GNG 1103

Design Project User and Product Manual

Bat Box and Entry Counter

Submitted by:

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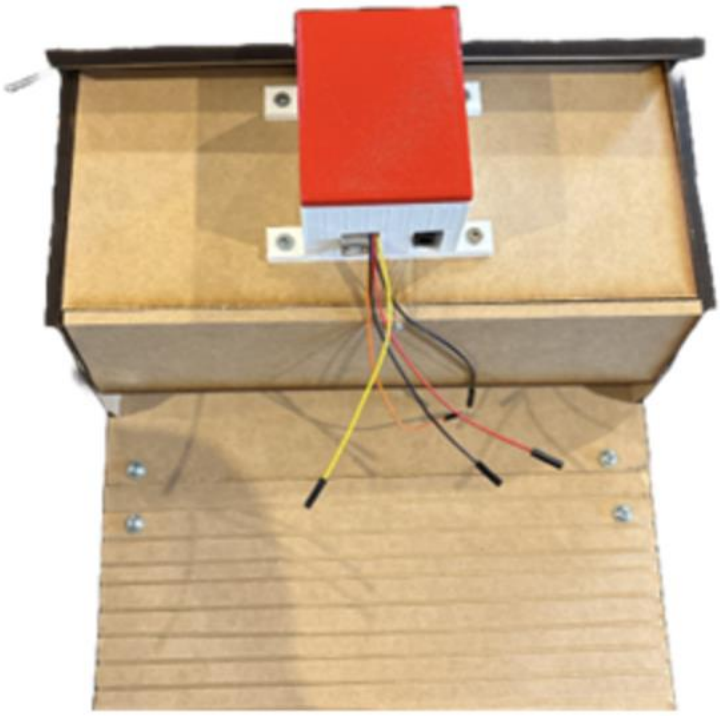

Figure 1: Our final prototype partially assembled.

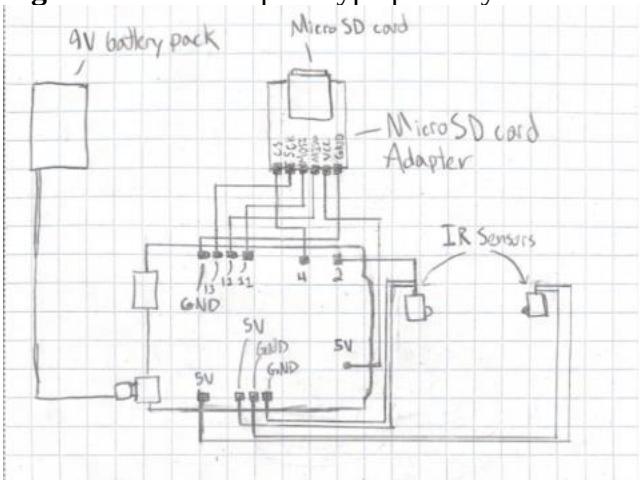

Figure 2: Detailed design drawing of the circuit.

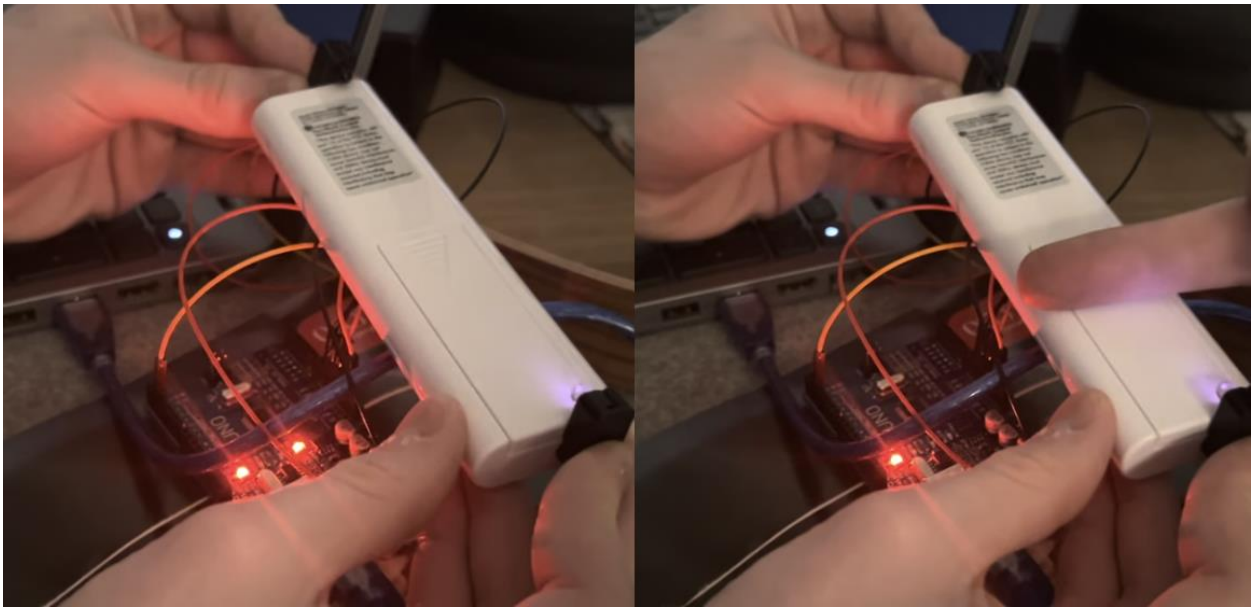

Figure 3: Testing our laser with an LED light than turns off when the beam is broken.

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List of Acronyms and Glossary

Table 1. Acronyms

Acronym	Definition
IR	Infra-red.
PETG	Polyethylene terephthalate is a thermoplastic polyester that is commonly used in 3D printing
PLA	Plastic like filament commonly used in 3D printing
SD	Storage device.
v	Volt.
MDF	Medium density fibreboard: the material we laser cut and used to build the box.
IDE	Integrated development environment.

Table 2. Glossary

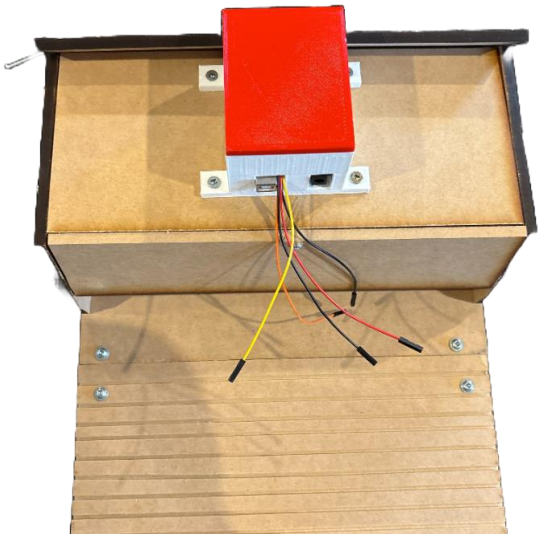
Term	Definition
IR sensor	A break beam sensor that uses infra-red light to detect objects, commonly used for garage doors.
SD card	A type of memory device used to store data.

1 Introduction

As bat populations in Ontario plumet due to losing their habitats because of our society's actions, there is a need for us to help ensure their survival. To accomplish this there has been an initiative to build artificial habitats for them in the form of bat boxes. Due to this we want to make sure that the bat boxes are efficient, which is why there is a need to track their usage. Our solution to this issue not only serves as an accurate way to track the number of entries on the box we manufactured but also provides an easily attachable way to track the number of entries of other preexisting boxes.

2 Overview

To accomplish the desired outcome, we utilized an infrared break beam sensor which is triggered whenever a bat enters or exits the box. To ensure the accuracy of this data we have an Arduino Uno which interprets the data to only register entries and to store it onto an SD card. These electronic components are stored in a 3D printed case and powered by a 9-volt battery.



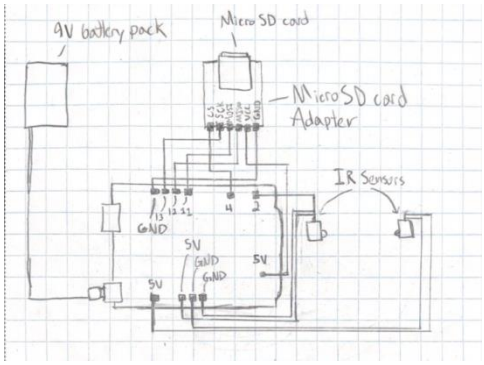
2.1 Cautions & Warnings

When handling the device do handle with care. Due to the use of delicate electronics the risk of damaging the device and altering its functionality. In addition, due to the use of screws please ensure to handle with care to avoid any potential injuries and/or damaging of the device.

3 Getting started

Device assembly:

1. The first step to properly assembling the device is to place the Arduino into the case with the ports properly aligned with their designated holes and secure it to the bottom utilizing double sided tape.
2. Once this is done, please pass the wires through the excess space of the USB type B port hole.
3. Now to properly connect the wires please follow the diagram below:



4. Once this is complete and the micro-SD card adapter is placed inside the box, you are now ready to put the top of the case on and screw it into the front face of the bat box.
5. The final step of the device assembly is to align the sensors along the entrance of the box. Once you have aligned them secure them into place using electrical tape and you are good to go.

3.1 Configuration Considerations

The device should be installed on a box that is no larger in width than 50 centimeters to allow the sensors to maintain high levels of accuracy. There needs to be screws and a drill available to fix the device to the box and tape to fix the sensors to either side of the box.

3.2 User Access Considerations

For the general accessibility of the collected data the only required instrument is a computer that has an SD card port. You simply need to remove the top portion of the case (the red portion),

carefully remove the card and insert it into your computer. From there the last step is to open the allocated file for the SD card and read the data.

3.3Accessing/setting up the System

To set up the system, ensure that the sensor's wires are connected to the Arduino and that the battery is properly attached to the Arduino as well. Ensure that the sensors are aligned by viewing the light on the Arduino by taking the top of the case off. Once these are all complete the system is set up.

3.4 System Organization & Navigation

The sensor communicates if the beam is broken through the wires which bring that information to the circuit board. The circuit board tracks the amount of time since the power was hooked up and combines that information with the beam being broken to write a string to a text file that says the time that the beam was broken.

3.5Exiting the System

Thanks to some features specific to the Arduino, to turn off the system you just simply unplug the 9v battery and you're done. All the data that has been collected will still be on the SD card and retrievable without risking any loss of data.

4 Using the System

The following is a collection of the different parts of the system. Firstly, the bat box itself is a relatively standard model containing grooves on the landing pad, and a slanted bottom to make sure any guano that might accumulate slides out. We made sure that the width of the model was accurate to a small bat box you could currently find in use to make sure that the distance between the two lasers was accurate to real-world designs. Speaking of the lasers, they are placed on each side of the entrance of the bat box and detect whenever a bat enters. We can differentiate entries and exits with some code that can detect when a bat leaves the box or if guano falls out, due to the much shorter time of it crossing the laser. The Arduino containing this code is contained in a small

3D printed case that's attached to the front of the bat box and is easily detachable and can be attached to many different bat boxes of various sizes.

4.1Data collection

The data collection system is the most important part of the project. It attempts to track the number of bats who are entering the bat box and conveys this number to an Arduino uno which writes the number and time of bats entering to an SD card. This system avoids tracking guano by limiting the number it tracks to things that trigger the sensor for more than 250 milliseconds.

5 Troubleshooting & Support

5.1Error Messages or Behaviors

One likely behavior is the dealignment of the IR sensors. In this scenario, no false counts will occur, however the device won't be able to detect any entries that occur until they are put back into proper alignment. To correct this error, it will require the user to manually move the sensors until they are back in alignment. To ensure that they are back to being aligned simply slowly pass an object through the entrance and ensure that it is recorded on the SD card.

5.2Special Considerations

If there is no cause for the issue it is worth taking the device apart and testing the components individually to see if there are defective parts that are causing issues for the whole device.

5.3 Maintenance

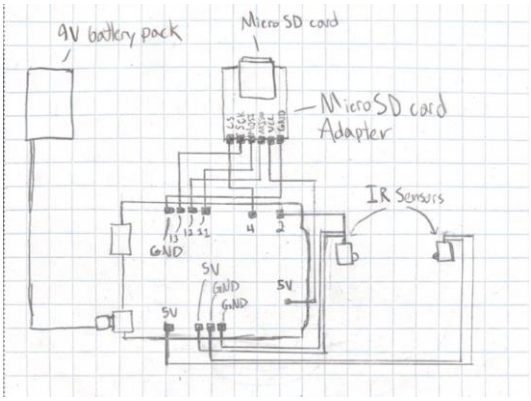
To ensure the proper performance of the device monthly maintenance is required. This includes replacing the 9v battery and as well as recording the data that is stored on the SD card.

5.4Support

If there are issues with specific parts, please consult the companies help line regarding that specific issue. For issues with the main circuit board consult the Arduino forums or the Arduino website. If there are issues with the sensors consult the Adafruit website for help.

6 Product Documentation

The final prototype was split into four different sections, those being the circuit, the code, the case for the circuit, and the actual box itself. The process of creating the final prototype began by creating the circuit outside of the case and ensuring it worked all together. This circuit was made up of two IR sensors, one sending and one receiving, a micro-SD card and a microSD card adapter, an Arduino uno r3, and the wires to attach all these together. They are all important to create the functioning circuit. After this the case for the circuit was made. This was 3D printed out of PLA filament, with two holes in the side to attach the power jack and the USB connector to the Arduino. PLA filament is not the best filament so it would be more effective to use a different filament such as PETG for weather resistance. It has 4 legs on the bottom with holes to appropriately screw it into the box. After this the box itself was made. It was laser cut out of a sheet of MDF. This material was only used for its time effectiveness as it is not particularly good at anything. If you are making your own box to use with this device, consider using more heavy-duty materials to create the best base for everything else to attach onto. Finally, the last part of the prototype being the code. There is not much explanation for the code. It must be written for the Arduino IDE which means it must be written with the Arduino programming language which is based of C++. There is no definitive way to recreate our exact code as it was original to our group. Shown below is the exact circuit we used for our device.



6.1

6.1.1 BOM (Bill of Materials)

ITEM/MATERIAL	PRICE	LINK
9V BATTERY	4.52 $	Makerstore.ca
9V BATTERY BOX	4.04 $	Emartee.com
ARDUINO IDE	0.00 $	Arduino
ARDUINO SD LIB	0.00 $	Arduino
ARDUINO SPI LIB	0.00 $	Arduino
ARDUINO UNO	17.23 $	Makerstore.ca
ELECTRICAL TAPE	1.91 $	Canadiantire.ca
INKSCAPE	0.00 $	Inkscape.org
MDF	3.61 $	Makerstore.ca
MICRO SD MODULE	2.26 $	Amazon.ca
ONSHAPE	0.00 $	Onshape.com
PHOTOELECTRIC SENSOR	36.72 $	ADAFRUIT.COM
PLA FILAMENT	2.20 $	Temu.com
SCREWS	2.82 $	Makerlab.ca
SD CARD	13.54 $	Amazon.ca
WIRES	1.13 $	Makerstore.ca

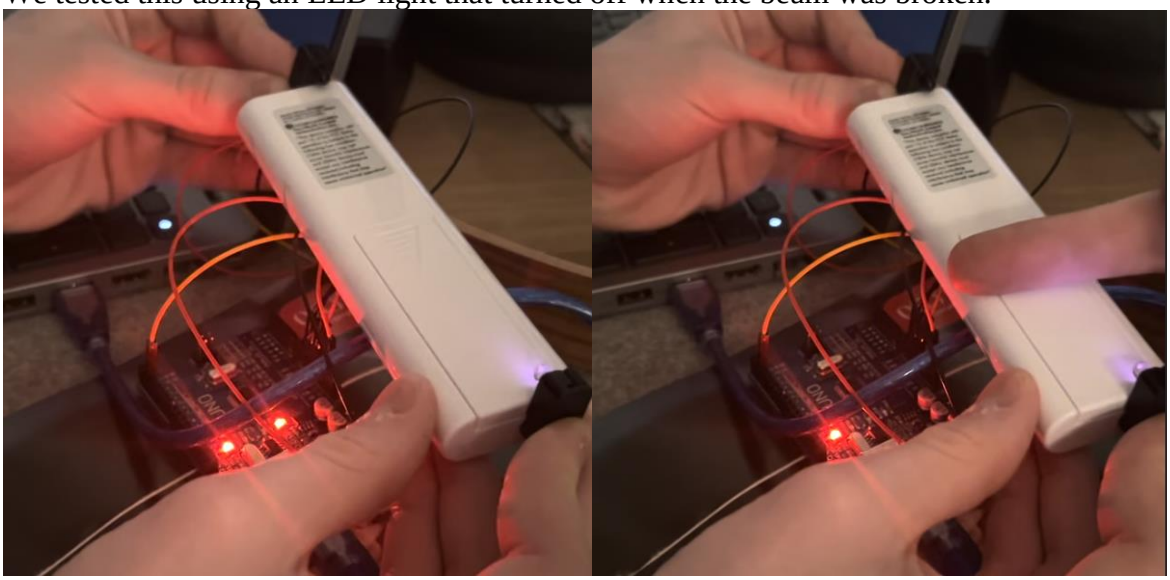
6.1.2 Equipment list

- 3D printer
- Laser Cutter
- Table Saw
- Drill
- Soldering kit

6.2Testing & Validation

The tests we did with our prototype were mainly around the code and the lasers to ensure that they could differentiate exits and entries. Prototype 1 was centered around the Arduino and the code,

which we could only test once we had prototype 2 assembles, which was the laser set-up. With the lasers aligned, we could test if the Arduino could detect when the beam of the laser was broken. We tested this using an LED light that turned off when the beam was broken.



We experimented with different distances to make sure that the laser would still be functional, and applicable in a box that is currently used.

7 Conclusions and Recommendations for Future Work

Due to some of the troubles we encountered we have learned a few lessons which would be helpful to anyone who is looking to further develop the device. First the investment into a better-quality sensor would be crucial. Due to the quality of the sensor our device incurred many alignment issues which caused testing the device extremely difficult. Another lesson that we learned from this project is the importance of being flexible. Even when recognizing the faults of our sensor we still stuck to it determined to make it work, however this caused many headaches which could have easily been avoided if we had changed sensors once recognizing the initial one's faults.

For future work to this project, we would invite the revisiting of the layout of the electronics and case, as well as a potential aid for the alignment of the sensors to limit the chances that they get misaligned. For the current layout it proves to be quite bulky and exposes the electronics to potentially be damaged by the elements. To correct the first step would be to look into attaching components in width instead of height.

8 Bibliography

Bat Houses in BC. British Columbia Bats. Published 2015..
https://www.bcbats.ca/attachments/Bat_houses_in_BC_2015.pdf.

About Bats: Bat Gardens and Houses. Bat Conservation International.
https://www.batcon.org/about-bats/bat-gardens-houses/.

Guide to Arduino Uno R3 Power. Tech Explorations.
https://techexplorations.com/blog/arduino/guide-to-arduino-uno-r3-power/#h-external-power-supply-options

TESTED: Timekeeping on ESP8266 Arduino Uno WITHOUT RTC. Instructables.
https://www.instructables.com/TESTED-Timekeeping-on-ESP8266-Arduino-Uno-WITHOUT-/.

APPENDICES

9 APPENDIX I: Design Files

Table 3. Referenced Documents

Document Name	Document Location and/or URL
Base of the electronics case	Link
Top portion of the electronics case	Link
Bat box	Link
Maker Repo	Link