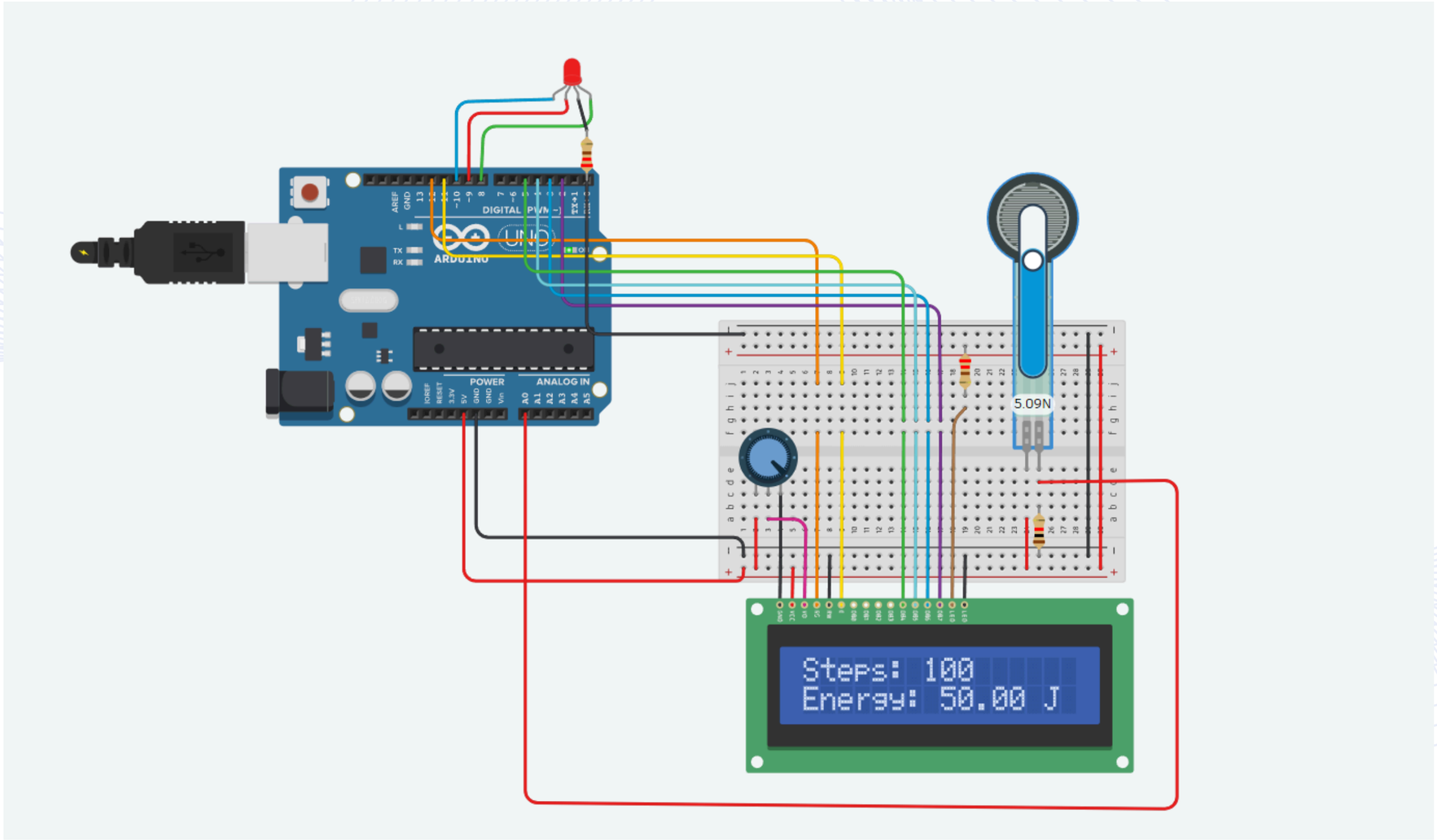
Breadboard & Wires

Facilitate connections between all components.

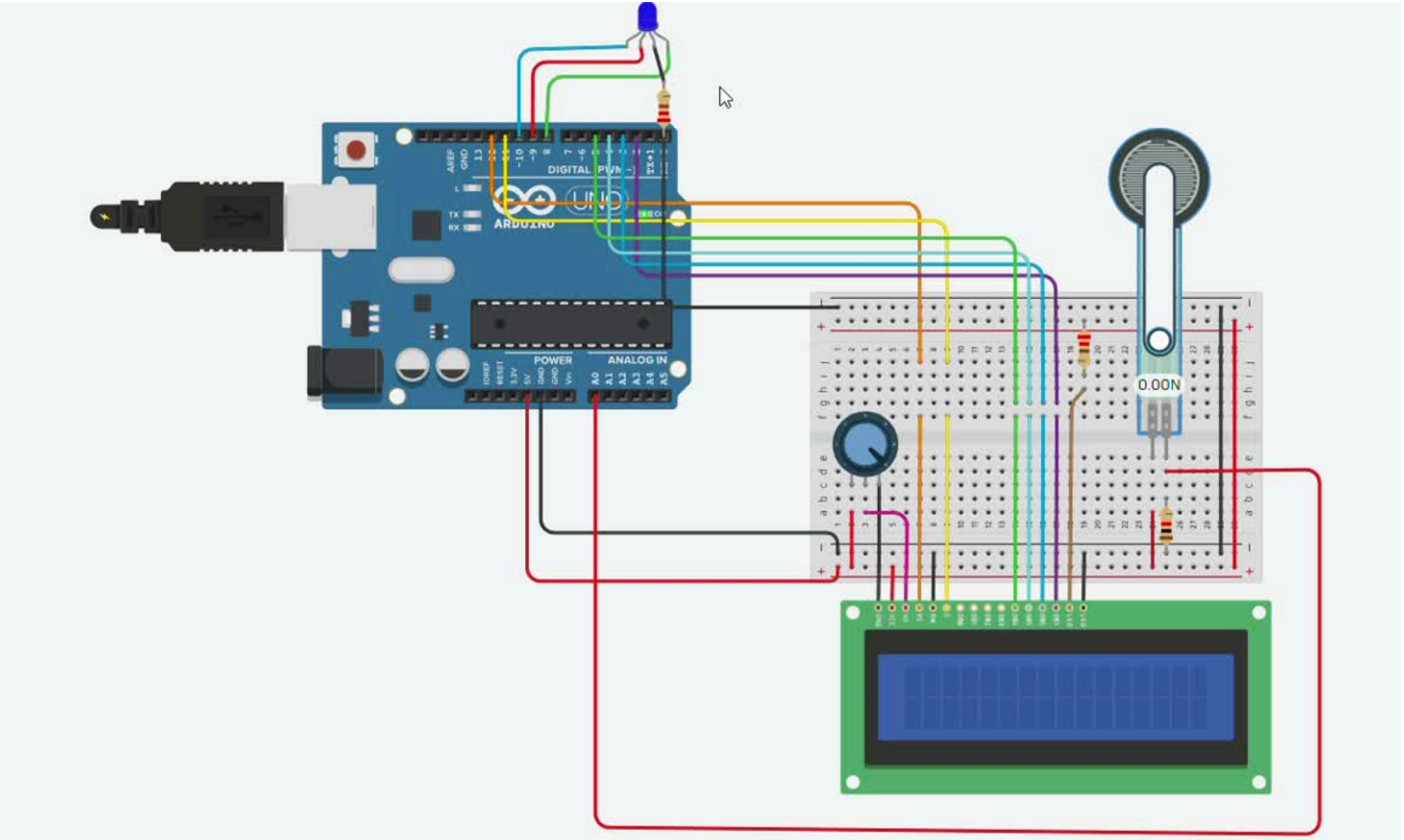
Schematic Diagram



Circuit Diagram / wiring



Simulation Video (Click to watch it) tinkerCAD simulation video



Project -name: FootSteps to Power by *Team_Triple_Connect*

Code

```ino
#include <LiquidCrystal.h>

// LCD pin setup: RS, E, D4, D5, D6, D7
LiquidCrystal lcd(12, 11, 5, 4, 3, 2);

// Pins
const int sensorPin = A0;  // Force Sensor (FSR)

// RGB LED pins (BRCG order)
const int bluePin = 10;
const int redPin = 9;
const int greenPin = 8;

// Variables
int sensorValue = 0;
int stepCount = 0;
float totalEnergy = 0.0;
const float energyPerStep = 0.5;

void setup() {
  lcd.begin(16, 2);
  Serial.begin(9600);

  // RGB LED pins
  pinMode(redPin, OUTPUT);
  pinMode(greenPin, OUTPUT);
  pinMode(bluePin, OUTPUT);

  lcd.print("System Ready");
  delay(1500);
  lcd.clear();
}
```

```ino
void loop() {
  sensorValue = analogRead(sensorPin);
  if (sensorValue > 100) {
    stepCount++;
    totalEnergy += energyPerStep;
    lcd.setCursor(0, 0);// LCD display
    lcd.print("Steps: ");
    lcd.print(stepCount);
    lcd.print("   ");

    lcd.setCursor(0, 1);
    lcd.print("Energy: ");
    lcd.print(totalEnergy);
    lcd.print(" J   ");
    Serial.print("Step: ");// Serial Monitor (for debugging)
    Serial.print(stepCount);
    Serial.print(" | Energy: ");
    Serial.println(totalEnergy);
    delay(300); // Debounce
  }

  if (totalEnergy < 5.0) { // RGB color status
    showColor(0, 0, 255);   // 🔵 Blue = Low
  } else if (totalEnergy < 10.0) {
    showColor(0, 255, 0);   // 🟢 Green = Medium
  } else {
    showColor(255, 0, 0);   // 🔴 Red = Full
  }
  delay(100);
}
void showColor(int red, int green, int blue) { // Function to set RGB color
  analogWrite(redPin, red);
  analogWrite(greenPin, green);
  analogWrite(bluePin, blue);
}
```

Code explanation

1. Library Inclusion

```cpp
#include <LiquidCrystal.h>
```

- The `LiquidCrystal` library is included to interface with a **16x2 LCD display.**
- It allows the Arduino to send characters and control cursor positions on the LCD.

2. LCD Initialization

```cpp
iquidCrystal lcd(12, 11, 5, 4, 3, 2);
```

This line specifies the **digital pins** connected to the LCD: RS, Enable, D4–D7.

It initializes communication between the Arduino and the LCD module.

3. Pin Definitions

```cpp
const int sensorPin = A0;
const int bluePin = 10;
const int redPin = 9;
const int greenPin = 8;
```

- `sensorPin`: Connected to the **Force Sensitive Resistor (FSR)**, which detects foot pressure.
- RGB LED pins control **visual feedback** based on energy levels:
  - Blue (Low)
  - Green (Medium)
  - Red (High)

4. Variable Initialization

```cpp
int sensorValue = 0;
int stepCount = 0;
float totalEnergy = 0.0;
const float energyPerStep = 0.5;
```

- `sensorValue`: Stores analog data from the FSR.
- `stepCount`: Tracks total steps detected.
- `totalEnergy`: Accumulates energy value over time.
- `energyPerStep`: Defines fixed energy (in Joules) generated per step (assumed 0.

Code explanation

⚙️ 5. Setup Function

cpp

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```cpp
void setup() {
  lcd.begin(16, 2);
  Serial.begin(9600);
  ...
}
```

- Initializes the **LCD screen (16 columns, 2 rows).**
- Starts the **Serial Monitor** at 9600 bps for debugging.
- Sets RGB pins as OUTPUT.
- Displays "System Ready" message briefly.

🔄 6. Loop Function (Main Program Logic)

cpp

```cpp
void loop() {
  sensorValue = analogRead(sensorPin);
  ...
}
```

- Continuously reads the FSR.
- If pressure exceeds a threshold (100):
  - Increments `stepCount`.
  - Increases `totalEnergy`.
  - Updates values on both the LCD and Serial Monitor.

🌈 7. RGB LED Feedback Logic

cpp

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```cpp
if (totalEnergy < 5.0) {
  showColor(0, 0, 255);
}
...
```

- RGB LED provides **real-time feedback** on energy level:
  - **Blue:** Low Energy (< 5.0 J)
  - **Green:** Medium Energy (5.0–10.0 J)
  - **Red:** High Energy (> 10.0 J)
- Improves user engagement and understanding of system status.

🧠 8. RGB Color Control Function

cpp

```cpp
void showColor(int red, int green, int blue) {
  analogWrite(redPin, red);
  analogWrite(greenPin, green);
  analogWrite(bluePin, blue);
}
```

- This function controls the **PWM output** for each LED color.
- Allows **custom color mixing** by adjusting brightness levels (0–255).

Working Demonstration

👣 A virtual footstep is simulated by applying pressure on the Force Sensor in Tinkercad, which acts as a stand-in for a real piezoelectric sensor.

⚖️ The Force Sensor sends an analog signal to the Arduino Uno, which processes the pressure data in real time.

🔦 Based on the intensity of the applied pressure, the system lights up an RGB LED in different colors: green for low pressure and red for high pressure, visually representing energy intensity.

📊 Simultaneously, a 16x2 LCD Display updates to show the corresponding simulated energy output, displaying values like "Energy Generated: 10 units".

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01 Limited Hardware Access

Lack of access to real piezoelectric sensors forced us to simulate with a Force Sensor.

02 Simulation Constraints

- No direct support for piezoelectric components in Tinkercad.
- Restricted to logic-based simulation, not real voltage or current flow.

03 Pin Limitations on Arduino

Limited number of I/O pins made it tricky to connect LCD + RGB LED + sensor.

FUTURE IMPROVEMENTS

Real Piezo Integration

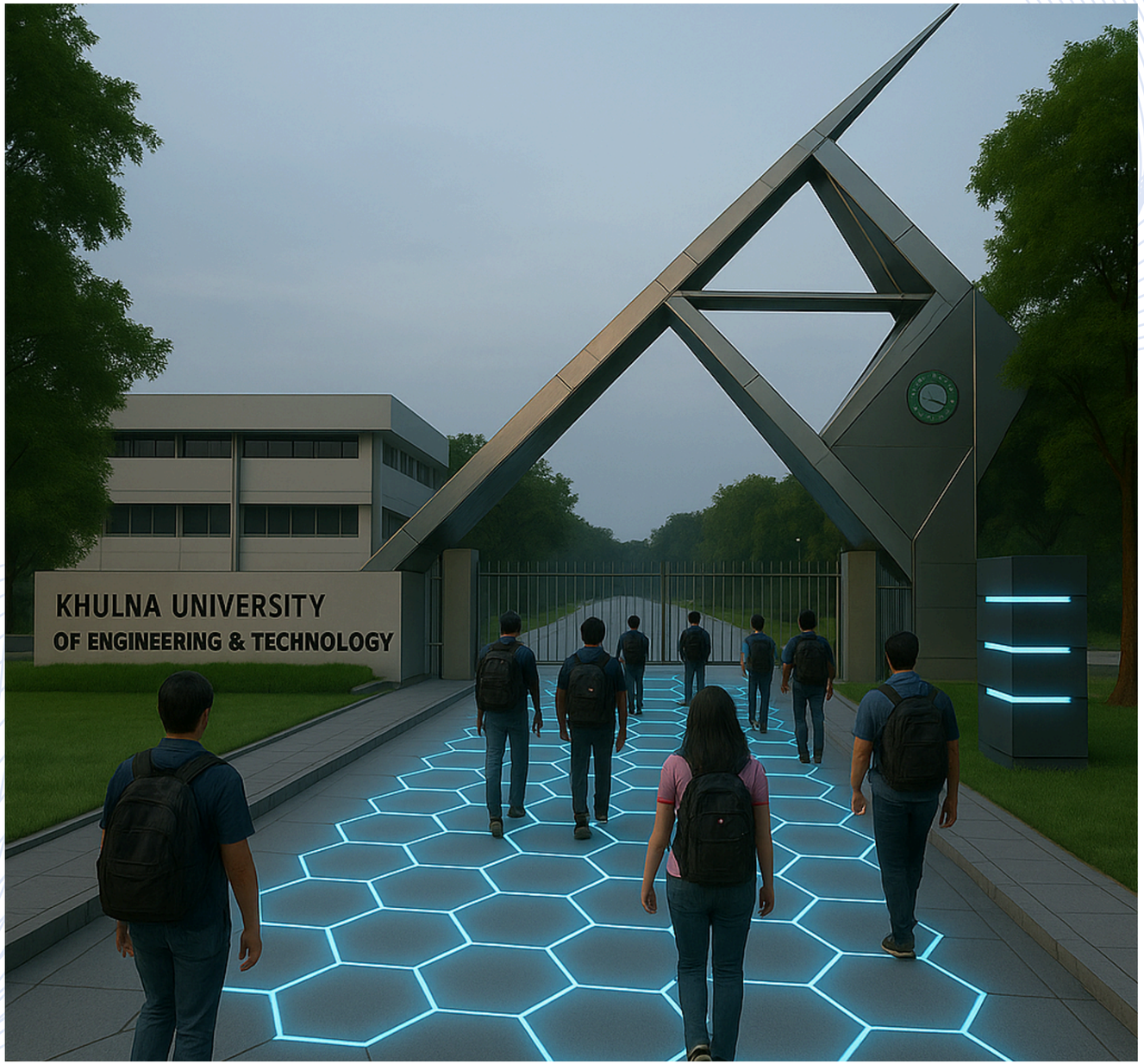
Replace the FSR with actual piezoelectric tiles for genuine energy harvesting.

Mobile Synchronization

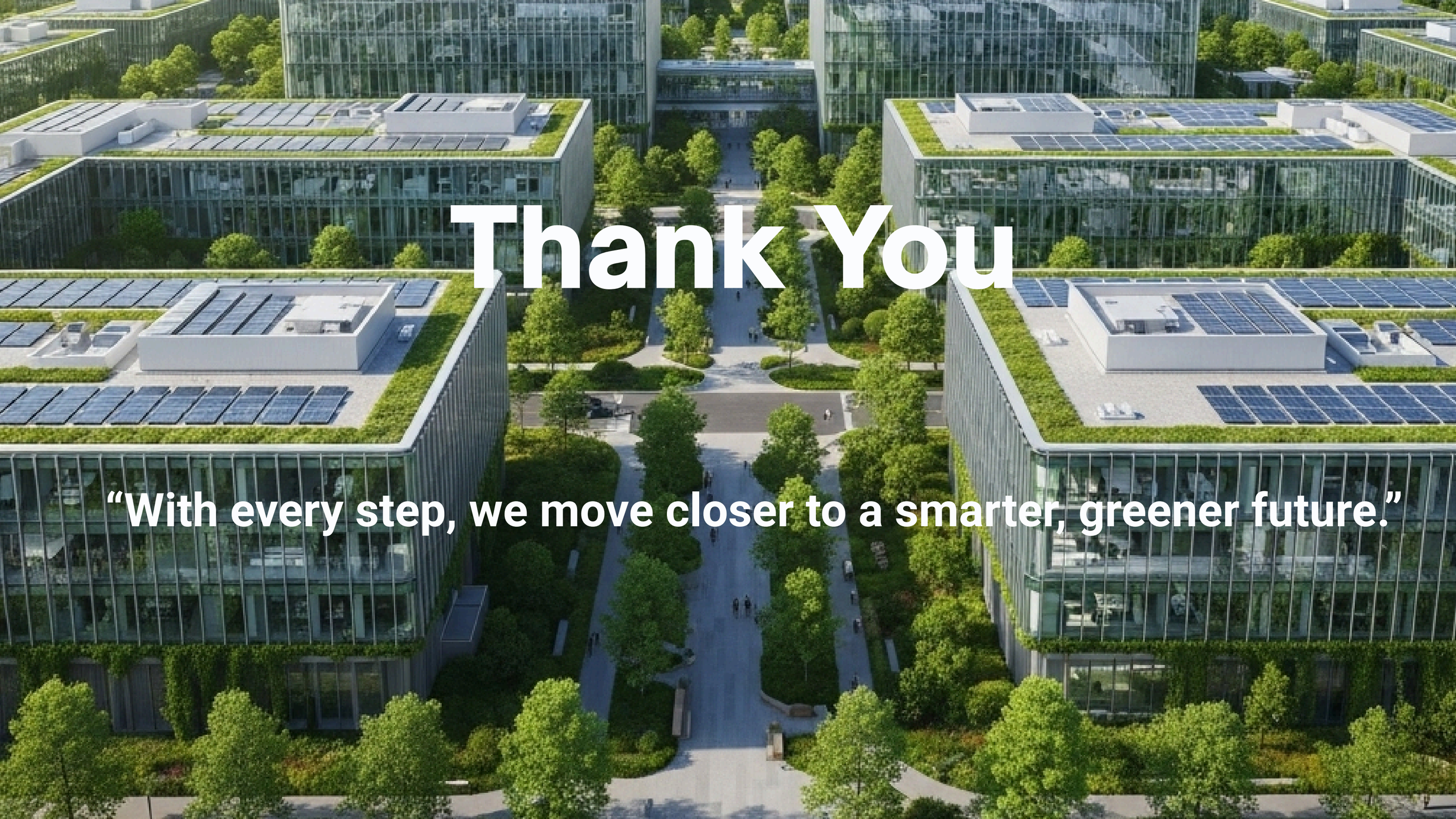
Integrate a Bluetooth module (HC-05) to allow real-time data monitoring via a mobile app.

KUET Walkway Prototype

Develop a real-world prototype for installation and testing on a high-traffic walkway at KUET.



showcasing how the KUET main gate area may appear after implementing piezoelectric floor tiles as part of the energy harvesting project


Thank You
“With every step, we move closer to a smarter, greener future.”