GNG <1103> Project Deliverable K

Design Project and Product Manual

University of Ottawa

GNG 1103

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Table 1. Acronyms

Acronym	Definition
UPM	User and Product Manual
HCE	Hot Car Emergency
BOM	Bill of Materials

Table 2. Glossary

Term	Acronym	Definition
Arduino Uno	N/A	A microcontroller board that are connected to different microsensors to activate or deactivate coded functions
Microsensor	N/A	It is used to detect different conditions such as pressure, temperature, chemical concentration, etc.
TinkerCad	N/A	A web browerthat helps users to generate 3D design models and run simulations using coding system

1. Introduction

This User and Product Manual (UPM) provides the information necessary for customers to effectively use the hot car emergency solution and for prototype documentation.

Children dying in locked cars due to heat strokes and carbon monoxide poisoning is not only a persistent problem in his country, UAE, but also a world-wide concern of parents and guardians. This product was designed to save children or pets locked inside a car by detecting movement with motion sensors and activating an audio system that alerts parents and passing by pedestrians.

This product is intended to be used by any parents or guardians who want to add a safety measure to prevent unfortunate events that could happen by accidently leaving their children in locked cars. We assumed that potential consumers have no engineering background; thus the device should be simple and easy to install.

2. Overview

According to NSC Injury facts, on average, 38 children under the age of 15 die each year in the US from heat stroke after being left in a vehicle (NSC, 2021).

Although some children were intentionally left by their parents, most deaths were due to "Forgotten Baby Syndrome," which refers to parents who accidentally leave their child in a locked car. The 80% of temperature increase will occur in the first 30 minutes (NSC, 2021) so it is imperative to get children out of the car as soon as possible. Therefore, there is a need to design a simple and easily-accessible device to notify parents and guardians without making any physical or software modification.

While phone applications can give wider range of services, it could be complicating and even not accessible for some users. Our device doesn't require the connection with phones and functions with a rechargeable battery. In addition, it will be activated once the car engine is off, which will always function regardless the status of the car engine.
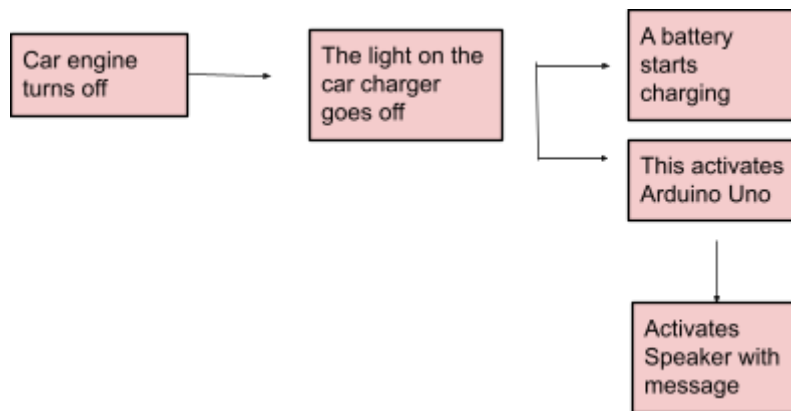

Figure 1. Final Prototype
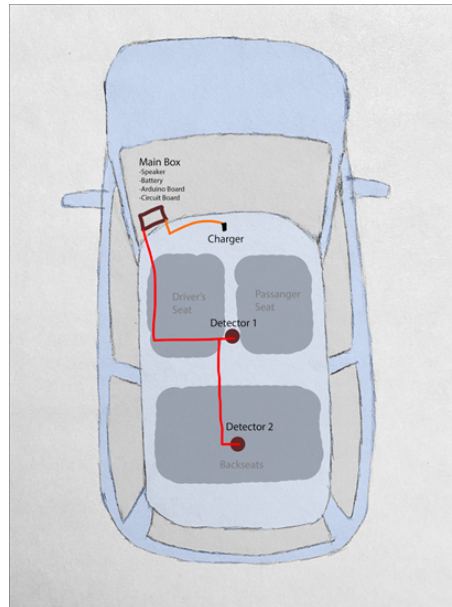
Figure 2. The diagram of how our device works

Figure 3. Conceptual Design of the HCE device

When car engine is on, LED light, Arduino board, and the rechargeable battery get charged. When car is off, the battery supplies power and the photoresistor detects the dark situation and activates the speaker.

2.1 Conventions

When the motion sensor starts scanning, it will use the command "digitalRead" set by Arduino Uno coding. Instead, we used "digitalWrite" function to adjust the volume of the speaker in the previous code.

2.2 Cautions & Warnings

There is no major warnings associated with this design. However, users should make sure that a car charger is always connected to the car.

3. Getting Started

3.1 Set-up considerations

Since our device doesn't require phone or WIFI connection, all user needs to do is connect the car charger with the vehicle, conect the DC port wire, and stick the motion sensor to the right place.

3.2 User Access Considerations

There is no restriction on system accessibility for user, our device designed adaptable for every kinds of vehicle. For differnet location, the our put of the car charger might be differnet, user could use an adapter to transfer the output power to 5v to 12v, that's the limit for the Arduino board.

3.3 Accessing the System

There is no need for user to login to any system, all they need to do is plug the car charger in the car and place the motion sensor in the right place

3.4 System Organization & Navigation

There are three cases in total. Two with the motion sensor and one is the mian box with the Arduino board, circuit board, battery, and the speaker. Two cables connect with the main box and two cases of sensor. There will be also three wires coming out of the main box, one is the USB cable that connect with the car charger for power supply, the other one is also a type-C cable connect with the car charger and LED light for detecting the statu of the vehicle, the last one is a wire that connects with the DC port of the main box for the battery power supply.

3.5 Exiting the System

When user want to turn the device off, they can unplug the car charger and the DC port wire which connect with the battery.

4. Using the System

The following sub-sections provide detailed, step-by-step instructions on how to use the various functions or features of the HCE device.

4.1 Powering the System

There are two powering systems for this device. The first is a user's car and the other is a 9V battery. The car charger should be connected to the user's car and a 9V battery should be connected using a battery clip connector.
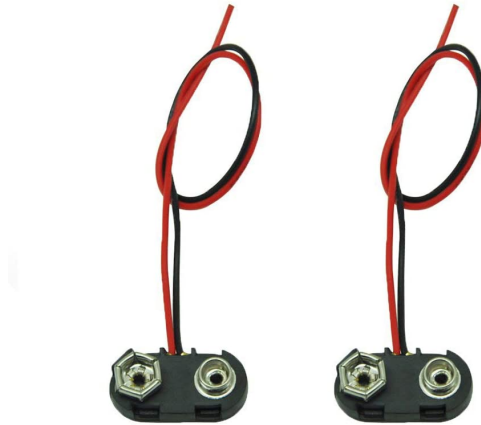
Figure 4. Battery clip that connect a 9V battery to Arduino

4.2 Collected Data from Arduino

If the user wishes to view the data generated by sensors, the Arduino Uno should be connected to the user's computer using a USB cable. The user should launch the Aruino App and follow the steps below:

1. Open the "maseter code" (Ctrl + O)
2. Open the "salve code" (Ctrl + O)
3. Select the component you are currently used by the Arduino Uno.
4. Press upload button.
5. Select the comport you will be using for the slave code. Tools -> port -> computer number.
6. Press Upload

NOTE: You follow the same procedure to make changes to the existing coding.

5. Troubleshooting & Support

5.1 Error Messages or Behaviors

The user first needs to make sure that all microsensors are properly connected to the Arduino Uno. Next, we need to make sure that pins are correctly positioned. When replace the battery, user need to open the back side of the case, they can't glue the board back, but they can use tape instead. When stick the motion sensor at the middle or the back of the seats, make sure to point the roof of the sensor to the correct seat.

5.2 Special Considerations

When replacing the battery or the LED lights, make sure to unplug the car charger and the DC port cable that connect with the battery. And after replacing new item, make sure the stability connection of the wires that connect with the Arduino board.

5.3 Maintenance

The device should be kept in the case since the arduino uno and its compartments are not water-proof. The user should avoid extreme physical stress on the device as well. During the regular maintenance, make sure to check the LED light life. Although the battery is rechargeable, we suggest replace the battery every two years.

5.4 Support

If you have any concerns or questions regarding our product, please contact us:

Fred Xu, *technical administrator*
rxu101@uottawa.ca

Yunsu Lee, *system administrator*
ylee144@uottawa.ca

Please use the heading "HCE device inquiry" in your emais. Service is available 24/7.

6. Product Documentation

We considered using glass as our case material, but the robustness of the material doesn't achieve our requirements. In addition, we considered using nails to stablize the case instead of using glue, but this idea was cancelled because some parts of our material are magnetic. We also considered and discussed with TA about cutting hole on the car window, but it not worked since the client expects there is no damage on the car.

6.1 Physical Compartments

6.1.1 BOM chart

Table 3. BOM chart of the HCE device

	A	B	C	D	E	F	G	H	I
1	Name	Links	Unit Price	Tax	Total per item	Quanity	Total before tax	shipping	Total after shipping
2	Motion sensor	link	$10.99	$2.08	$13.07	2	$26.14	0	$26.14
3	Speaker	From GNG lab	$0.00	$0.00	$0.00	1	$0.00	0	$0.00
4	Car charger	link	$15.29	$2.53	$17.82	1	$17.82	0	$17.82
5	Electrical Wire	link	$9.98	$2.70	$12.68	2	$25.36	0	$25.36
6	Arduino Board	From GNG lab	$0.00	$0.00	$0.00	1	$0.00	0	$0.00
7	breadboard	From GNG lab	$0.00	$0.00	$0.00	1	$0.00	0	$0.00
8	Jumper wires	From GNG lab	$0.00	$0.00	$0.00	20	$0.00	0	$0.00
9	Resistors	From GNG lab	$0.00	$0.00	$0.00	15	$0.00	0	$0.00
10	Battery	From GNG lab	$0.00	$0.00	$0.00	1	$0.00	0	$0.00
11	Male to Male header pin	From GNG lab	$0.00	$0.00	$0.00	1	$0.00	0	$0.00
12	Arduino Cable USB Type A-B	From GNG lab	$0.00	$0.00	$0.00	1	$0.00	0	$0.00
13	Protoboard	From GNG lab	$0.00	$0.00	$0.00	1	$0.00	0	$0.00
14	MDF sheet	link	$2.50	$0.00	$2.50	5	$12.50	0	$12.50
15	5FT Hook-Up wire 22AWG(Black, Red, White)	link	$1.60	$0.00	$1.60	6	$9.60	0	$9.60
16	Total		$40.36	$7.31	$47.67		$91.42		$91.42

Table 3 presents all the materials required to build the HCE device. Please note that the currency is Canadian dollars and there might be a change in price for some materials.

6.1.2 Equipment List

The list of required equipment will be provided. Please note that parts from different brands could be used and should give you the same output.

Table 4. Required equipment

1	Name
2	Motion sensor
3	Speaker
4	Car charger
5	Electrical Wire
6	Arduino Board
7	breadboard
8	Jumper wires
9	Resistors
10	Battery
11	Male to Male header pin
12	Arduino Cable USB Type A-B
13	Protoboard
14	MDF sheet
15	5FT Hook-Up wire 22AWG(Black, Red, White)

Most of the equipment can be found on Amazon.ca or makeerpo.com
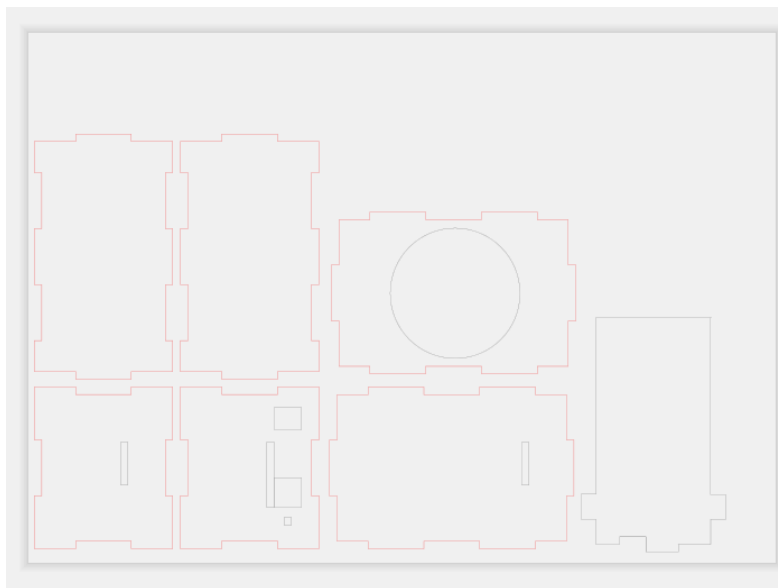
6.1.3 Instruction

Figure 5. Arduino Uno casing diagram

First, we use Inkscape to build a diagram (Figure 5) to laser cut the Arduino Uno, circuit board and speaker.

Figure 6. Laser-cut Arduino Uno case

Next, we laser cut and glue the parts together (same procedure for the motion sensors and the speaker).

Figure 7. Motion sensors and speaker in the cases with connected wires

We connect the car charger with the type-C cable adapter with the LED light and the USB cable with the Arduino board. The USB cable directly supplies energy power to the Arduino board. On the other side, we connect the DC port on the Arduino board with a 9v battery to supply power in case the power supply from the car charger is off. We put the LED light and the photoresistor inside the box to test when the car engine is off, the photoresistor detects no light and the motion sensor detects something inside the range, the Arduino board will activate the speaker and alarm the driver. And we soilder the photoresistor and the wires of speaker and the wires connected with the breadboard on the circuit board. Finally we wrapped the external wire with tape to protect the accident.
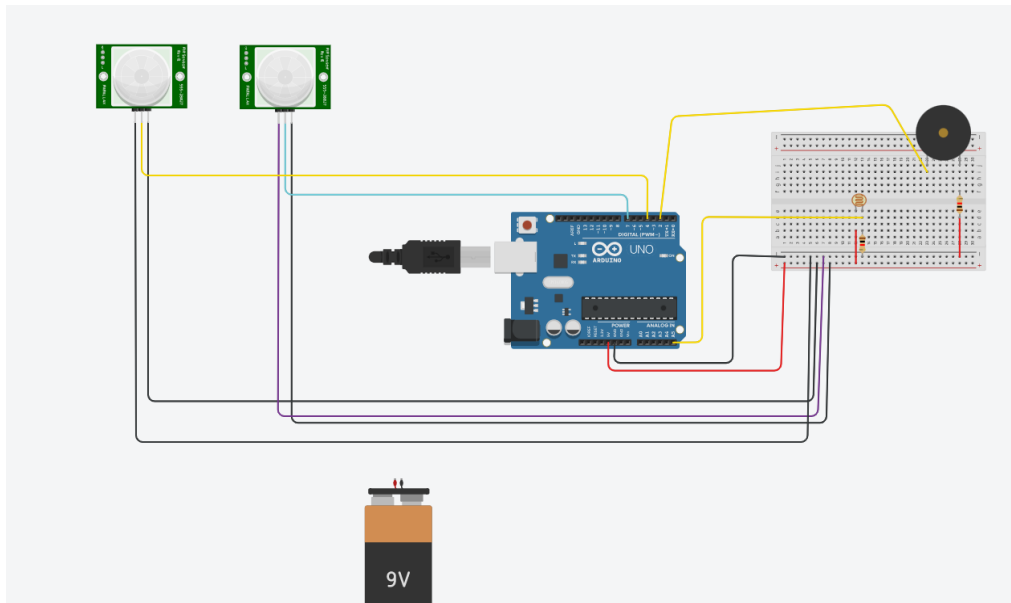
6.2 Testing & Validation

Figure 8. Final Simulation diagram

This is the final simulation on the Tinkercad, we can adjust the volume detection of the photoresistor; Therefore, we found that when the photoresistor detects the bright situation and the motion sensor detects motion, the speaker won't be activated. The speaker will be activated when photoresistor detects dark situation and motion detected.

7. Conclusion and Recommendations for Future Work

Our design consists of three major parts: motion detecting sensors, audio notification system and a photo sensor that will help activate the device once the car engine turns off.

The key advantage of our model is the fail-proof way of activating the device regardless of the deactivation of the car engine. During the last meeting with the client, he expressed his concern about providing power to the device. Since there was no coding solution for the system to determine whether the device is car-powered or battery-powered, we decided to use a light-activated switch circuit; when the car engine turns off, the LED light will also be off, which then triggers the circuit and turns on our detection system.

On top of that, when the car engine turns off and the motion sensor detects a child or a pet in the car, the audio system will automatically play the alarm "ALERT, there is a baby or a pet in the car." This will make sure that the driver checks their backseat before they leave the car. Also, even if the driver still leaves a child in the car, the alarm will keep playing so that pedestrians passing by the car can help the child.

Our device is designed so that it can save a child's life in the shortests yet in a fail-proof way. It is also an affordable solution for all the potential customers. This light and easy-to-install device will help parents and guardians avoid unfortunate accidents in the future.

If we have a few more months to work on this project, we could make our equipment more sophisticated. Due to lack of time, our equipment has not reached the best level. Sufficient time allows us to have more choices in material selection. With the replacement of materials, our code can also be further improved, and we can do better in the diversity of vehicles and targets. At the same time, we can also make some different styles in decoration, such as different cases for children and adults.

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   wg=Kgj6k&pf_rd_r=SFR9Y335TRKY8V0F4EZM&pd_rd_r=47d801d6-c081-450f-bcf6

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Appendices

9. Appendix I: Design Files

Table 5. Referenced documents

Document Name	URL	Issurance Date
Deliverable A	https://uottawa-makerspace.s3.us-west-2.amazonaws.com/1fcl8li4xuw775hoixv510iu27jn?response-content-disposition=inline%3B%20filename%3D%22Deliverable%20A_Group15_Yunsu_Lee.pdf%22%3B%20filename%2A%3DUTF-8%27%27Deliverable%2520A_Group15_Yunsu_Lee.pdf&response-content-type=application%2Fpdf&X-Amz-Algorithm=AWS4-HMAC-SHA256&X-Amz-Credential=AKIA34PB766H365QOAG6%2F20211213%2Fus-west-2%2Fs3%2Faws4_request&X-Amz-Date=20211213T045223Z&X-Amz-Expires=300&X-Amz-SignedHeaders=host&X-Amz-Signature=0a2c55e33e62c6a6f1896c685ae3a435bdec77b47ace8a3de3ebdac8958f844a	December 7, 2021
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Deliverable K	https://uottawa-makerspace.s3.us-west-2.amazonaws.com/nubkywp82mh132bhuhbrv0j05vfg?response-content-disposition=inline%3B%20filename%3D%22Deliverable%20H_Group%2015.pdf%22%3B%20filename%2A%3DUTF-8%27%27Deliverable%2520H_Group%252015.pdf&response-content-type=application%2Fpdf&X-Amz-Algorithm=AWS4-HMAC-SHA256&X-Amz-Credential=AKIA34PB766H365QOAG6%2F20211213%2Fus-west-2%2Fs3%2Faws4_request&X-Amz-Date=20211213T045510Z&X-Amz-Expires=300&X-Amz-SignedHeaders=host&X-Amz-Signature=1e7b42954d1bac720a8f2ea92aef7ba1b4b5237caa4b9f991da10b95d2545289	December 12, 2021
Coding Motion Sensor	https://makerepo.com/yunsulee/946.hot-car-emergency-group-15dfy	December 7, 2021
Coding Lights	https://makerepo.com/yunsulee/946.hot-car-emergency-group-15dfy	December 7, 2021

10. Appendix 10: Coding

TemperatureController_student

```
int photo =0;
int sensor1 = 4;// PIR sensor connect to 4
int v1 = 0;
int sensor2 = 7;// PIR sensor connect to 7
int v2 = 0;

void setup()
{
pinMode(sensor1, INPUT);
pinMode(sensor2, INPUT);
pinMode(A5,INPUT);
pinMode(2, OUTPUT);
Serial.begin(9600);
}

void loop ()
{
  photo = analogRead(A5);
  Serial.println(photo);

  v1 = digitalRead(sensor1);
  //Serial.println(v1);

  v2 = digitalRead(sensor2);
  //Serial.println(v2);

  if(photo < 200) //Assuming that the dark condition resistance values are greater than 300
  {
    if(v1 == HIGH || v2 == HIGH)
    {
      tone(2,500,100);
      Serial.println("Motion is detected by one of the PIR Sensors");
    }
    else
    {
      tone(2,0,100);
      Serial.println("No Motion is detected by any of the PIR Sensors");
    }
  }
}
```

Figure 9. Coding

We connect the port 4 and 7 with the motion sensor as the input, A5 as the input for the photoresistor, and 2 as the output for the speaker. Firstly we use the photoresistor and motion sensor to detect the dark situation and motion, if it reach the condition, then motion sensor will activate the speaker and play the sound.