The Robins

Deliverable G - Prototype II and Customer Feedback

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Introduction

Our second prototype is a functional vibration sensor system designed to count the number of bats that land on the landing pad of a bat box. It consists of an Arduino Nano circuit, electrical wiring, and a vibration sensor, with the code written in C using the Arduino IDE app. The system tracks bat landings by detecting vibrations when a bat lands on the landing pad and enters the box. Data can be retrieved by connecting the sensor to a laptop via USB-C cable. We have been testing the sensor's sensitivity using objects of similar weight to bats and evaluating how factors like wood thickness affect its performance. The goal of this deliverable is to further enhance the prototype based on these test results to enhance its accuracy and functionality.

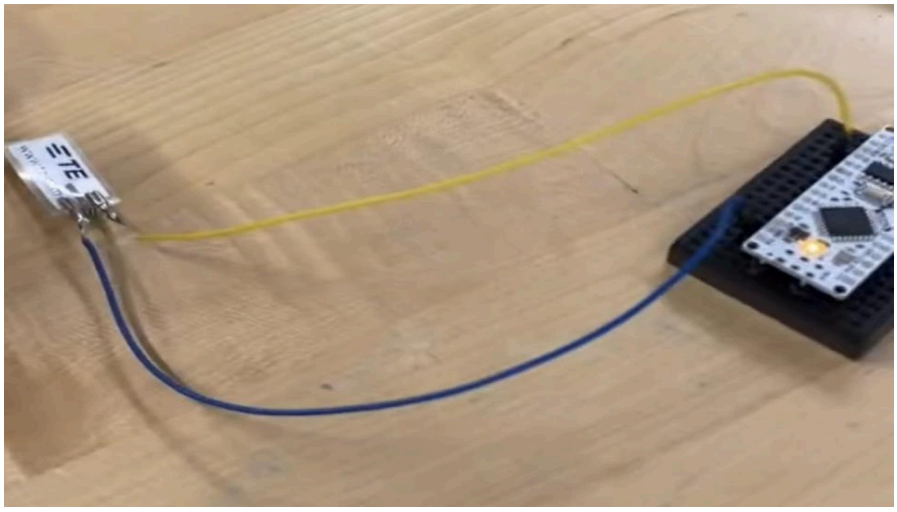

Figure 1. Our sensor connected to the Arduino Nano

Analysis of Components and Systems

For Prototype 2, we selected an Arduino Nano assembled with a vibration sensor. The assembly process took approximately five minutes, while setting up the code and calibrating the sensor's sensitivity required an additional hour to hour and a half. We tested the sensor's responsiveness by varying the thickness of the wood, fine-tuning it to ensure accurate detection of bat landings. In the next phase, we plan to integrate the sensor into the bat box, along with a protective case for the sensor, effectively combining Prototype 1 and Prototype 2. The primary objective for this prototype was to ensure the sensor was fully operational and the code was ready for implementation once the bat box assembly is complete.

Prototype test Plan, Analysis and Results

Test 1

The first test was to recheck the assembly time. The box design was changed a bit for this version to account for the size of our sensor and properly putting the box together, as last time the proportions were a bit off. Using the same material, MDF, we cut out the pieces, which took about an hour. Assembling all the pieces, including the sensor, took about 30 minutes. Though this is shorter altogether than last time, we believe that the time assembly can be cut down quite a bit. We shall implement this by having a ready step-by-step plan for the next prototype.

Test 2

For this test, we tested how much weight the box can withstand. For this test, we stacked heavy objects on the box like large textbooks. The box withstood the weight very well which is most likely due to the new wood glue that was used in this prototype which helped the box stay together much better than the first set of tests that were done. For the next prototype, we will continue to use this wood glue to keep our box together.

Test 3

For this test, the group had to run a test on the sensor box by checking its water resistance. From the last test, it was brought up that the box leaked water. We had decided that we would use a silicone sealant, but due to time constraints, we did not end up getting the sealant. That means this test was inconclusive and we'll have to test it in the next prototype. Another possible option is 3D printing the box itself.

Test 4

We also tested the durability of the sensor box by dropping it from various heights without the sensor inside, using a new wood glue. After dropping it out the window from the top floor of a two-story house the box remained intact with scratches and light damage which shows that the new wood glue that was used was much more effective than the hot glue that was previously used in the first set of tests. We believe that the glue used in this prototype was highly effective in keeping the box together and making sure it didn't break therefore we plan to continue to use this new wood glue in the future.

Test 5

Arguably the most important test of this whole project. This test was run by throwing a small lip balm the same weight as a small brown bat at the box with some wood overtop. It ended up reacting best to a sensitivity of 14, though sometimes counting the impacts twice. The next test we shall run will be with a full bat box that we would be able to properly simulate a bat landing on and we can calibrate the sensor to not take hits twice.

Customer Feedback for Prototype I

- **Ensure sensor functionality:** It's important to ensure that the sensor is fully operational and performing as expected.
- **Be mindful of time constraints:** The limited project timeline was highlighted, which increases the need to stay focused on deadlines and deliverables.
- **Positive feedback on insulated case:** No issues were raised regarding the design or effectiveness of the case for the sensor.
- **Clarify sensor data inputs:** The customer spoke about what data the sensor collects, regarding the force impact required to trigger the vibration sensor. This will be addressed during the calibration process (prototype II)
- **Sensor limitations:** The customer also spoke about the importance of understanding the sensor's limitations, including its range and sensitivity.

We will take these comments in mind as we design our future prototypes and continue to develop the product.

BOM of Prototype 2

Material	Source	Amount	Justification	Price Per Unit (CAD)	Total Cost with Tax (CAD)	Actual Cost with Tax (CAD)
Resistor (1 MOhm)	Digikey	1	Used for the sensor and its respective electronics.	.047	0.05	0.5
Battery holder	Digikey	1	Used to plug the battery into the microprocessor	0.90	1.02	1.02
Vibration Sensor	Digikey	1	Used to detect when bats land on the landing portion of the bat box	9.41	10.63	10.63
Arduino Nano	Makerlab	1	Used to receive and store data from the vibration sensor.	8.00	8.00	8.00
9V Battery Duracell	Makerlab	1	Used to power the electronics for prolonged periods of time.	1.00	1.00	1.00

Total Cost with tax (CAD) = 21.15

Test Plan for Prototype 3

Our prototype 3 will be an MDF model of our bat box design to test the size, durability, strength and accessibility of our design and make modifications if necessary.
The following tests planned for prototype 3 are as follows:

Test ID	Test Objective (Why):	Description of Prototype Used and of Basic Test Method (What):	Description of Results to be Recorded and how these results will be used (How):	Estimated Test duration and planned start date (When):
1	Estimate how many bats can fit inside the bat box chamber to see if the box size needs increased.	How many objects with a similar size as the bats can fit inside.	Count how many objects (clumps of paper) fit inside and compare to the objective.	3-5 minutes 2024-11-17
2	Testing weather resistance to see if it meets goals.	Placing the box outside for 3 hours to see how it is impacted and additionally hose the box down.	Record whether water enters the bat box/wind blows through to detect holes or possible flaws in the design.	4 hours 2024-11-17
3	Test the sensor box application to see if it properly sticks and is easily accessible.	Use simple glue to see if the box securely and quickly sticks to the back.	See if it holds with simply applied pressure and consider other mounting methods if it doesn't.	2-3 minutes 2024-11-17
4	Test the durability of the box to simulate worst-case weather scenarios.	Drop the box from different heights and apply force to key areas to see if the design holds.	Determine if there are any weak points and address them in the design.	20 minutes 2024-11-17

5	Test the top door hinge.	Test the door hinge by opening and closing the door, testing if the door naturally stays closed when not in use.	Determine if the door hinge needs to be changed or a latch needs to be added to secure the door closed.	2-3 minutes 2024-11-17
6	Test the mounting of the box.	Test the mounting feature in the back by attempting the mount itself.	Determine if the box is hindering the mount at all and if it is able to hold up properly	30 minutes 2024-11-17
7	Test the sensor's abilities.	Testing the sensor to make sure it would be able to pick up a bat landing	Determine the sensitivity of the sensor and possible errors it may make	2 hours 2024-11-17