GNG1103

Design Project User and Product Manual

Baby Car Seat Alert System (BCSAS)

Submitted by:

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List of Acronyms and Glossary

Table 1. Acronyms

Acronym	Definition
ACS	Automated Call System
BCSAS	Baby Car Seat Alert System
BOM	Bill of Materials
CD	Current Detection
CO	Carbon Monoxide
I/O	Input/Output
IAS	Immediate Alert System
IDE	Integrated Development Environment
LED	Light Emitting Diode
PAS	Passerby Alarm System
PCB	Printed Circuit Board
PIR	Passive Infrared
RGB	Red, Green, Blue
SAS	Secondary Alert System
TS	Temperature System
UPM	User and Product Manual

Table 2. Glossary

Term	Acronym	Definition
Baby Car Seat Alarm System	BCSAS	The BCSAS is the device that alerts the user if their child is under stressful conditions.
Carbon Monoxide	CO	Colorless, odorless, tasteless gas produced when burning gasoline.
Integrated Development Environment	IDE	Software used to write and upload computer code.
Passive InfraRed	PIR	Electronic sensor that measures infrared light coming from objects in its range of view.
User and Product Manual	UPM	A manual with instructions and information on how to use the BCSAS.

1 Introduction

This User and Product Manual (UPM) provides the information necessary for guardians and caregivers to effectively use the Baby Car Seat Alert System (BCSAS) and for prototype documentation. The BCSAS was developed to satisfy the need to quickly rescue children or pets abandoned in a car and susceptible to heat stroke, hypothermia or Carbon Monoxide (CO) poisoning. We assumed this product's main users would be good-natured, but not able to perform frequent product maintenance. This UPM covers all the steps taken to create this product, from problem identification to final prototype, and has been made available for public use.

2 Overview

Every year, globally, tens of children suffocate of heat stroke trapped inside a car, the cause for their abandonment commonly being considerable distraction affecting their busy parent or caregiver after a drive. In rarer cases, some children pass away after infiltrating their parents' car on their own during hot and sunny weather and falling asleep. Thus, there is a need for guardians to remain aware of their child or pet's presence in their car after a car trip; it is essential to create a system that can detect a child or pet in a car, detect the car's internal conditions—temperature and CO levels—and communicate with guardians and passersby. The BCSAS is a complete solution uniting reliable detection and a well-structured alert system. (It is essential to understand that the system's final prototype is low-fidelity, as a result of cost and time constraints, which considerably limited its development.)

Figure 1: The Elite4 BCSAS Final Prototype

The BCSAS detects the presence of a child or pet in the backseat of a car and keeps track of the car's internal conditions; it activates as soon as the car is turned off and movement is detected in the backseat, and it is programmed to send out various alerts: an audible followed by a mobile alert to users and a visual alert to passersby; these features are coordinated by an Arduino Uno microcontroller. Users are responsible for providing the phone numbers they wish the device to alert and for physical installation on their car's front seat.

2.1 Cautions & Warnings

Device can cause harm to child or pet or damage back seat if poorly fastened or if fastens are loosened. Keep out of reach of child or pet.

3 Getting started

Step 1: Fasten the Velcro straps to the driver seat headrest's vertical metallic supports, making sure little to no space remains between the device and each support.

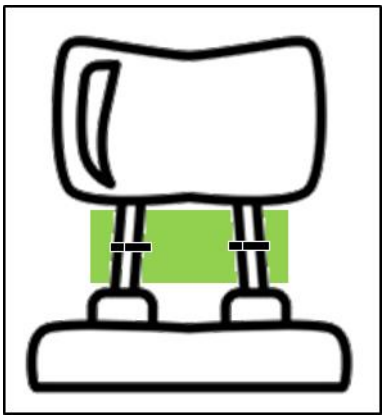

Figure 2: Proper Fastening the BCSAS

Step 2: Connect the USB cable to the car's USB port.

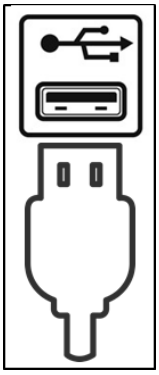

Figure 3: Connecting the BCSAS to Your Car's USB Port

Step 3: Stick the LED strip to the window frame adjacent to the driver's seat, as shown below.

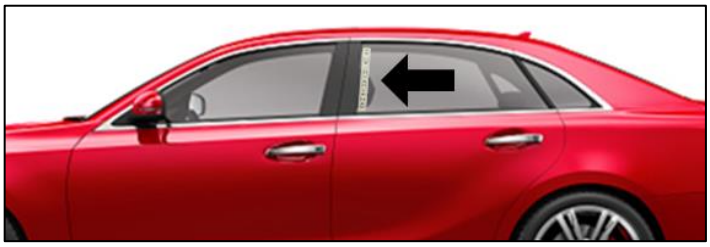

Figure 4: LED Strip Installation Location

Step 4: Install the informative sticker on the smaller surface of the rear driver side window shown below. The sticker could also be installed on the back window.

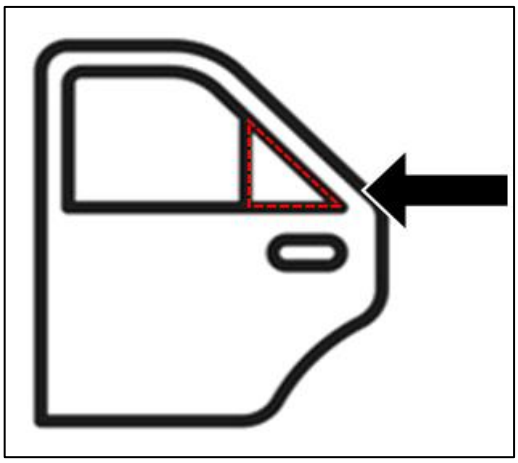

Figure 5: Suggested Sticker Application Area

3.1 Set-up Considerations

The BCSAS includes a sensor module, recognizable by its lime-green casing, a two-meter USB connector, a foot-long LED strip and an informative window sticker. The system uses Wi-Fi to send out text messages and calls. Input devices include temperature, CO and movement sensors and a current detector, which detects the presence of an electrical current flow from the car's USB port to the BCSAS. Output devices include LEDs, a buzzer, located inside the sensor module, and a Wi-Fi module.

3.2 User Access Considerations

This device was built for parent/caregiver direct access, and if applicable, friends/family members whose phone numbers were included at purchase can end the secondary alarm system (SAS), which includes an automated phone call, frequent SMS alerts and the visual passerby alert, using command "Halt".

3.3 Accessing the System

Drivers must connect Wi-Fi module to a Wi-Fi network to enable the system to work correctly. When receiving SMS alerts, users (including caregiver and friends/family if applicable) can stop the SAS by texting back the command "Halt".

3.4 System Organization & Navigation

The BCSAS is mostly mechanical, but the guardian is responsible for connecting the system's Wi-Fi module to an Internet source.

3.5 Exiting the System

Texting back "Halt" to the system's Wi-Fi based phone number stops all system operations until the car is turned on and back off.

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 BCSAS.

4.1 Immediate Alert System/IAS

The IAS system consists of CD system, PIR system, Audible system and a SMS system to notify the parent/caregiver that their child/pet is moving under stress along with the option to terminate the alert with a single text message from the parent/caregiver saying “HALT”. In this situation, the parent/caregiver is expected to respond immediately while they leave the vehicle.

4.1.1 CD system/Motion detection

The CD system activates after the device is turned ON and takes the input value of the current coming from the USB 3.0 to detect if the parent/caregiver has left the car and turned the car OFF.

4.1.2 PIR system/Motion detection

The PIR system will turn ON as the device is ON to detect vigorous motion of the child/pet placed in front of the device to initiate the IAS.

4.1.3 Audible System/Buzzer alert

The audible system consists of the buzzer feature that will turn ON after the CD system detects that the parent/caregiver has left the car. When ON, the buzzer will make a sound for 10 seconds.

4.1.4 SMS System/Text message alert

The SMS system activates after CD system, PIR system, and the Audible system have turned ON. A text message will be sent to the configured phone numbers on the IFTTT messaging mobile application with a response option where the parent/caregiver can text back “HALT” to acknowledge that the child/pet is moving and is safe. If the parent/caregiver does not response “HALT” to the IAS, then, continuous SMS alerts will be sent to friends/family members every 3 minutes for a 30-minute period.

4.2 Secondary Alert System/SAS

The SAS will be activated when the device is turned ON from the 9V lithium battery. This will activate the whole system where subsystems such as the CD, TS, CO

system and the PIR system will input all the required values and ensure they are not critical. If they are critical, then the SAS will initiate in a step-by-step manner to use output functions from the PA system, ACS and SMS system to alert the parent/caregiver.

4.2.1 CD system/Motion detection

The CD system activates after the device is turned ON and takes the input value of the current coming from the USB 3.0 to detect if the parent/caregiver has left the car and turned the car OFF.

4.2.2 TS/Temperature detection

The TS will collect continuous values for temperature inside the vehicle in ℃ as the device is turned ON and the parent/caregiver has left the vehicle. If critical temperature values over 37.5℃ is detected by the SAS, then the output will result in the PA system flashing LED lights to notify any passerby, ACS will send an automated call to the parent/caregiver and friends/family members, and lastly the SMS system will be activated as well.

4.2.3 CO system/CO detection

The CO system activates upon input of critical CO values of 70ppm which outputs an alert through ACS, PA system and the SMS system to notify the parent/caregiver.

4.2.4 PIR system/Motion detection

The PIR system will turn ON as the device is ON to detect motion of the child/pet placed in front of the device to input any vigorous motion from the child/pet and output an alert through the PA system, ACS and SMS system.

4.2.5 PA System/Flashing LED alert

The passerby system consists of the installation of an LED strip on the blind spot mirror on the driver hand side. The LED strip will alert any passerby to have them save the child/pet under stress. The input comes from the CD system and TS with critical values to output an alert through the PA system.

4.2.6 ACS/Automated call alert

The ACS has an output of sending an automated call to the parent/caregiver and friends/family members based off the critical values input from the PIR system, TS, and the CO system.

4.2.7 SMS system, Text message alert

The SMS system inputs critical values from TS, CO system and the PIR system to output text message alert to the parent/caregiver and family/friends every 3 minutes for a 30-minute period.

5 Troubleshooting & Support

5.1 Error Messages or Behaviors

Text messages or automated calls are received even after responding "halt":

- Ensure the USB cable is well connected.
- Disconnect the BCSAS from and reconnect to chosen source of Wi-Fi.
- Open lid, disconnect and reconnect the 9V battery.
- If problem persists, please contact client support.

Buzzer alarm sounds when no child or pet is in backseat:

- Ensure no object could have been in motion for more than 30 seconds after stopping the car.
- Open lid, disconnect and reconnect the 9V battery.
- If problem persists, please contact client support.

5.2 Special Considerations

If uninstalling the BCSAS for inspection or troubleshooting, it is important not to forget to uninstall the LED strip before removing the sensor box.

5.3 Maintenance

Battery replacement might be necessary after 5 years of use or later. Irregular buzzer silence is the best indication of a dead battery. (However, make sure USB cable is correctly connected.)

5.4 Support

For any technical support, please contact:
Laurent David
ldavi096@uottawa.ca
819-918-7042
Identified problems with the BCSAS are to be reported directly by email or telephone.

6 Product Documentation

6.1 Prototype I/O, Communication and Circuitry

6.1.1 BOM

- Arduino Uno: $9.00
  https://edu-makerlab2021.odoo.com/shop/product/arduino-5?search=arduino#attr=5

- ESP-8266 Wi-Fi Module: $9.48
  https://www.amazon.ca/gp/product/B09F2ZVSZ8/ref=ppx_yo_dt_b_asin_title_o07_s00?ie=UTF8&psc=1

- Passive Buzzer for Arduino: $2.00
  https://edu-makerlab2021.odoo.com/shop/product/buzzer-10?search=buzzer#attr=250)

- RGB LED strip: $16.00
  https://www.amazon.ca/gp/product/B08SHYGF5Q/ref=ppx_yo_dt_b_asin_title_o06_s00?ie=UTF8&psc=1

- HC-SR501 PIR sensor: $3.00
  https://edu-makerlab2021.odoo.com/shop/product/pir-sensor-46#attr=

  OR (possible but less efficient replacement)

  HC-SR04 ultrasonic sensor: $4.00 (what we used due to lack of time/material availability)
  https://edu-makerlab2021.odoo.com/shop/product/ultrasonic-sensor-60#attr=

- DHT22 temperature and humidity Sensor: $9.99
  https://edu-makerlab2021.odoo.com/shop/product/humidity-temperature-sensor-23#attr=187

- MQ-7 CO sensor

- ACS712 Current Detection Board

- 1-meter USB cable

- PCB (5 x 7 cm) OR breadboard (what we used due to lack of time, not ideal)

- Electrical wire

- Female to male wires OR male to male wires (for breadboard)

6.1.2 Equipment list

- Soldering iron
- Arduino IDE
- DHT Library
- Adafruit Unified Sensor Library
- USB-A to USB-B cable

6.1.3 Instructions

- Create the Arduino sketch shown in folder Elite4_Arduino_Sketch (see Appendix I). (A sketch incorporating a PIR sensor can also be found in the Previous_Arduino_Sketch folder, available in Appendix I).
- Make the Arduino circuit shown below:

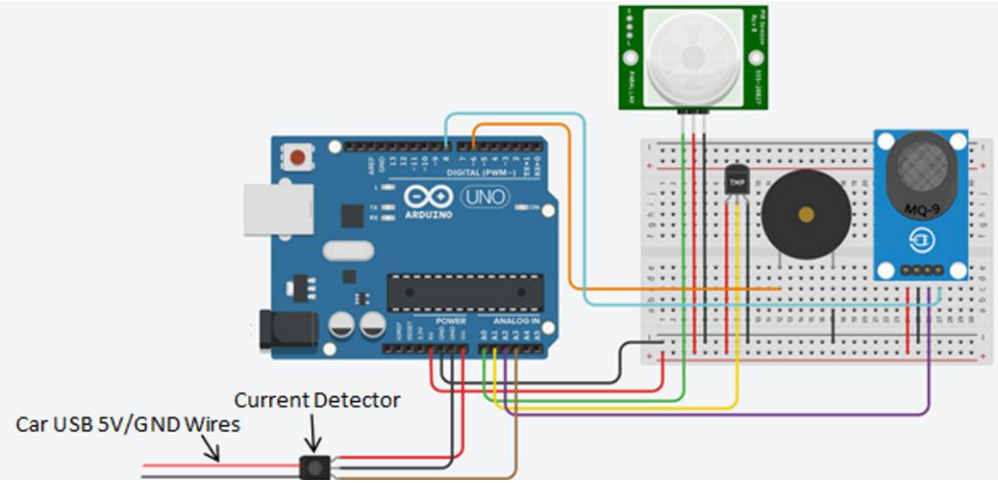

Figure 6: BCSAS Circuitry
Components connected to breadboard from left to right: PIR sensor, temperature sensor, buzzer, CO sensor.

Notes:
Circuit for DHT22 temperature sensor should be connected to digital pin and may vary if sensor is obtained with 4 pins instead of 3.
Wi-Fi module may be connected to circuit, but was not used for this prototype due to lack of time, as the associated application used to control the module was found to be inadequate.

If using an ultrasonic sensor instead of a PIR sensor, connect ultrasonic sensor as shown below (circuitry for 3-pin ultrasonic sensor may vary):

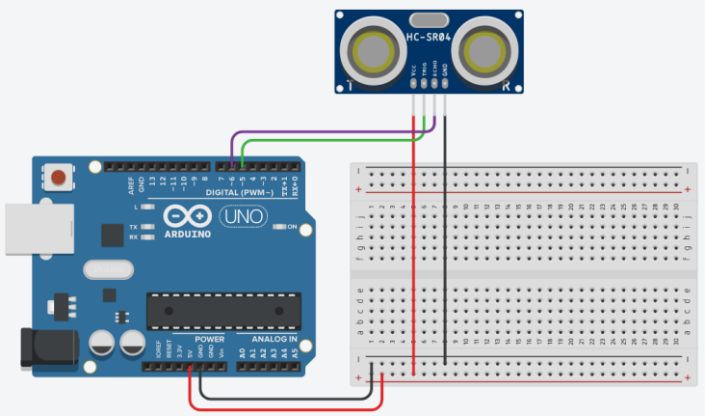

Figure 7: HC-SR04 Ultrasonic Sensor Circuitry

- Connect the LED strip accordingly (depending on the type obtained). In our case, we soldered electrical wires to the R, G, B and 5V endings of our LEDs, connecting the RGB ends to digital pins and the 5V end to the connected positive power rail on the breadboard.

6.2 Power System

6.2.1 BOM

- 9V lithium battery
- 9V to barrel jack adapter

6.2.2 Equipment list

No equipment required

6.2.3 Instructions

- Connect the 9V battery to its adapter.
- Connect the adapter to the Arduino's barrel jack after correctly configuring and combining the other subsystems.

6.3 Casing and Fasteners

6.3.1 BOM

- Two 6” velcro straps
- ABS filament (color left to builder’s discretion; other materials are possible, but need to be able to withstand extreme temperatures)
- 3/8 in.-16 tpi x 1-1/2 in. Zinc-Plated Hex Bolt: $1.36 https://www.homedepot.com/p/Everbilt-3-8-in-16-tpi-x-1-1-2-in-Zinc-Plated-Hex-Bolt-87206/204960790

6.3.2 Equipment list

- 3D printer
- Wrench

6.3.3 Instructions

- Print the casing created in the BCSAS_Casing folder (see Appendix I) using a 3D printer. If new to 3D printing, always ask for help to use printer.
- Attach the Velcro straps, as shown below:

Figure 8: Velcro Strap Attachment

- Install the two combined subsystems inside the case, fitting each appropriate component (ultrasonic sensor, LED strip, USB cable) to its corresponding opening.

Figure 9: BCSAS Openings View

(Recommendation: at least use electric or duct tape to keep components in place inside the casing. Casing redesign is highly recommended.)

- Using the appropriate bolt wrench, screw the bolts in each of the 4 corners of the casing.

6.4 Testing & Validation

Arduino code and mechanical components were first tested for accuracy. After assembling the prototype, the sensor module was placed in front a person sitting down, the Arduino connected to a computer's USB port (using a USB-A to USB-B cable), and the code uploaded into the Arduino. As expected, since temperature and CO levels were safe, no action occurred. The upper limit of "acceptable" temperature was modified in the code (changed from 25 to 20 centigrade), and the sketch was reuploaded to the module. As expected, at the slightest movement of the person in front of the sensors, the buzzer, which was configured to function at that moment, started sounding for 5 seconds, and the LEDs shone red at a regular frequency. (Reminder: this prototype was not high-fidelity because of lack of time, meaning this test did not reflect our product's target functionality.) However, an issue (possibly with the sketch) left unresolved was the LEDs turning red for about 2 seconds and subsequently turning light blue. Afterwards, the Arduino and battery were tested, as the Arduino was disconnected from the computer and connected to a 9V battery (via 9V to Barrel Jack adapter). Once again, the module was placed in front of a person sitting down, and the prototype produced identical results to the previous test. In

all, we were on the right track to producing a fully functional, high-fidelity product, but lack of time and resources limited our options when building and testing our final prototype.

7 Conclusions and Recommendations for Future Work

The importance of rigorous time management (e.g., not working at the last minute), contingency planning and responsible material handling should not be overlooked in projects for which time and resources are limited. Furthermore, materials should be obtained as early as possible to optimize testing opportunities for early prototypes and minimize unexpected situations that could alter the final prototype's fidelity and completeness.

I we had had additional months to complete this project, we would have built fully comprehensive and functional prototypes, using all components described in our expected design. More specifically, we would have printed our informative sticker design on a waterproof vinyl sticker, reprinted the casing after modifying it to make it better structurally organized and found a functional mobile application allowing us to test the Wi-Fi module. Thus, more testing would have been performed as well, especially inside a car. Moreover, creating a mobile application for the BCSAS could have considerably increased the system's immediate configurability and the mobile alarms' efficiency. Finally, to satisfy one of the client's requests, we would have created an Arduino sketch that would have enabled communication with the car's relay for emergency situations in order to lower windows or to activate the car's air conditioning or heating system.

8 Bibliography

Arduino. (n.d.). UOttawa MakerLab. Retrieved December 22, 2021, from https://edu-makerlab2021.odoo.com/shop/product/arduino-5?search=arduino

Berelli TV LED BACKLIGHT STRIP – Perfect For 25" to 60" TV – RGB 16+ Million Color Options – USB Powered 5V – Bluetooth App Control + Includes 40-Key Remote Control – Dimmable RGB Mood Lighting – Perfect For TV, Computer, Mirror, Gaming, Monitor, PS4 Accessories and more (2M/6.56ft): Amazon.ca: Tools & Home Improvement. (n.d.). Amazon.Ca. Retrieved December 22, 2021, from https://www.amazon.ca/gp/product/B08SHYGF5Q/ref=ppx_yo_dt_b_asin_title_o0

Buzzer. (n.d.). UOttawa MakerLab. Retrieved December 22, 2021, from https://edu-makerlab2021.odoo.com/shop/product/buzzer-10?search=buzzer

ESP-01S Module for Wireless WLAN, ESP8266 ESP-01 Serial Wi-Fi Wireless Transceiver Module with ESP-01 Adapter: Amazon.ca: Electronics. (n.d.). Amazon.Ca. Retrieved December 22, 2021, from https://www.amazon.ca/gp/product/B09F2ZVSZ8/ref=ppx_yo_dt_b_asin_title_o07_s00?ie=UTF8&psc=1

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APPENDICES

9 APPENDIX I: Design Files

This BCSAS UPM is based on the work documented in previous project deliverables, found in this product's Makerepo project page. This UPM references all three other folders included below, which are stored in a Microsoft Onedrive (link shortened for space) available to all. In this Onedrive can also be found the project deliverables (also available on the Makerepo project page).

Table 3. Referenced Documents

Document/Folder Name	Document Location and/or URL	Issuance Date
BCSAS_Arduino_Sketch	https://bit.ly/3JdAXnR	2021-12-22
BCSAS_Casing	https://bit.ly/3JdAXnR	2021-12-22
Makerepo Project Link	https://makerepo.com/shahid06/956.b20-elite4-car-sensor	N/A
Previous_Arduino_Sketch	https://bit.ly/3JdAXnR	2021-12-22
Project Deliverable B - Needs Identification and Problem Statement	https://bit.ly/3JdAXnR	2021-12-23
Project Deliverable C - Design Criteria and Target Specifications	https://bit.ly/3JdAXnR	2021-12-23
Project Deliverable D - Conceptual Design	https://bit.ly/3JdAXnR	2021-12-23
Project Deliverable E - Project Plan and Cost Estimate	https://bit.ly/3JdAXnR	2021-12-23
Project Deliverable F - Prototype I and Customer Feedback	https://bit.ly/3JdAXnR	2021-12-23
Project Deliverable G - Prototype II and Customer Feedback	https://bit.ly/3JdAXnR	2021-12-23

Project Deliverable H - Prototype III and Customer Feedback	https://bit.ly/3JdAXnR	2021-12-23