Project Deliverable D

Conceptual Design

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Abstract

The goal of this document is to explore possible solutions for preventing the death of a child in a locked car and alerting their parents and their surroundings. This report describes a project of 3 conceptual designs and final global applicable design that was agreed upon during the meeting. After the meeting that happened between the three group members a CO2 sensor as a final solution was designed. It consists of a radio communicator and a CO2 sensor which detects the CO2 after reaching a certain threshold, the radio communicator in the car will automatically connect to the parent device. We made this final solution very accessible and a universal solution for any type of vehicle, this design will work in any car models and school bus with some adjustments to the CO2 sensor threshold.

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1. Introduction

Based on the client's needs, we have so far developed a problem statement, benchmarking and the product specifications. In this deliverable, each member will come up with at least one conceptual design and we will combine the ideas to come up with three functional solutions. Finally, we will choose the best global concept and analyze it for further development. The conceptual designs will be based on the functional requirements that we have determined during the last meeting which are alert system, motion detection, mobile connectivity, CO2 detection and temperature monitoring.

2 Conceptual Ideas by Yunsu Lee

2.1 Subsystem Design Concepts

Three subsystem designs will be presented which will fulfill the functional requirements from Deliverable C. These designs put child detection and alerting systems as priority.

2.1.1 Camera with motion detection

With the advancement of technology, we now have small, affordable and easily-accessible cameras with motion-detection, which will only record videos when motion is detected whether in light or darkness. Such models have been used for child and pet monitoring for indoor usage. We can incorporate the same design to use in the car; it will function the same as the indoor camera, only it will not record videos since this will require a significant amount of data usage. It can send a push notification to parents' mobile devices when a motion is detected.

2.1.2 Temperature monitoring system

In case a child is asleep, motion detection will not be useful, and we need an alternative way of child detection in the car. In this situation, the temperature monitoring system will play a significant role. A small thermometer can be added to the device and when a certain temperature is reached, it can send a mobile push to parents and guardians.

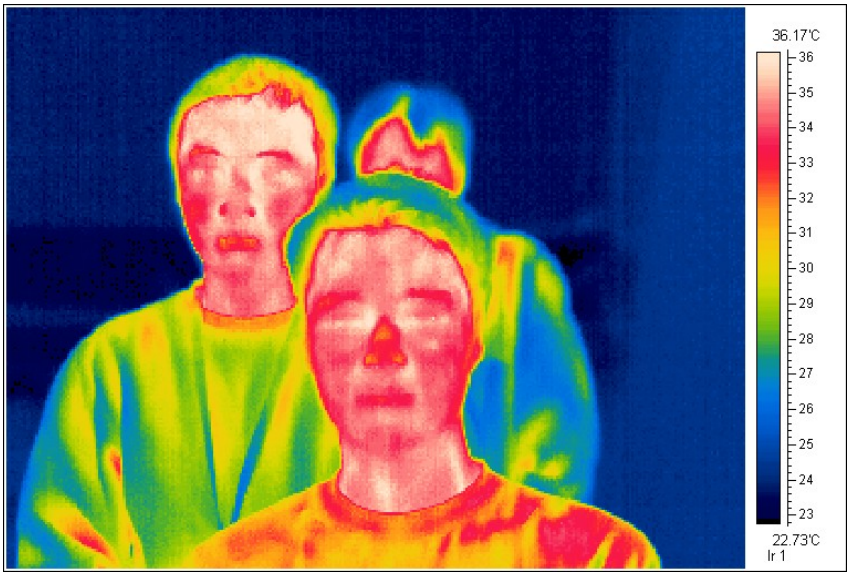

Figure 1. Heat sensor camera for temperature monitoring (Pyrosales, 2020)

We can upgrade the temperature monitoring system and use a heat sensor camera (Figure 1). It works in a low visibility environment and picks up minute differences in temperature (Pyrosales, 2020). Although this device will be highly effective in monitoring temperature, it is not cost-effective since the cost ranges from $450 - 3000 (Pyrosales, 2020).

2.1.3 Two-way audio system

During the first meeting, the client emphasized the importance of keeping children calm. Two-way audio system will be a great tool for communication with a child. With a mobile app, you can monitor the car conditions (temperature) and also activate an audio system to talk to a child in the car. Furthermore, when a sound is detected in the car through a two-way audio system, parents can receive a notification on their mobile devices through a connected application. Most security and indoor monitoring cameras are equipped with two-way audio systems. Therefore, the audio system can be added to a camera with the motion detection so that it can be used as a tool of communication or child detection.

3. Conceptual Ideas by Fred Xu

3.1 Subsystem Design Concepts

3.1.1. Child-specific pressure cushion that can be connected with Bluetooth.

The outside of this device is a seat cushion with a seat belt, and on the side, there is a button to open the Bluetooth connection (like AirPods), and it uses a button battery. There is a pressure sensor inside. When the Bluetooth connection is turned on, if the parent's mobile phone is 20 meters away from the device, the parent's mobile phone will receive a constant vibration prompt. This device will have an APP in which you can check the battery level and set emergency contacts. When the parent's mobile phone is 50 meters away from the device, it will send an emergency alert to the parents and the emergency contact's mobile phone.

Figure 2. Pressure Sensor Example Image (BABI, 2021)

3.1.2. CO2 concentration detector

This device is similar in appearance to a thermometer and will detect the concentration of carbon dioxide in the car. If the concentration of carbon dioxide in the car is too high, it will automatically turn on the ventilation system (or lower the windows) (and will not start the engine). The advantage of this device is that you don't need to download the mobile phone's APP, and it will open automatically whenever you park. The disadvantage is that the design is more complicated and requires a battery.

Figure 3. CO2 detector example image (Langkou, 2021)

3.1.3. Voice reminder device connected with car system.

This device is connected to the engine of the car. Whenever you turn off the car's engine, the car's system will automatically send out a voice reminder: "Please don't forget your child in the back seat." In order to prevent hearing fatigue, this device will record voices of different voice types. This device can be connected to the power supply of the car, so no battery is needed

4. Conceptual Ideas by Amrou Eldeabis

4.1 CO2 and Humidity sensor

The SCD30 from Sensirion is a high quality Nondispersive Infrared (NDIR) based CO_2 sensor capable of detecting upto 10000 ppm with an accuracy of ±(30ppm+3%). It will be connected to an open log and will be connected to the other sensors.

4.2 Motion and camera detector

The motion detector will monitor the child in case the Parents forget the Child after they leave the car and it'll display an audio message saying a child in the back.

4.3 Alarm system

An alarm will be connected to the open log and will be installed outside of the car or in the trunk due to it's noise. It'll act as an Alert the surrounding in the nearby that there is a kid in the back which in return will make them able to act upon it.

5. Conceptual Ideas by Don Hung

5.1 Backseat pressure sensor in conjunction with parent device

There are 2 components to this design, a pressure sensor in the backseat that connects to a separate device on the parent.

The pressure sensor repeatedly sends signals to the parent device, when the parent device is out of range of the pressure sensor while it last sent a pressure signal to it, then the parent device will vibrate indefinitely until the 2 devices come in close proximity again.

5.2 Three-device array that will work flawlessly

One device is a bracelet that goes on the child, one device is a device that permanently goes into the car, the last device stays with the parent, either on the back of their phone or on one that is on a keychain.

When the bracelet is in close proximity with the car, but the parent device is not, the parent device will begin to vibrate indefinitely until it is in close proximity with the car and bracelet. This ensures that the parent device will never vibrate if the child is not in the car.

A drawback is that a device has to be on the child. And there must be 3 separate devices, increasing the chances of malfunction.

5.3 A device connected to a pressure sensor that plays a message whenever the parent leaves the car.

The device will play a message: “Is there a child in the backseat”. The message will play everytime the parent leaves the car. But the voice that plays back the message will change every time the message is played to ensure the parent does not get used to that message. This is because people get used to sounds they hear everyday and will subconsciously ignore these sounds. For example, the ticking of a clock.

This is a device that prevents the parent from forgetting the child, but will not notify the parent if the child is forgotten.

5.4 CO2 activated glass cutting device

A suction cup cups onto a car window. With 2 arms, one is equipped with a hard glass cutting edge, the other is equipped with a heating element to melt the plastic layer in the car window.

The 2 arms will start spinning in a circle when the integrated CO2 sensor detects a certain concentration of CO2. This will cut a hole in the car window, allowing fresh air to flow into the car.

6 Final Conceptual Design

6.1 Functional Solutions

After a group discussion, we have selected conceptual designs that will be incorporated into our final solution design.

6.1.1 Solution #1

Since we put heavy emphasis on child detection in a car, we have selected CO2 or temperature monitoring systems as the final solution design. In the end, the temperature monitoring system has been removed from the final conceptual design due to the possible effects of turbulent weather conditions. On the other hand, CO2 detectors can be a valuable source of detecting child presence. A child will produce a certain amount of CO2 which will be detected by the monitoring system regardless of the weather conditions. The CO2 detector will only activate 10 or 15 minutes after a driver has left the car since the amount of CO2 that a driver has produced would affect the level of CO2 in the car. Once a certain threshold is reached, a two-way audio system will activate and start vibrating, and parents can hear their baby crying or even talk to a kid to calm them down.

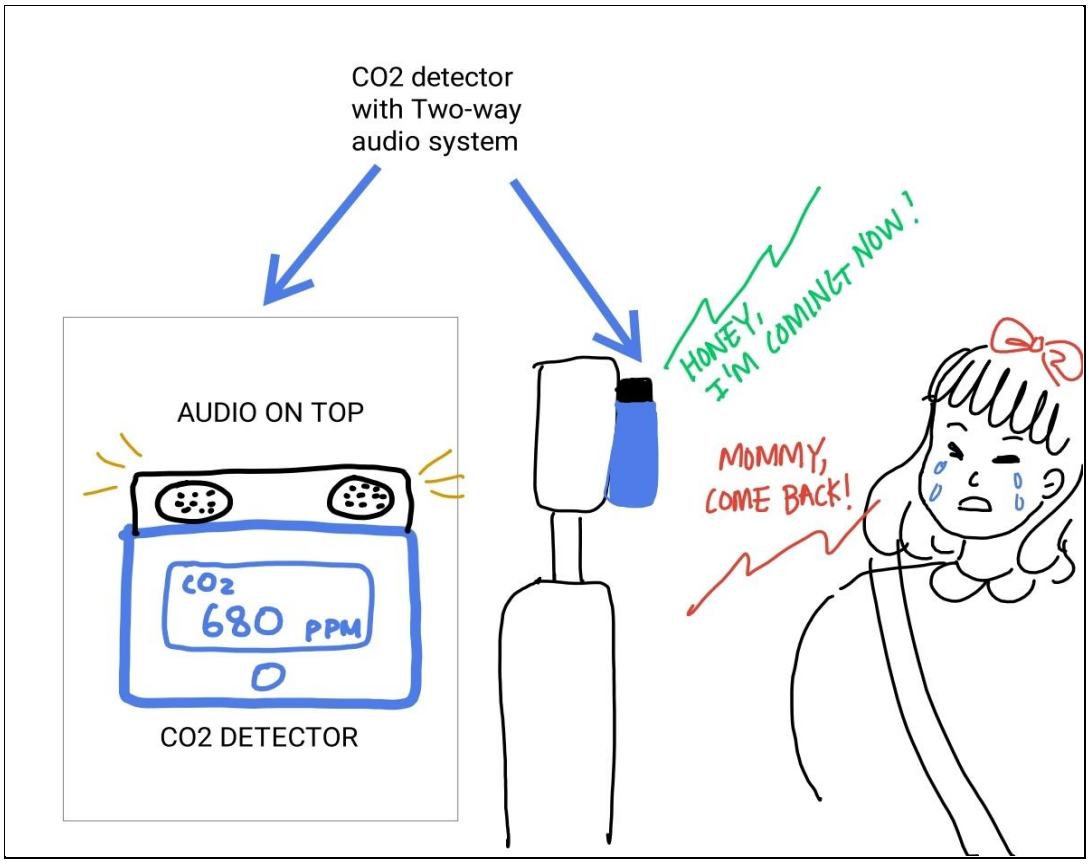

Figure 4. Final Solution Conceptual Design #1 (Lee, 2021)

6.1.2 Solution #2

The shape of this device is a seat with a seat belt, the size of the seat is suitable for children from 0 to 5 years old. The side of the seat is a place to install button batteries and switches. This device has no charging function and all its components are installed in the mezzanine of the seat.

There are three layers inside the seat, the upper and lower layers are filled with textile and cotton, which ensure the comfort of the seat, and the middle layer is the main equipment. There is a hard shell in the middle layer to ensure that it will not be broken by the child. The internal equipment has two functions, one is the pressure sensor, and the other is the Bluetooth device. When the switch is turned on, the pressure sensor and Bluetooth will be activated. When the parent's mobile phone is 10 meters away from the device, the mobile phone will keep vibrating. When the parent's mobile phone is 20

meters away from the device, the mobile phone will keep vibrating and an alarmed voice will remind parents that the child is forgotten in the car.

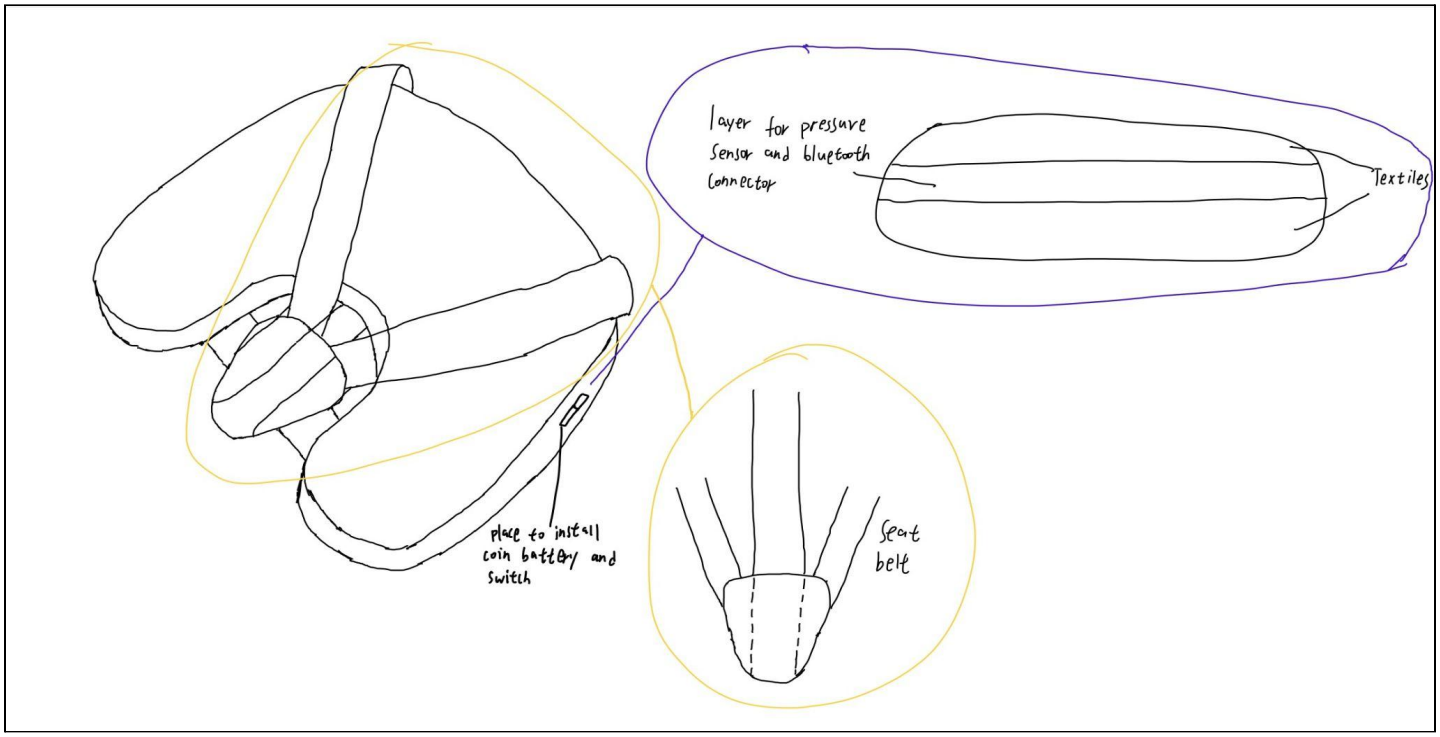

Figure 5. Final Solution Conceptual Design #2 (Xu, 2021)

6.1.3 Solution #3

There are three parts to this product. The first is a device installed on the outside of the driver's car door. The pressure sensor is the second device, which contains a battery and is connected to a charger. The third device is a car charger, charging the battery in the pressure sensor.

A message “is there a child in the back seat” will be played when the driver car door closes, given that there is a signal from the pressure sensor. However, the message will not be played when the car is turned on. The product could determine whether the car is on or not because the pressure sensor will not receive electricity when the car is off. This is important because the parent must put a child in the car and close the driver door, this prevents accidental alert sounds.

The car door device can detect a door closing because there is a wire suspended to a soft spring that will touch another wire when enough force is applied to it. The force is generated by closing the car door. Since the car door device is connected to the pressure sensor, the sound will not be played when there is no child in the back seat. The message will be played indefinitely until the child is removed from the pressure sensor. In the scenario that the parent does forget the child, the sound being played will alert nearby pedestrians.

Because the car door device is on the outside, it must be weather resistant. The magnet holding the device in place must also be strong enough to keep the device in place even when there are strong winds and vibration while driving. Also, the device has to be completely waterproof, and not break or crack due to temperature extremes. This means the device has to be completely sealed.

Due to the fact that the car door device must be completely sealed, the speaker in the device must be loud, and it will not contain a battery. The car door device only contains the speaker activation mechanism and the speaker. It is powered by the battery in the pressure sensor.

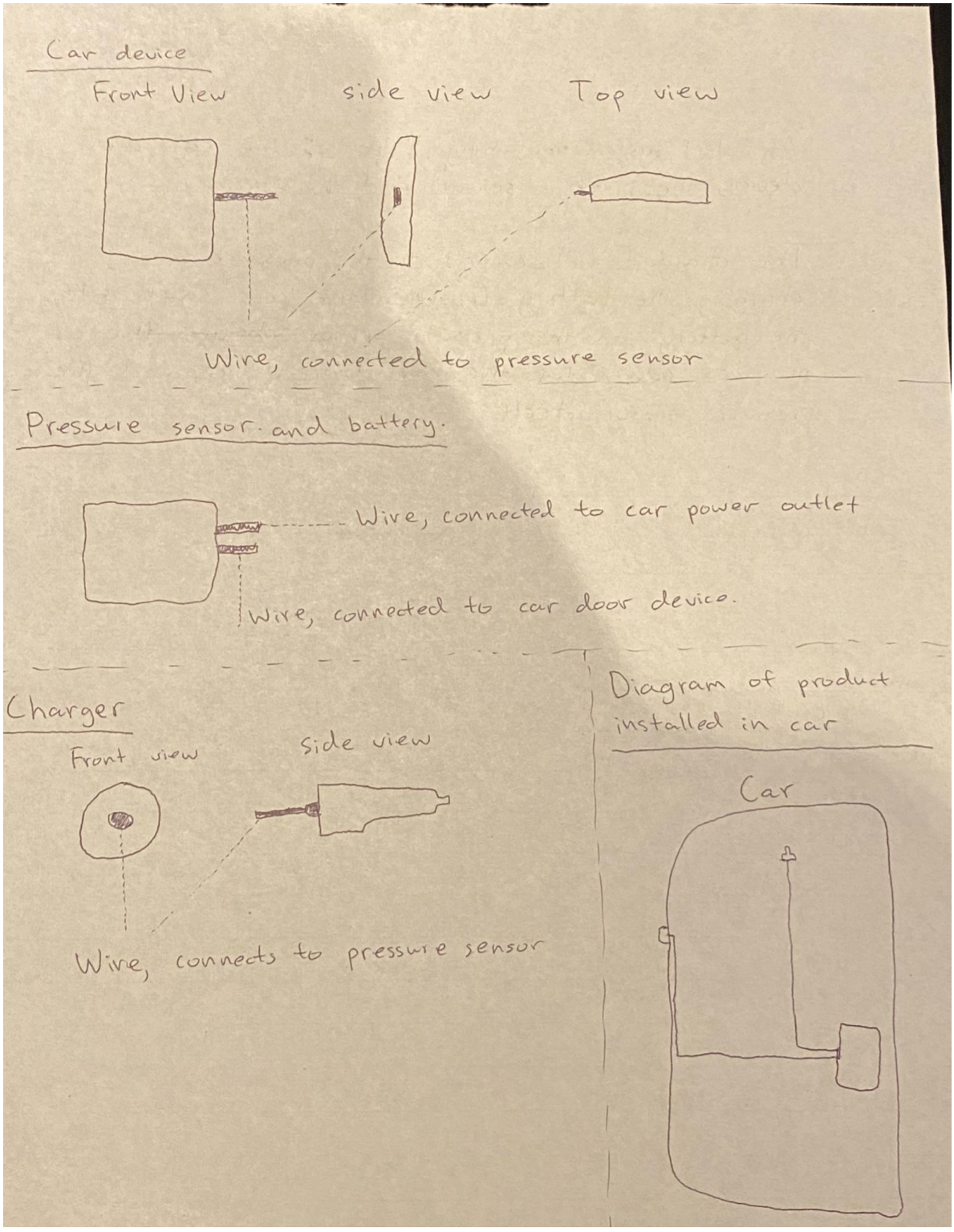

Figure 6. Final Solution Conceptual Design #3 (Hung, 2021)

6.2 Best Global Concept

6.2.1 CO2 sensor with two-way audio system, from solution #1

Just like a walkie talkie, a parent could communicate with the child from afar. In the scenario that a child is left alone in a car, they will generate CO2. When the CO2 in the car is steadily increasing and reaches a certain threshold, the radio communicator in the car will automatically connect to the parent device. As the client wants the final solution to be a universal solution to any type of vehicle, this design will work in any car models including a school bus. A pressure sensor device will be limited in usage in a school bus as it would not be economical to put a cushion with a pressure sensor in every seat. Instead, we can install a CO2 detector and lower its threshold so that it can also operate in a bigger capacity vehicle.

7. Conclusions and Recommendations

For the beginning parts of this report, each group member gives three different conceptual ideas with graphs. Then we had a group discussion to summarize three main ideas: CO2 detector, pressure sensor, and audio device. everything we summarized is based on preventing the death of a child in a car and alerting parents that the child is forgotten in the car

8. Future Work

Solution 1 contacts the parent that a child is in the backseat via radio, but will not prevent a child from being forgotten, while solution 3 reminds the parent that a child is still in the car, preventing it from happening, but will not notify them. Combining solution 1 and 3 will completely prevent a child from dying in a car, as it will cover the weaknesses of each solutions. For example, a new solution could be created by modifying solution 1 such that a phone notification is sent to the parent when the pressure sensor from solution 3 is activated. So even if the parent accidentally ignores the message from solution 3, they could still be notified from afar.

9. References

1. “Air Quality Monitor Indoor, CO2 Detector with pm2.5/1/10.” *Langkou*, https://www.findthisbest.com/brand/165170-langkou.

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3.“What is Thermal Screening and Scanning?” *Pyrosales*, 28 April 2020, https://www.pyrosales.com.au/blog/news/what-is-thermal-screening-and-scanning/.