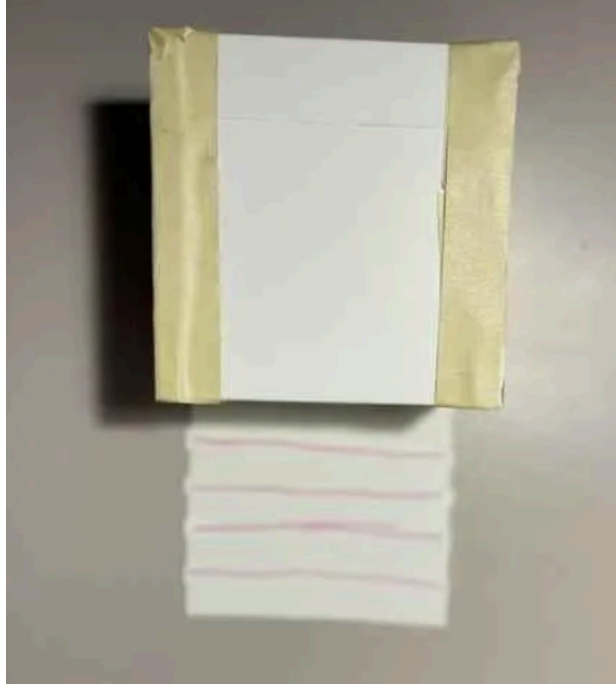
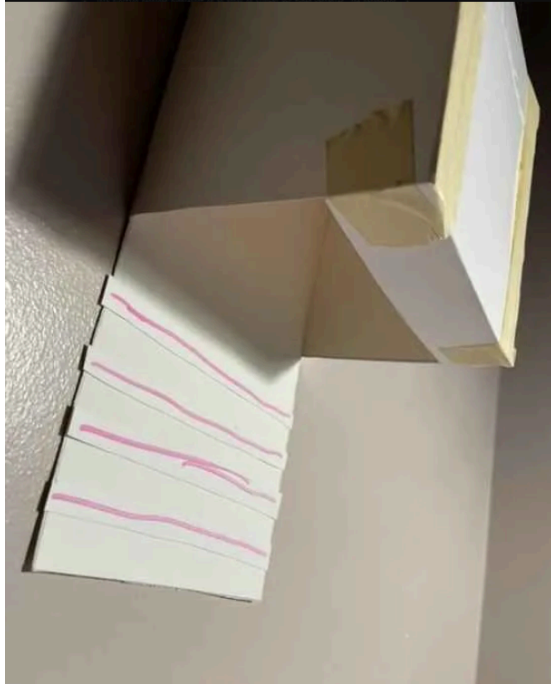


## Previous Prototype Progress:

```
1
2 int cm = 0;
3 int count = 0;
4
5 long readUltrasonicDistance(int triggerPin, int echoPin)
6 {
7     pinMode(triggerPin, OUTPUT); // Clear the trigger
8     digitalWrite(triggerPin, LOW);
9     delayMicroseconds(2);
10    // Sets the trigger pin to HIGH state for 10 microseconds
11    digitalWrite(triggerPin, HIGH);
12    delayMicroseconds(10);
13    digitalWrite(triggerPin, LOW);
14    pinMode(echoPin, INPUT);
15    // Reads the echo pin, and returns the sound wave travel time in
16    return pulseIn(echoPin, HIGH);
17 }
18
19 void setup()
20 {
21     Serial.begin(9600);
22 }
23
24 void loop()
25 {
26     // measure the ping time in cm
27     cm = 0.01723 * readUltrasonicDistance(7, 7);
28
29     Serial.print(cm);
30     Serial.println("cm");
31
32     if(cm <= 10) {
33         count++
34     }
35     Serial.println(count)
36
37     delay(10); // Wait for 10 millisecond(s)
38
39 }
```





### **Test Plan for Prototype III**

#### **Objective:**

To refine the previous prototype by further testing its functionality, environmental resistance, long-term durability, while also integrating any additional user feedback into the design. The goal of this test plan is to meet/exceed all performance metrics while ensuring that the users requirements are met.

#### **Key Testing Areas**

1. **Enhanced Motion Sensor Accuracy**
2. **Temperature Control and Ventilation**
3. **Advanced Weatherproofing**
4. **Structural and Long-Term Durability**
5. **User Feedback Integration and Usability**

---

#### **Components to Test and Metrics**

##### **❖ Enhanced Motion Sensor Accuracy**

- **Objective:** Ensure that the sensor accurately detects motion at the bat boxes entrance with a 98% accuracy rate. (3% improvement from previous prototype)

- **Metric:** At most, 1 incorrect detection out of 50.
- **Test:**
  - Simulate bat movements, ensuring testing with various speeds and sizes of objects at the entrance.
  - Test various angles of entrance.
  - Test multiple bats entering or exiting the bat box at the same time.
  - Vary conditions during testing such as distance, lighting, speed, etc.
- ❖ **Temperature Control and Ventilation**
  - **Objective:** Verify that the internal temperature of the bat box remains below 40 degrees Celsius at all times, while also ensuring optimal ventilation to avoid moisture build up and mold.
  - **Metric:** Humidity should remain below 60% while internal temperature remains below 40 degrees Celsius.
  - **Test:**
    - Placing the box under direct sunlight to simulate daytime conditions and utilize a temperature sensor to monitor temperature.
    - Using a thermometer or a hygrometer to monitor internal temperature and humidity over time.
    - Test with multiple ventilation options to optimize cooling, for example, utilizing active cooling such as fans to improve airflow, or passive vents.
- ❖ **Advanced Weatherproofing**
  - **Objective:** Prevent water infiltration during rainy conditions to a higher degree.
  - **Metric:** Maximum 1% of water load is allowed to enter the box (if 100mm of rain falls, no more than 1.0mm of water should enter).
  - **Test:**
    - Simulate heavy rainfall, dust, debris exposure to check the effectiveness of the seals and waterproofing.
    - After each test, check the interior for any leaks that are points of entry for debris.
    - Test all seals, joints, and vents for any potential weaknesses and reinforce as needed.
- ❖ **Structural and Long-Term Durability**
  - **Objective:** Ensure the prototype is able to withstand any outside forces such as strong winds, potential impacts, and continuous use without experiencing any major structural damage.
  - **Metric:** The box should withstand forces around 50kg (Approx 150 km/h wind forces), which is 15kg heavier than our previous prototype criteria.
  - **Test:**
    - Apply force gradually to the box using weights.
    - Inspect the box after each test for any signs of cracking, weakening, or any structural damage.
    - Perform multiple, repetitive stress tests to assess how the bat box may hold up under long term-use and wear.
    - Perform a **weight test** on the inside by applying 15kg of load, ensuring that the box handles much more than the maximum bat capacity (5 lbs more).
- ❖ **User Feedback Integration and Usability**
  - **Objective:** Confirm that the prototype meets user expectations and is easy to operate.
  - **Metric:** A ranking system from 1 - 5 when it comes to usability, functionality, etc.
  - **Test:** These surveys should be asked to a large group and should receive at least 80% positive ratings, otherwise improvements should be made.

## Stopping Criteria:

Each test will be considered complete once the following conditions are met:

1. **Sensor Accuracy:** Achieves 98% accuracy across multiple test conditions (size, speed, distance).
2. **Temperature:** Internal temperature remains consistently below 40°C for at least 4 hours under simulated sunlight.
3. **Weatherproofing:** No more than 1% of water enters after simulating different rainfall levels.
4. **Durability:** The box remains structurally intact after simulated wind forces and weight application.
5. **Fidelity and Adjustments:**
  - This prototype aims to achieve a higher level of **accuracy and durability** than the second version.
  - If any components fail to meet the stopping criteria, adjustments will be made to the design, and the test will be rerun until all criteria are met.
  - Each failure will be analyzed, and we will make appropriate changes.

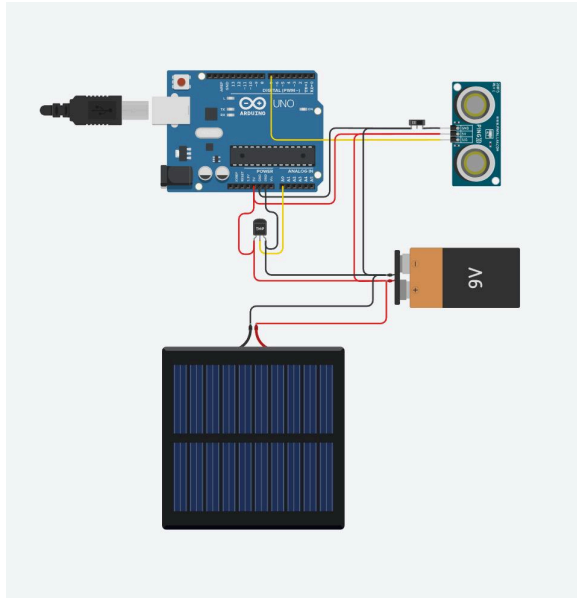
## Note on Feedback:

We will gather further feedback on this prototype from users (e.g., bat conservation experts or potential clients) regarding the overall design and performance, especially focusing on **sensor performance** and **environmental resistance**. Based on this feedback, we will refine the design. Furthermore, we will also ask for feedback on the dimensions, setup, and convenience of our design, and make changes if necessary.

---

## Analysis of Components:

- i) Circuit setup for the Arduino, Battery, and solar panel.



(In this setup, the battery acts as backup power for the components; however, in our real design, the battery will directly power the Arduino. The software that we used did not allow using the battery to power the Arduino.)

## ii) General Design

Firstly, we are including ventilation holes near the top of the bat box, to help regulate temperature and airflow throughout the box. This is because the bats do not enjoy being in hot temperatures, so simple ventilation will help ensure the box does not overheat. Another component of our design is multiple roosting slabs in the interior of the box, creating more space for bats. This will increase the capacity of our box, making it more flexible to hold many more bats compared to a simple one-slab design.

In terms of weatherproofing, we are going to seal cracks as best as possible and create a sloped roof. Sealing cracks will help eliminate any risk of large quantities of rain entering, and the sloped roof will ensure that rain or snow does not build up on the top of the box.