PROJECT DELIVERABLE K:
USER AND PRODUCT MANUAL

Submitted by

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List of Acronyms and Glossary

Table 1. Acronyms

Acronym	Definition
UPM	User Product Manual
GND	Ground
Ω	Ohms
CAD	Computer Aided Design
PLA	Polylactic Acid
PET-G	Polyethylene terephthalate glycol

Table 2. Glossary

Term	Acronym	Definition
Microcontroller	MCU	Is a small computer on a single metal-oxide-semiconductor (MOS) integrated circuit (IC) chip.
Subsystem	SBS	A self contained system within a larger system
Ground	GND	The reference point in an electrical circuit from which voltages are measured,and a common return path for electric current
Cathode	N/A	Is the negatively charged electrode. The cathode positive charge.
Anode	N/A	An electrode through where the conventional current enters into a device

1 Introduction

This User and Product Manual (UPM) provides the information necessary for the design process for the Emergency Beacon system. It is made to provide a comprehensive guide about the project's work, detailing the process that was required to achieve the final product. Along

with the different kinds of prototypes, and the various tests done to complete the project. This manual also contains information about all the parts and programming used for this alarm system as well as detailed explanations of certain sections and item uses throughout the entire project.

2 Overview

With the onset of the COVID-19 pandemic, the food delivery market experienced a massive surge. The lack of in-person dining options and the risk of getting sick drove many people to spend the extra money to receive their food at the doorstep. The food delivery industry suffers from “extortionate” fees, slow delivery times and lack of coverage in rural areas. This increase in the popularity of food delivery and the many issues plaguing the food delivery industry encouraged the team at JAMZ to come up with an innovative solution. The team at JAMZ is developing a new drone designed specifically for food delivery. This new drone plans to increase delivery speeds, reduce costs and increase the areas in which food delivery will be available.

The team needs a module that will protect the drone from undesired flight path deviations, and theft, by reporting constant feedback to the operator, alongside alerting bystanders, while being cost-effective and lightweight.

With a simple lightweight, and aerodynamic encasing the perfect sizable electronics, we have created a design that is both innovative and viable. The small compact design gives the module a more lightweight and efficient design in comparison to other alarms. This also reduces overall cost.

Figure 1: The system.

2.1 Conventions

There are no conventions that the user must know about in this manual.

2.2 Cautions & Warnings

If a resistor from this circuit is missing or gets damaged the user runs the risk of frying a part or even the entire circuit if they were to activate it while missing a necessary resistor. This alarm system is not suited for continuous use in climates that are below freezing, permanent damage may occur on the component if used excessively under these conditions. If this item were to break apart due to some sort of accident, there is a likelihood that the device is still live and would be running current, so it is ill advised to just blindly grab it.

3 Getting started

To set up the Viable Solutions Emergency Beacon and Anti-Theft Alarm you first need to identify the power source and 15cm x 15cm flat surface that the module will sit on top of, make sure that there are no surrounding intrusions that can affect the performance of the system.

Once the power source and surface are identified connect your raspberry pi microcontroller to the module through the underside of the 3D printed case. Once both microcontrollers are connected, the system can now be mounted onto the surface.

Using the M3 screws and bolts provided, secure the system making sure that the system is unable to move and

Now that the module is set up it can be activated through the connection from the Raspberry Pi which will send a message to Arduino which will activate the lights and speaker, therefore warning bystanders of the fallen drone keeping surrounding members of the community safe.

3.1 Set-up Considerations

In order to set up this system, you will need a microcontroller (prefered to be Raspberry Pi but an arduino will work less efficiently), a screwdriver for M3 screws and access to a soldering iron. Our onboard apparatus microcontroller communicates with the host microcontroller. This is through the serial connections on both microcontrollers. The onboard batteries of accompanying devices, power the module and its components.

3.2 User Access Considerations

Due to the nature of the apparatus, usage will be limited to those interacting directly with the JAMZ drone, and or similar organizations (those working with transportation appliances such as drones) that require the features the apparatus provides. As in this particular case, the JAMZ operator must have access to our apparatus for interactions with the drone, there will be no system accessibility restrictions in place, as the operator is to have full accessibility.

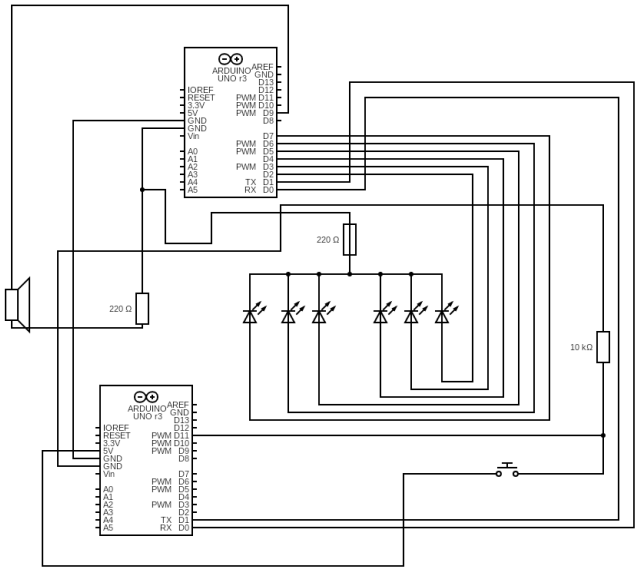
3.3 Accessing the System

To access/turn on the system, the apparatus must be plugged into all connections on board the drone. This includes the JAMZ 44v power supply, and the native JAMZ Raspberry Pi. There is no user interface login ID required to access the code that runs the apparatus' system, however the Arduino IDE must be downloaded on operator devices.

3.4 System Organization & Navigation

The physical connection system of the apparatus works with the JAMZ's power supply and Master Raspberry Pi connecting to the Arduino Uno on board our apparatus, and all necessary components. The following figure depicts the electrical organization of the components, and how the microcontrollers connect to the components. The components are connected directly to the onboard apparatus microcontroller, and the speaker is powered by an external power. The host microcontroller is responsible for communicating data to the onboard apparatus microcontroller.

Figure 2: Arduino to Arduino electrical circuit



3.5 Powering Off the System

The system's power is automatic, when the primary microcontroller that is linked to our add-on supplies sufficient power to the system it will turn on as the drone is turned on and off.

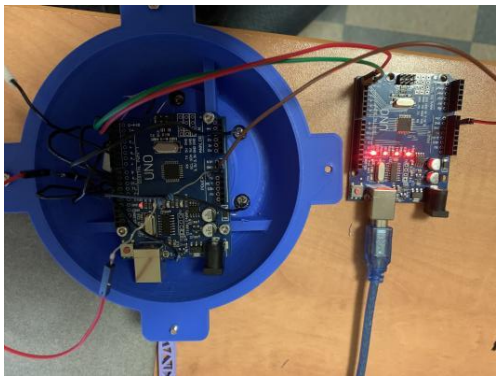
4 Using the System

The following subsections provide detailed, step-by-step instructions on how to use the various functions or features of the Anti-Theft Emergency Beacon.

4.1 Anti-Theft Alarm

The Anti-theft alarm serves the purpose of alarming all those in the vicinity of the drone that the drone is being stolen, if that were to occur. The system causes the lights from the alarm system to be lit up when the alarm is triggered, sending a flashing signal that lights up the area to warn all those in the area. Along with the lights the speaker will also activate and send a sound signal to alert all in the area.

Figure 3: Arduino connection.



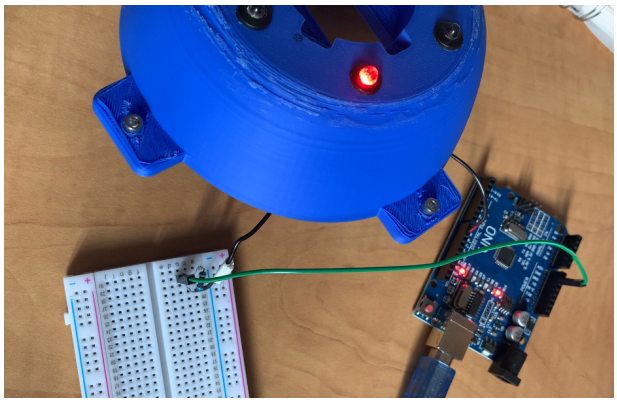
The user of the device must be able to properly input the address and route in which the drone will take to deliver its package in order for the alarm to sound when something goes awry.

4.1.1 Software Communication

It is important to note that the Arduino itself will be connected to a Raspberry Pi that comes with the drone, this Raspberry Pi will help feed in information into the system so that the alarm system will be able to activate when deemed appropriate.

The Leds and Speaker run on separate programs within the Arduino UNO and are not necessarily reliant on one another in order to activate.

Figure 4: Individual LED activation..

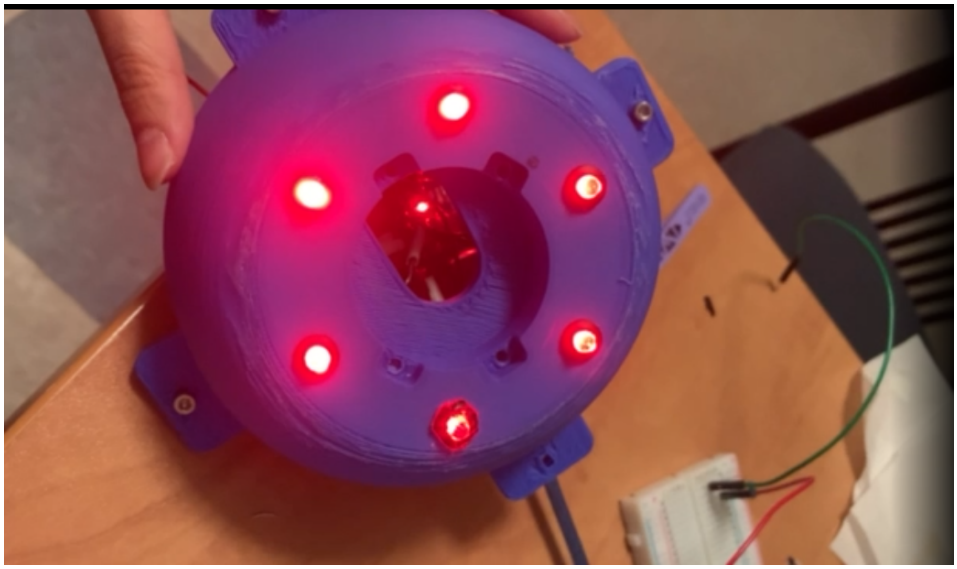


4.2 LED and Speaker Systems

The LED system is made to serve the purpose of giving a visual indication to those around the drone that something is occurring. It is independent of the speaker system and would still function even if the

speaker were to malfunction. However if the Arduino were to malfunction then this would affect the system. The emittence level of the LEDs is expected to be seen at a relatively far distance. This will only activate if the drone is rearing off from its intended course.

Figure 5: LED system



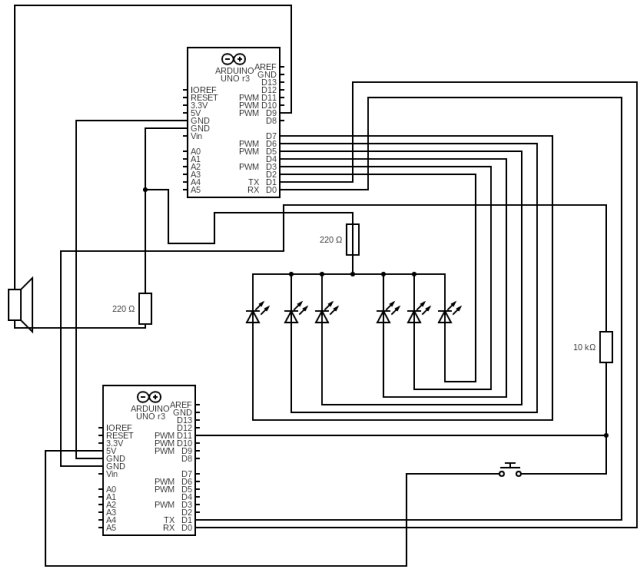
The speaker system is made to allow audio input to be heard to those around the area, it like the LED system is not reliant on the other system to activate. It however much like the LED system is reliant on the Arduino UNO from not malfunctioning. The speaker is expected to emit a loud noise that all in the vicinity will be able to hear. The current prototype is missing the audio amplifier and runs the risk of not being loud enough.

Figure 6: Speaker software.

```
void buzzAlarm(){
  for(int i = 0; i < 150; i++){
    if(i%2 == 0){
      digitalWrite(4, 1);
    }
    else{
      digitalWrite(4, 0);
    }
    delay(10);
  }
}
```

The Arduino UNO itself is to be connected to the Raspberry Pi within the system and is what runs the code. Changing the pins on the Arduino UNO will change the outputs that the Arduino UNO emits. It is expected that the user does not mess with the pin layout of the components.

Figure 7: Arduino to arduino connection.



5 Troubleshooting & Support

5.1 Error Messages or Behaviors

If the LEDS glow unnaturally bright and hot then it is likely that the resistor has an issue and must be switched with a new one that has the same resistance level otherwise the bulbs will blow and the LEDs will become useless. Same rules apply to the speaker if too loud and audio begins to crackle, a new resistor is required, or audio amplifier.

If the code does not compile then that means that either the Arduino is not connected properly or that there are errors within the changes to the code, please look through and fix any issues stated by the arduino program found.

Any disconnected wires must be reconnected, to the original positions.

5.2 Special Considerations

Prior to operating the drone in adverse conditions please ensure all weather resistant seals are intact. The failure to maintain the seals can lead to damage to the anti theft system and the drone.

5.3 Maintenance

To prevent failure of the system, please check the casing and internal systems every month to make sure no liquid or other substances have reached the internal components of the casing. In addition, if PET-G with waterproofing has not been used to 3D print the case, the electrical failure rate increases exponentially. When the inter components are not protected by the elements, regular maintenance needs to be done in order to make sure the elements have not damaged the internal parts.

If internal components need replacement or maintenance, the system can be very easily accessed by removing the peripheral four M3 8mm screws. Once they are removed all of the electronics inside will be accessible except for the speaker. To remove or replace the speaker, remove the four M3 8mm screws from the top speaker cover shown in the figure below and disconnect the speaker from the Arduino UNO.

Figure 8: Peripheral M3 8mm screw locations.

Figure 9: Speaker cover M3 8mm screw locations.

5.4 Support

Arduino.cc is the official website for arduino uno programming, if questions and issues were to come up regarding the system, you can access the website to help deal with your troubleshooting needs.

As far as questions or concerns about the anti theft system as a whole feel free to email support@viablesolution.ca. This helpline will answer any questions you may have.

For emergency assistance please contact Michael Hetu at 780-297-4384 or mhetu104@uottawa.ca.

6 Product Documentation

In this section you can find the materials and instructions to recreate our most recent prototype.

6.1 User Manual

6.1.0 Considerations

Before commencing assembly of this anti theft beacon it is important to consider a few factors. This device is meant to be used on a drone, operating outdoors in adverse weather conditions. As such the following is of importance:

If full water resistance is required the best option is to wrap around a layer of waterproof (hydrophobic) speaker mesh around the speaker cover and glue it in place. This will prevent water from making its way to the electrical components of the system. The mesh should be tucked inside the gap between the speaker cover and dome for best results.

Additionally it is good practice to apply resin to the LED holders in order to isolate them further from the elements. By default the LED holders provide a good seal from water and dust, however under heavy rain or prolonged use, this seal may fail. Resin applied to the holder will aid in maintaining the water resistant nature of it. It is also a good idea to apply a resin seal in the gap between the drone and the dome, to prevent water from entering below the dome, and into the drone.

The material used for 3D printing the dome is also of utmost importance. Proper material must be used, otherwise water will be able to make its way through the plastic into the electrical components of the system. This team recommends PETG, as it possesses good water resistance characteristics, and is commonly used in beverage bottling.

Finally consider an amplification circuit for the speaker. We found that the arduino does not exploit the full potential of the speaker due to current limitations.There are many built in circuits available for purchase, and they should be relatively easy to implement into the existing circuit.

6.1.1 Required materials and equipment

Table 1: Required hardware.

Hardware	ID	Quantity	Appendix Ref. Number
Arduino Uno	-	1	1
LED holder	2174	6	2
5mm LED	VLCS5830	6	3
Speaker	SP-4008Y	1	4
M3 8mm screws	-	11	5
Electrical wire	#22 AWG	10ft	6
220Ω Resistor	CFR-12JB-52-220R	1	7
100Ω Resistor	CFR-25JB-52-100R	1	8

Note: to purchase components, refer to hyperlinks in section 10 (Appendix).

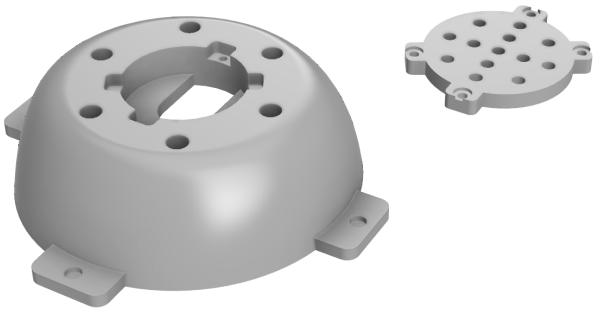
As well as the hardware mentioned above certain equipment will be necessary in order to assemble the system:

- 3D printer.
- Soldering iron.
- M3 Screwdriver.

6.1.2 Assembly

Before commencing assembly, ensure all required parts are present, including the 3D printed dome and the 3D printed speaker cover. The files can be found in section 9 of this document.

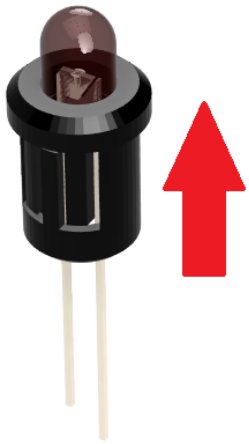
Figure 10: 3D printed dome and speaker cover.



Step 1:

Insert the six LEDs into the six LED holders:

Figure 11: Inserting the LED into the LED holder.



Step 2:

Insert the six LED holders into the six slots in the 3D Printed dome:

Figure 12 :Inserting the LED holder into the 3D printed dome.

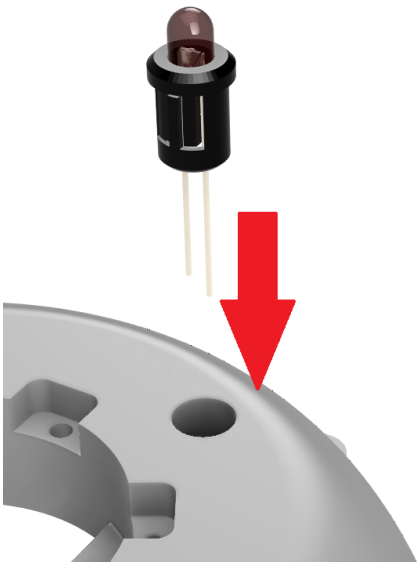
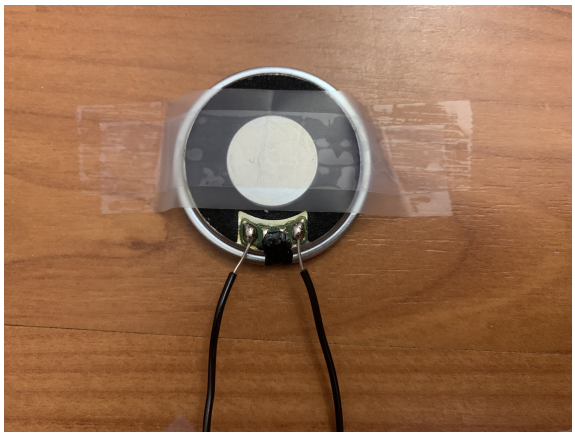


Figure 13: LED holder in the 3D printed dome.

Step 3:

Solder wire connections to the SP-4008Y speaker:

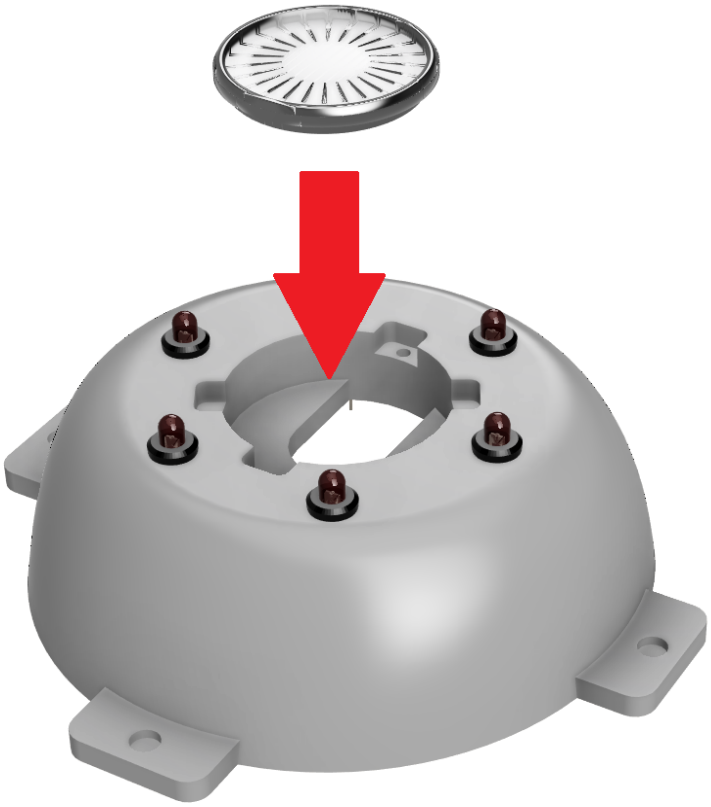
Figure 14: Soldered speaker connections.



Step 4:

Insert the speaker into the speaker compartment in the 3D printed dome:

Figure 15: Inserting the speaker into the dome.



Step 5:

If water resistance is required, attach a waterproof speaker mesh to the inside of the 3D printed speaker cover.

Attach the 3D printed speaker cover and screw it in with four M3 8mm screws:

Figure 16: Inserting the speaker cover into the dome.

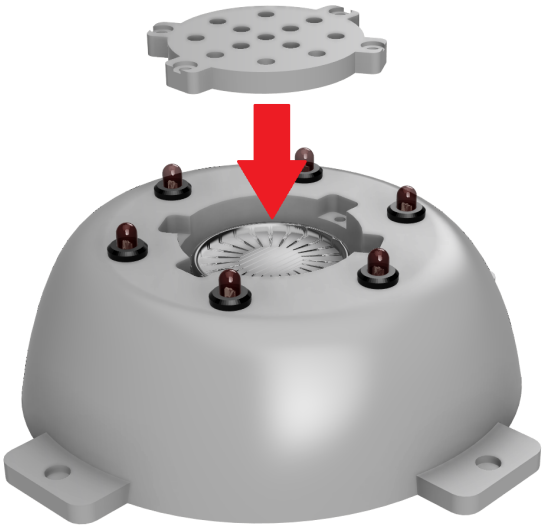


Figure 17: Inserting M3 8mm screws into the speaker cover.

Step 6:

Wire all electrical connections to the arduino and drone Raspberry Pi according to the circuit diagram below. Some soldering might be required:

Figure 18: Arduino below the dome and its electrical connections.

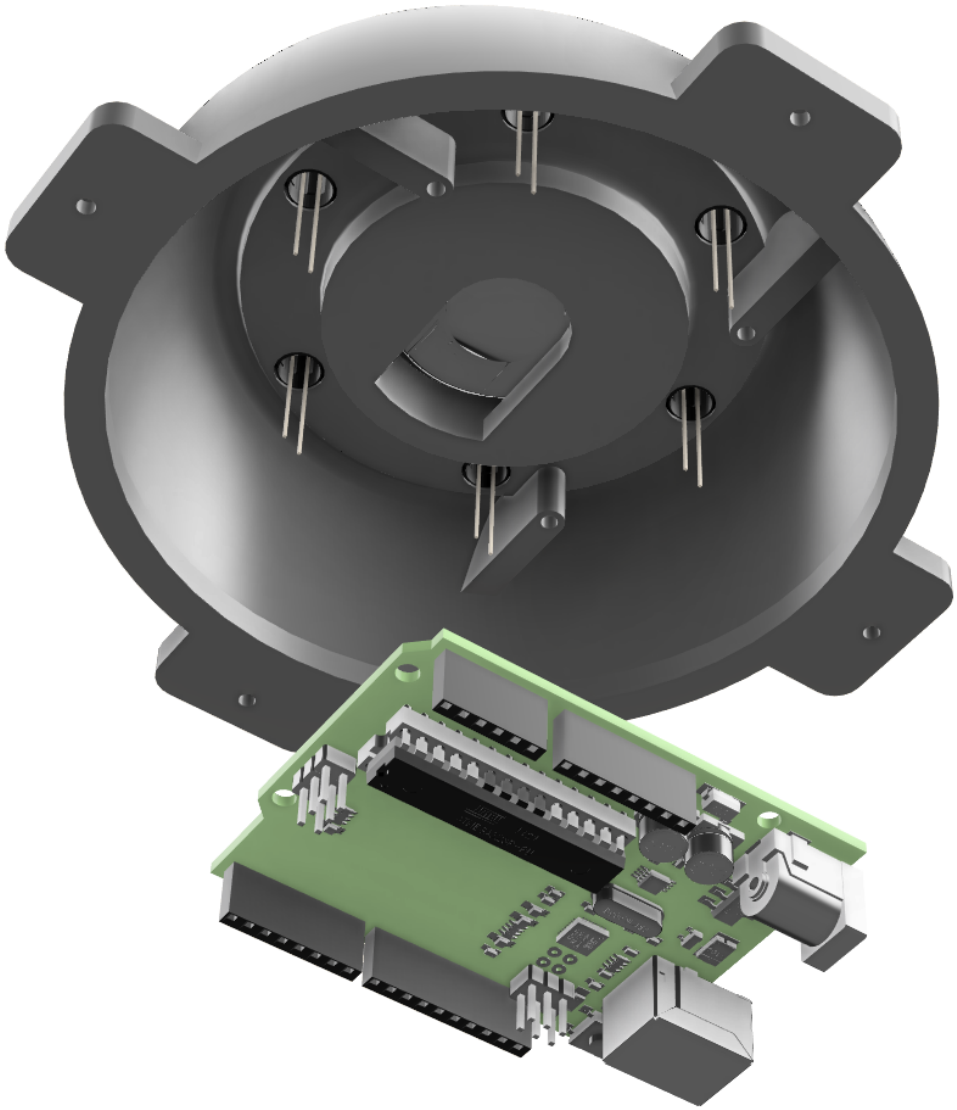
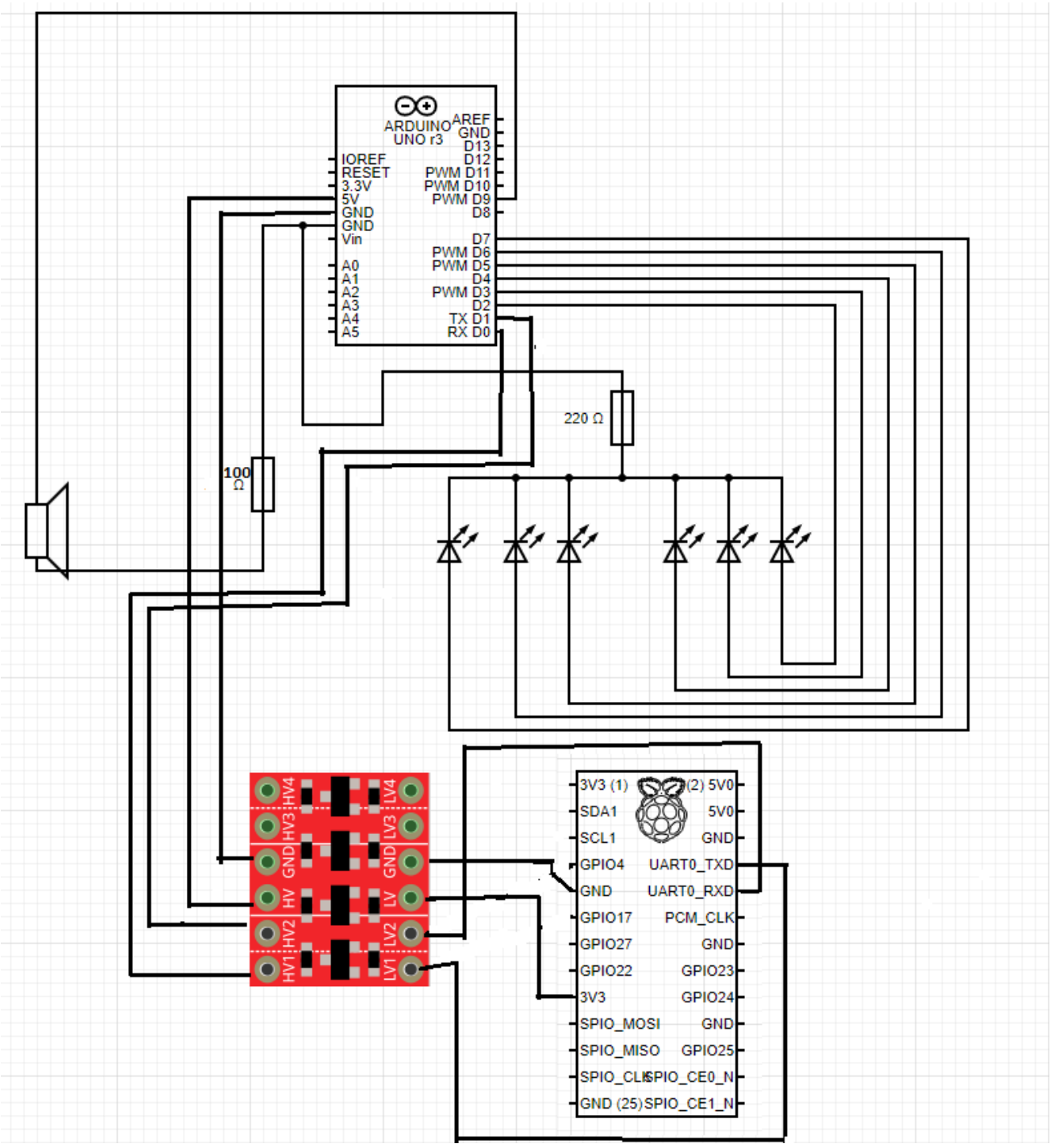


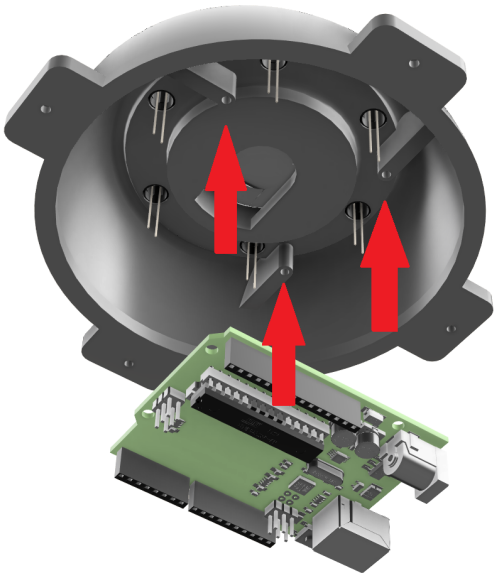
Figure 19: Circuit Diagram



Step 7:

Attach the arduino to the arduino mounts inside the 3D printed dome using three M3 8mm screws:

Figure 20: Attaching the arduino to the inside of the dome with M3 8mm screws.



Step 8:

Attach the 3D printed dome to the drone using four M3 8mm screws:

Figure 21: Attaching the dome to the drone with M3 8mm screws.

6.1.3 Software

The software for this project is meant to be customizable and further refined based on user needs. With the arduino IDE you can set up custom communication using the SPI protocol. You can also set custom alarm activation patterns and triggers as well as manual activation from the Raspberry Pi microprocessor.

In order to fully utilize the functionality of this system you will need access to a USB port on your computer and knowledge of the arduino IDE and the SPI protocol.

Figure 22: System code (Arduino IDE).

```
#include <SPI.h>

int alarmState = 1; //0 is off. 1 is on.

float droneActualCoordinateX = 0; // Actual drone coordinates received from drone telemetry.
float droneActualCoordinateY = 0;
float droneActualCoordinateZ = 0;

float droneExpectedlCoordinateX = 0; // Expected coordinates received from drone.
float droneExpectedlCoordinateY = 0;
float droneAExpectedCoordinateZ = 0;

float maxCoordinateDeviation = 2; //Max deviation for any drone coordinate, if reached alarm triggers.

void setup() {
  pinMode(4, OUTPUT);
  pinMode(8, OUTPUT);
  pinMode(9, OUTPUT);
  pinMode(10, OUTPUT);
  pinMode(11, OUTPUT);
  pinMode(12, OUTPUT);
  pinMode(13, OUTPUT);

  SPI.begin();
}

void loop() {
  if(alarmState == 1){
    setLeds(1);
    buzzAlarm();
    delay(400);
    setLeds(0);
    buzzAlarm();
    delay(400);
  }
  else{
    setLeds(0);
    delay(1000);
  }
}

void setLeds(int state){
  for(int i = 8; i < 14; i++){
     digitalWrite(i, state);
  }
}

void buzzAlarm(){
   for(int i = 0; i < 150; i++){
     if(i%2 == 0){
        digitalWrite(4, 1);
     }
     else{
        digitalWrite(4, 0);
     }
     delay(10);
  }
}
```

The structure of the software itself is very simple. Two functions, one responsible for the flashing of the LED's, and the other for the buzzing of the speaker are invoked based on the boolean variable alarmState. If alarmState is true or (1) then the speaker buzzes and the lights flash. If alarmState is false or (0) then nothing happens. All of these functions and their variables can be customized and modified through SPI serial communication.

6.2 Testing & Validation

For the LED lights, we tested the light system's luminosity levels. We will observe the true luminosity of the naked eye in a darkened environment (mimicking night-time deliveries). A test will be set up in a dark room, where the apparatus will be placed in the approximate centre and activated. The illumination of the LEDs on the walls will be measured in height from the ground up, to give a perspective on the luminosity of the LEDs. This will give a stronger indication of the abilities of the LEDs. In order to decipher when to stop our testing, or continue and re-adjust whether it is new LEDs, a different electrical circuit or new code, we created stopping criteria. For this specific test our stopping criteria is 250 lumens in a dark room. This took multiple attempts to perfect but for the prototype that is present, the goal was reached. The measurements were taken from a standard one metre away and measured with the phone app Luxmeter.

Table 2: Lighting system testing criteria.

Room	Amount Light (lumen)
Lit Room control	20
Lit Room + LED's	**170**
Dark Room control	0.7
Dark Room + LED's	**260**

For the speaker system, we tested the sound system's alerts that are created. The audio will be attempted to be heard from different distances from the device, in order to get an understanding of how loud truly is relative to the environment. The measured intensity of the sound, from increasing distance intervals, will be documented. This will serve to show the effectiveness of this subsystem in fulfilling its goal. This test was performed a multitude of times, although it reached our stopping criteria we did not account for the level of noise before creating the stopping criteria. In order to readjust to the alarm criteria, a new amplification system was created. This is because the speaker was not getting the power needed, so in order for the system to be optimized, power is drawn from the drone. This additional amplification system can be found in the above sections of the manual.

Table 3: Sound system testing criteria.

Distance (m)	Recorded Average (dB)
0	78
1	67
2	64
5	56

7 Conclusions and Recommendations for Future Work

During the design and manufacturing of our prototype there are many lessons we learned spanning from teamwork to time management, our team came face to face with few difficulties. One of them is time management, even though the schedule for our design was good, the team did not account for the shipment process of each component. This led to our prototypes being less advanced than we had hoped for each due date. We also learned to perfect the parts that we were good at and aid team members when they needed assistance.

One of the components we had the most issues with was the 3D printed case. The cover for the speaker can be taken in by 1mm in order for it to fit more soundly. We did not have time to re-print the entire cover, so we worked with what we had and ended up filing the cover until it fit soundly in the slot. Another thing we would've changed is the material we are working with. The case that we used is printed with PLA, the material is not waterproof, it actually absorbs water which would ideally not happen. A recommended material for the future is PET-G, a fully waterproof material that is easy to print with. PET-G is slightly more dense than PLA therefore increasing the weight factor slightly, but overall the system is compact and the material change should not be a big contributing factor to the overall weight. Cost wise, PET-G again is more expensive by about five dollars per kilogram but is the ideal material for this project.

The second component we had issues with is the speakers. It is not quite as loud as we had aimed to have it, so if we were given more time we would've revised and made an amplification circuit in order to increase the sound levels coming out of the speaker.

In conclusion, if our team had a few more months to work on the project we would improve and perfect the 3D printed case as well as improve our software. We would also look into adding parts to contribute to the other add-ons and making a multi-purpose add-on.

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CNXIN Hot! Power Cut Failure Outage Auotmatic Alarm Warn Siren LED Indicator. (n.d). Retrieved January 31, 2021, from https://www.newegg.ca/p/0ZK-08UH-0FY52?Description=siren&cm_re=siren-_-9SIAN8UC9B5464-_-Product

9 APPENDIX I: Design Files

Table 4. Referenced Documents

Document Name	Document Location and/or URL	Issuance Date
Maker Repository	https://makerepo.com/Ckwan020/808.d14-viable-solutions-	04-01-2021
3D Printed speaker cover	https://makerepo.com/rails/active_storage/blobs/eyJfcmFpbHMiOnsibWVzc2FnZSI6IkJBaHBBbXN2IiwiZXhwIjpudWxsLCJwdXIiOiJibG9iX2lkIn19--1fd5b61f09e8656defd8d6df99d1614bdbabb1d3/SpeakerCover.stl	04-01-2021
3D Printed dome	https://makerepo.com/rails/active_storage/blobs/eyJfcmFpbHMiOnsibWVzc2FnZSI6IkJBaHBBbW92IiwiZXhwIjpudWxsLCJwdXIiOiJibG9iX2lkIn19--2dd47eeddc5abc77954156d74d4125ce0c611a64/MainBody.stl	04-01-2021

10 APPENDIX II: hyperlinks to components

Table X: Required hardware hyperlinks (for purchase). Match reference number.

1) Arduino Uno:
https://store.arduino.cc/usa/arduino-uno-rev3

2) LED holder:
https://elmwoodelectronics.ca/products/5mm-plastic-bevel-led-holder-pack-of-5?variant=24126752963

3) 5mm LED:
https://www.digikey.ca/en/products/detail/vishay-semiconductor-opto-division/VLCS5830/4073503

4) Speaker:
https://www.digikey.ca/en/products/detail/soberton-inc/SP-4008Y/10638205?s=N4IgjCBcoCwGxVAYygMwIYBsDOBTANCAPZQDaIArPAAwwgC6hADgC5QgDKLATgJYB2AcxABfQgCZqADmqIQKSBhwFiZEDAAEAeQAWAW2wNmbSCACq-Xiy2oAsrnTYArt1yiJYagE45CpXkISSHIAZgB1IxBWdgsrG3tHFzcRMRAEaBBeABN2AFpPCGN2EEIWAE8mN1NHFBSgA

5) M3 8mm screws:
https://www.mcmaster.com/90116A153/

6) Electrical wire:
https://www.digikey.ca/en/products/detail/cnc-tech/3132-22-1-2000-001-1-TD/12749445

7) 220Ω Resistor:
https://www.digikey.ca/en/products/detail/yageo/CFR-12JB-52-220R/4013?utm_adgroup=Yageo&utm_source=google&utm_medium=cpc&utm_campaign=Smart%20Shopping_Supplier_Yageo&utm_term=&productid=4013&gclid=CjwKCAjwvMqDBhB8EiwA2iSmPDABO68V7tkfgtwaO0fLyOfQvyj_IcSbx5q_3m7r-5T4KtB96hJfphoC1tAQAvD_BwE

8) 100Ω Resistor:
https://www.digikey.ca/en/products/detail/yageo/CFR-25JB-52-100R/246?utm_adgroup=Yageo&utm_source=google&utm_medium=cpc&utm_campaign=Smart%20Shopping_Supplier_Yageo&utm_term=&productid=246&gclid=CjwKCAjwvMqDBhB8EiwA2iSmPBA_EbdEEM5x32Lb_BevSF04g_AgU180dbuXrfQUIFqHuqU59vYgRRoCo_8QAvD_BwE