Quarterly Projects 2018
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Team #1 Documentation

The Next Step

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Introduction

To us, sustainability means meeting the needs of people without sacrificing the resources of future generations. Our project attempts to capture sustainable energy from one of the simplest modes of transportation: walking. Humans walk an average of 5000 to 7000 steps a day, and our project aims to capture the energy of just a few of them. Utilizing a Piezo Ceramic Generator, a product which harvests energy from mechanical force/bending (a.k.a footsteps), and placing it upon a tile, we will display how much energy is being harnessed from every footstep onto an LCD screen. We store the energy via parallel capacitors and use it to power a LED light, allowing the energy to dissipate from the capacitors.

Materials

- Piezoelectric Ceramic Generator
- Arduino Uno
- LCD Screen
- Male to Male Wires
- Jumper Wires
- Capacitors
- Resistors
- Breadboards
- Wood Plank
- Styrofoam
- Felt cloth
- LED light
- Potentiometer

Instructions

1. **Gather Materials**
2. **Initial testing of Sensor Readings**
    1. Gather the Arduino, Piezo sensor, breadboard, resistor, and male-to-male wires
    2. Plug in a wire from A0 from the Arduino to the breadboard, in line with the resistor and the sensor (see Figure below)

3. Plug resistor from A0 to Ground on the breadboard (see Figure Below)
4. Plug from the sensor to Ground on the Arduino
5. Plug the LED light into port 13 on the Arduino
6. Follow the Knock Tutorial on the Arduino website in order to compile and run the code
7. Display the readings on the screen monitor on the Arduino

https://www.arduino.cc/en/Tutorial/Knock

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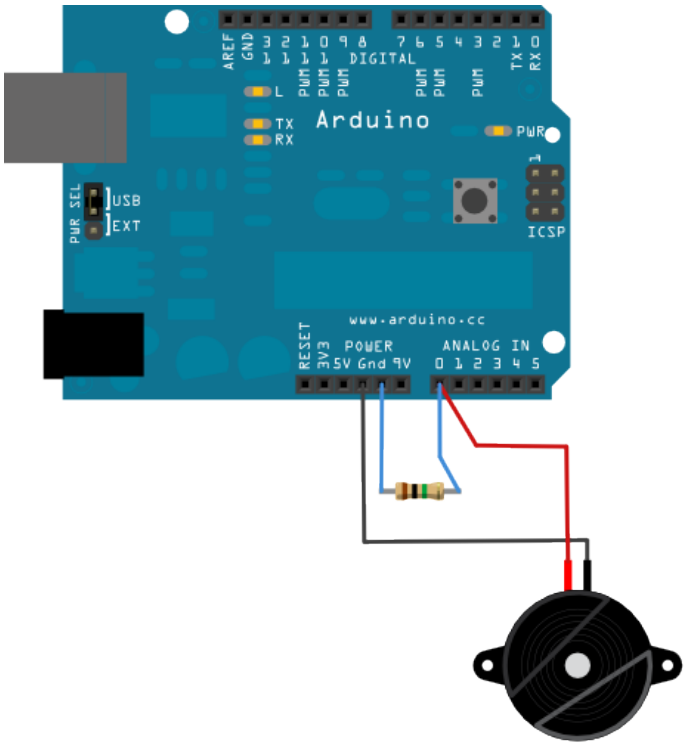
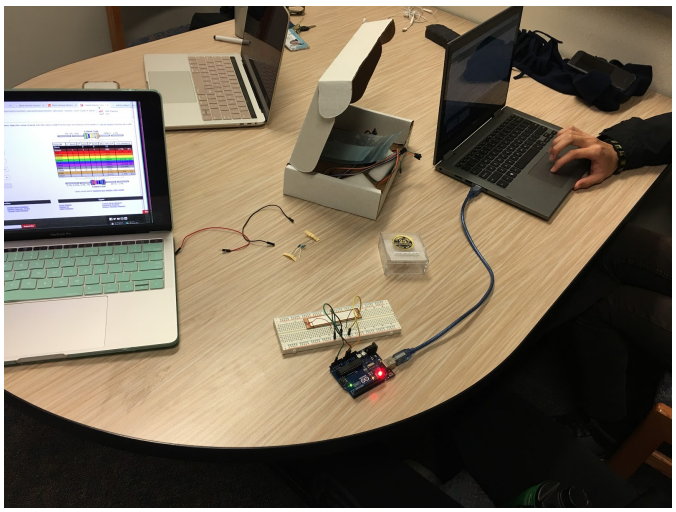
```
  by David Cuartielles <http://www.0j0.org>
  modified 30 Aug 2011
  by Tom Igoe

  This example code is in the public domain.

  http://www.arduino.cc/en/Tutorial/Knock
*/


// these constants won't change:
const int ledPin = 13;      // LED connected to digital pin 13
const int knockSensor = A0; // the piezo is connected to analog pin 0
const int threshold = 100;  // threshold value to decide when the detected sound is a knock or not


// these variables will change:
int sensorReading = 0;      // variable to store the value read from the sensor pin
int ledState = LOW;         // variable used to store the last LED status, to toggle the light

void setup() {
  pinMode(ledPin, OUTPUT); // declare the ledPin as as OUTPUT
  Serial.begin(9600);       // use the serial port
}

void loop() {
  // read the sensor and store it in the variable sensorReading:
  sensorReading = analogRead(knockSensor);

  // if the sensor reading is greater than the threshold:
  if (sensorReading >= threshold) {
    // toggle the status of the ledPin:
    ledState = !ledState;
    // update the LED pin itself:
    digitalWrite(ledPin, ledState);
    // send the string "Knock!" back to the computer, followed by newline
    Serial.println("Knock!");
  }
  delay(100);  // delay to avoid overloading the serial port buffer
}
```

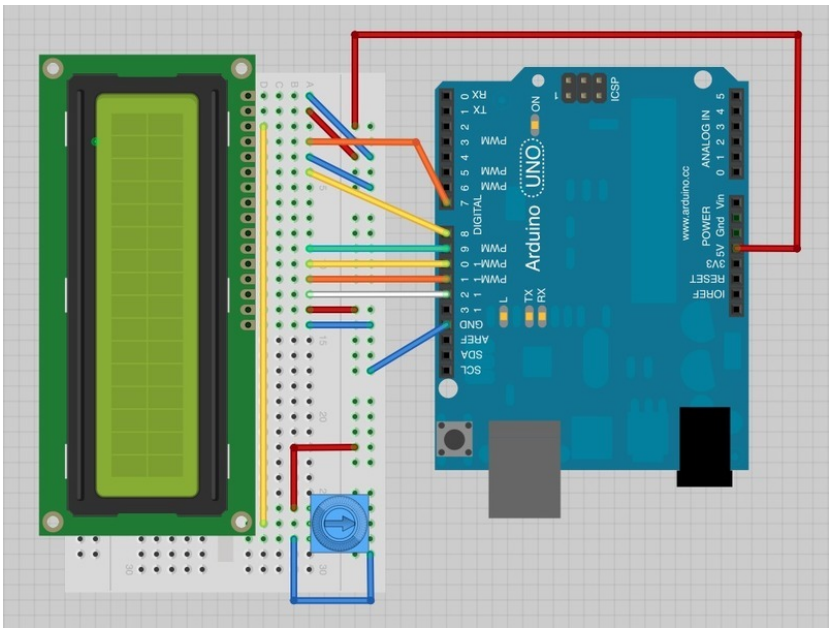
[Get Code]

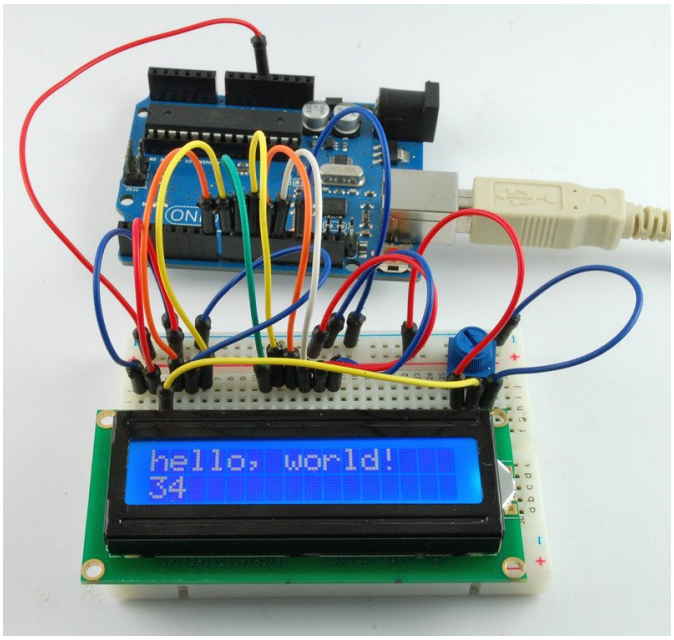




3. Initial Setup of the LCD Screen

1. Gather an Arduino, LCD Display, potentiometer, breadboard, and jumper wires
2. The Breadboard Layout uses many wires in order to configure all sixteen pins of the LCD screen. Please follow the schematic below to configure those wires
3. Follow the example tutorial on the Adafruit website to access the example code
4. Press reset button on Arduino to test if the count returns to zero





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```
1.  LiquidCrystal lcd(7, 8, 9, 10, 11, 12);
```

The arguments to this are as follows:

Display Pin Name Display Pin Number Arduino Pin (in this example) RS 4 7 E 6 8 D4 11 9 D5 12 10 D6 13 11 D7 14 12

After uploading this code, make sure the backlight is lit up, and adjust the potentiometer all the way around until you see the text message

In the 'setup' function, we have two commands:

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```
1.  lcd.begin(16, 2);
2.  lcd.print("hello, world!");
```

The first tells the Liquid Crystal library how many columns and rows the display has. The second line displays the message that we see on the first line of the screen.

In the 'loop' function, we also have two commands:

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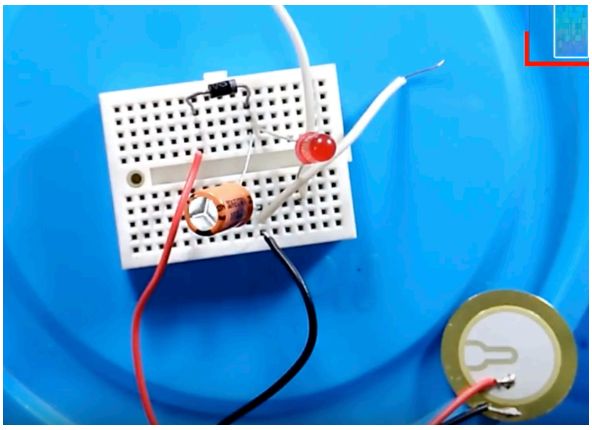
```
1.  lcd.setCursor(0, 1);
2.  lcd.print(millis()/1000);
```

4. **Initial Setup of Capacitors**
    1. Gather a capacitor, diode, jumper wires, breadboard, LED light, and diode
    2. Use a voltmeter to test the voltage running between the sensor when it is pressed
    3. Follow the schematic below
    4. Press on the sensor several times in order to store energy into the capacitor
    5. Touch the two red wires to each other in order to close the circuit, lighting up the LED

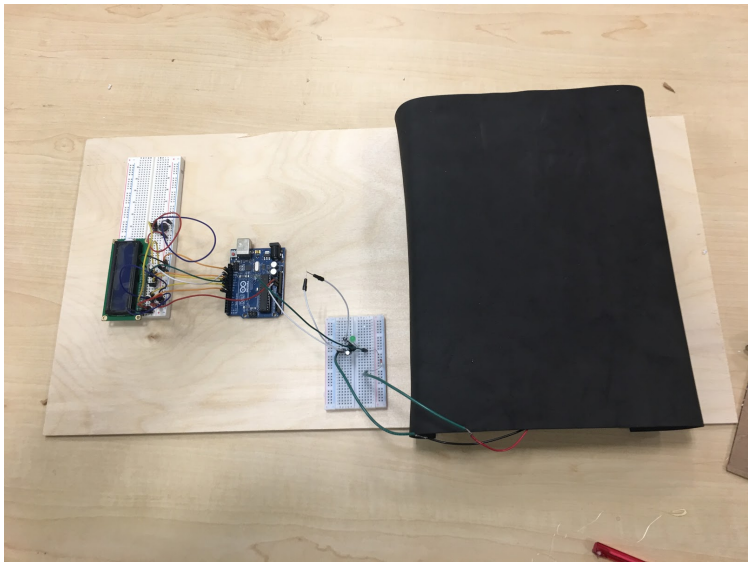


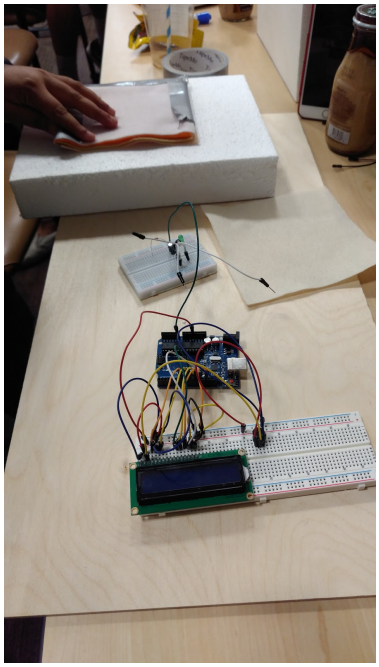
5. **Assembly of Previous Parts**
    1. Assemble all parts to one another on two separate breadboards with the Arduino in the middle (connected to the computer as a power source)
    2. Modify the prints on the LCD screen to print energy stored as well as the number of steps
    3. Modify the code so that it detects if the capacitor is full and turns the LED light when the energy is dissipated
    4. This will take multiple trials in order to check the voltage difference between each of the “steps” taken on the tile
    5. Make sure to convert the code from analogRead to voltage by multiplying by five volts and dividing by 1023
    6. Calculate the change in energy by using the equation:
        1. Potential Energy = (1/2)CV^2

6. **Creating Sensor Tile**
    1. Form padding layer of cloth for Piezo to rest upon
    2. Install Piezo upon padding layer and cover
    3. Add this to the styrofoam base
    4. Add cover material to house padding layer and base

5. **Designing Display Layout**
    1. Position parts before attaching them to the main display board
    2. Using hot glue, secure sensor tile to the main display board

3. Secure LCD and Breadboard using adhesive strip on the underside
4. Hot glue Arduino to main display board





Conclusion

In improved conditions, we would have liked to have prepared a more visually appealing project with wider functionality. For instance, we could have created a larger scale model which could support the weight of an actual footstep, requiring more sensors and materials.

Our greatest obstacle was integrating all the individual parts to form a comprehensive project. Each aspect of the project came with its own difficulties and challenges along the way, sometimes with implementation and others with just beginning.

Our proudest moment was when our project first had a valid display. This marked a shift of the project from something we had thought up in our minds into something tangible which could be interacted with.

References

https://learn.adafruit.com/adafruit-arduino-lesson-11-lcd-displays-1/overview

- Helped in getting the LCD display to light up and show text
- Provided a frame from which to build our visual aspect from

https://www.arduino.cc/en/Tutorial/Knock

- Provided a beginning to detecting a knock using our piezo

We would like to thank Antony, George, Ysabelle, Curtis, and Dillon for their support with our project. Thank you so much for your help!