University of Ottawa

Faculty of Engineering

GNG 1103 – Engineering Design

# Project Deliverable D: Conceptual Design

**Section B01**
**Team 5**

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# Introduction

In this document, team members individually generate at least one concept that addresses the design criteria. These concepts are explained and analyzed by each ideator to the team, highlighting its effectiveness in solving the client's problem, as well possible drawbacks the team could face in utilization of the concept. After individual presentation, the group will condense five concepts to three and pick the best solution for further development. Upon completion of this document, the team will have a concept that is the foundation for development of the first design prototype.

# Concept Ideations

**Concept 1:CO sensors**

The Arduino Carbon Monoxide sensor is able to detect Carbon monoxide levels, released from a range of 20 to 2000 parts per notation(ppm). An average adult feels the effects of CO poisoning at 200ppm and can die when there is a concentration of 1600 ppm of carbon monoxide gas in their environment. By using the Arduino CO sensor, the device created, would be able to detect any amount of CO gas emitted in any vehicle that could potentially affect passengers at any given time. The sensor works by cycling high and low temperatures, detecting CO levels in low temperatures.

Pros:

- Detects carbon monoxide levels at very low and poisonously high rates.
- Small
- Can be powered by batteries
- Sensitivity can be adjusted, using a potentiometer
- Responds Fast to Carbon monoxide detection
- Lasts Long.
- Simple Circuit.

Cons:

- May not be able to detect as fast as preferred due to location in the vehicle.
- Due to budget, only one can be used.

**Concept 2: Temperature and humidity sensor**

The Arduino temperature and humidity sensor is to use DHT11 temperature and humidity acquisition sensor to collect the room temperature and humidity. It applied digital module acquisition technology and temperature and humidity sensing technology. The sensor comprises a resistive humidity sensing element and a NTC temperature measuring element. It can measure temperature and humidity quickly and effectively. The measuring range of the sensor in temperature is 0-50 Celsius degrees. The measurement range on humidity is 20%-90% RH. (Hint: Humidity is the amount of water vapor in the air, exposure to low or high humidity can lead to arthritis or dry skin. Prolonged exposure to this environment may lead to death)

Pros:

- Small
- Easy to install
- Good long-term stability
- Convenient and practical
- High measurement accuracy

Cons:

- Cost
- Delay in response time
- Limited working environment

**Concept 3: PIR sensor**

Using an Arduino and a PIR sensor (Passive infrared) it would be possible to detect if there is a person or animal in the car. PIR sensors use a pair of pyroelectric sensors to detect heat energy in the surrounding environment. When applying this to our current problem we could have a top down PIR sensor to detect if there is a child/ animal in the car as soon as the user walks a certain distance away from the car.

It would be beneficial if the sensor was on the ceiling of the car because the sensor has a limited range as well as total field of view (110º), furthermore having it on the ceiling would limit its chance of being broken. It would be possible to 3D print a case to hold the Arduino and the required parts to then attach to the ceiling (shown below). It could also be recommended to the user that the positioning of the sensor on the ceiling would affect the area it encompasses. Since the PIR sensor can detect for heat of a person by default there would be no tampering required or ranges to set for this type of sensor.

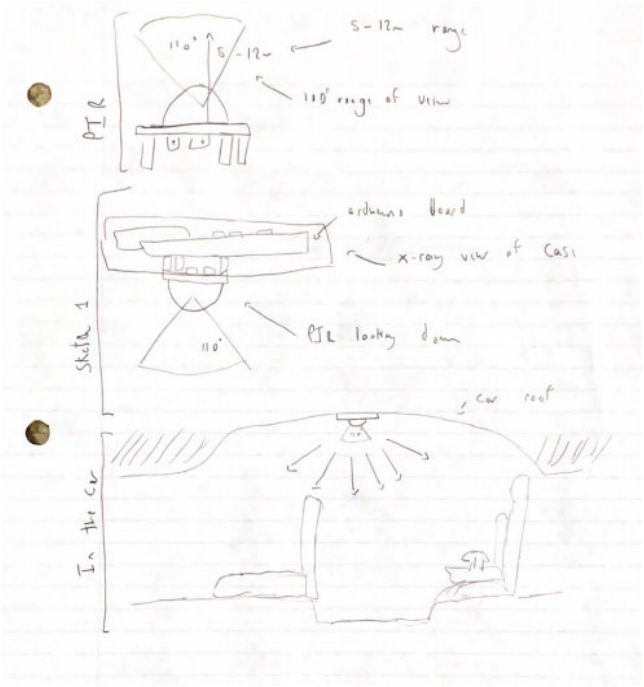



Figure 1: PIR Sensor Idea

Pros:

- Easy to install
- Small size
- Universal in detection
- High degree of accuracy in measurement
- Multi use ability
- Can encompass a large area

Cons:

- Cost
- Durability (can break easily)
- Could be damaged by extreme temperatures (ie; too hot or cold)
- Stands out

**Concept 4: Pressure sensor**

Another interesting concept would be to use pressure sensors and install them into a car seat to detect if there is a child or not, this could be paired with an app to notify the user if it senses pressure. This is quite an interesting concept because if there is no pressure sensed (i.e., no child) then there is no point to notify the user to check their car. An Arduino paired with FSR402**,** since this sensor is quite accurate there could be a function to indicate the weight of the child and then have a buffer room of +/- 10lbs. Moreover, having the pressure sensor integrated into a car seat would be very desirable to most parents because they wouldn't have to install anything directly to

their car. Lastly, there could be multiple products derived from this concept like a car seat with the sensor already built in, pressure pads that connect to the car.

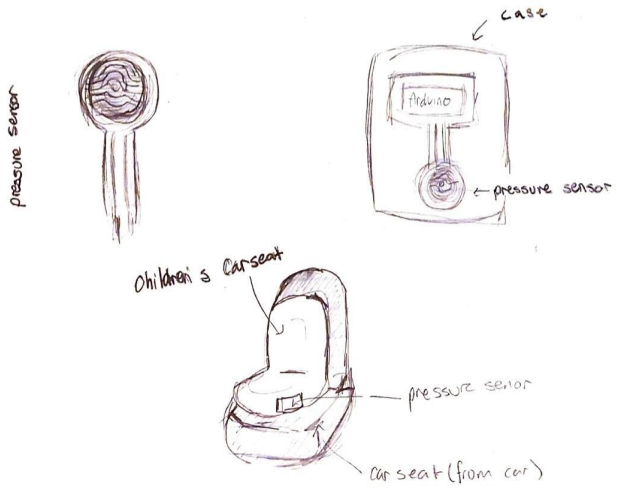



Figure 2: Pressure Sensor Idea

Pros:

- Simple to install
- Small
- Adjustable rages
- Not region or area based
- Simple to code
- Unnoticeable

Cons:

- Cost
- Durability
- Limited response time

**Concept 5: Radio Frequency Identification (RFID)**

When the driver is still in the car, the child is assumed to be safe. However, as soon as the driver leaves, our design problem is initiated. An RFID uses wireless radio frequency to transfer data for identification and tracking. RFIDs have a working range of 10cm to about 150m. They often come in a pair of a tag and a reader. Majority of car owners have car keys which they often take with them as soon as they leave the car. The idea is to have a tag attached to the car keys while the reader is in the car attached to the base of the baby car seat. An Arduino is also needed to interface with the RFID reader such that there's steady tracking going on between the car keys (driver) and the car seat (baby). The conditional statements will be such that once the tag is about 10ft away from the car seat (baby), the driver (now out of the car) is notified. This idea ensures that the driver is never so far out of the car that we are concerned with the air conditioning and ventilation inside the car is enough for the baby. A mobile app can be added to improve the user experience as well.

Pros**:**

- Easy to install
- Portable size
- Easily adjustable parameters
- High speed functionality
- Durable
- Easily automated

Cons**:**

- Possible signal interference
- Could be expensive

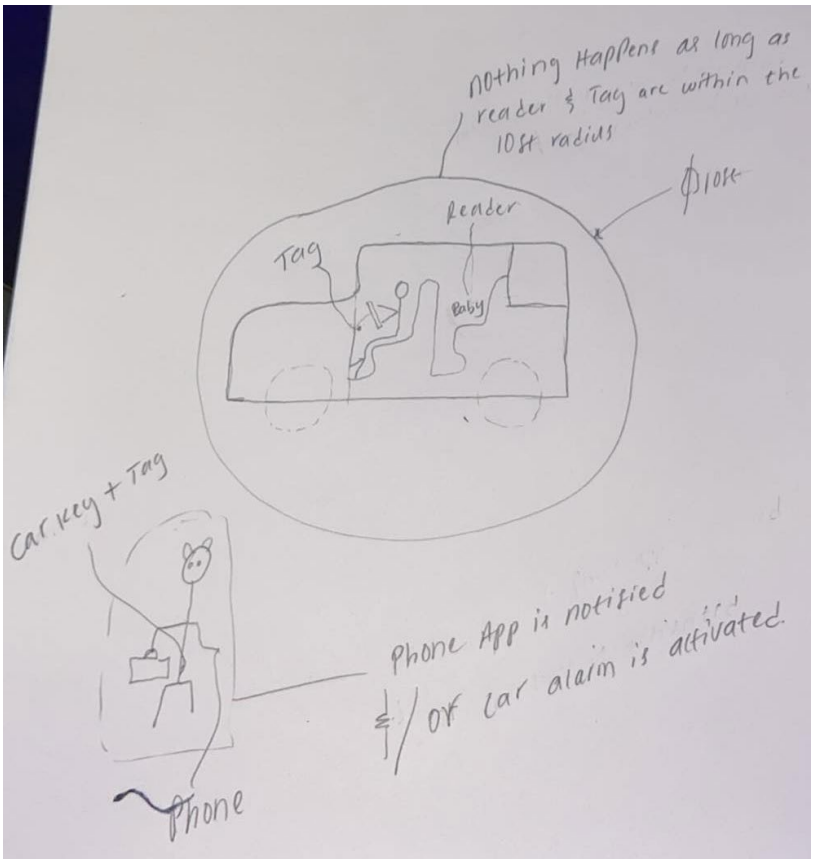



Figure 3: RFID Idea

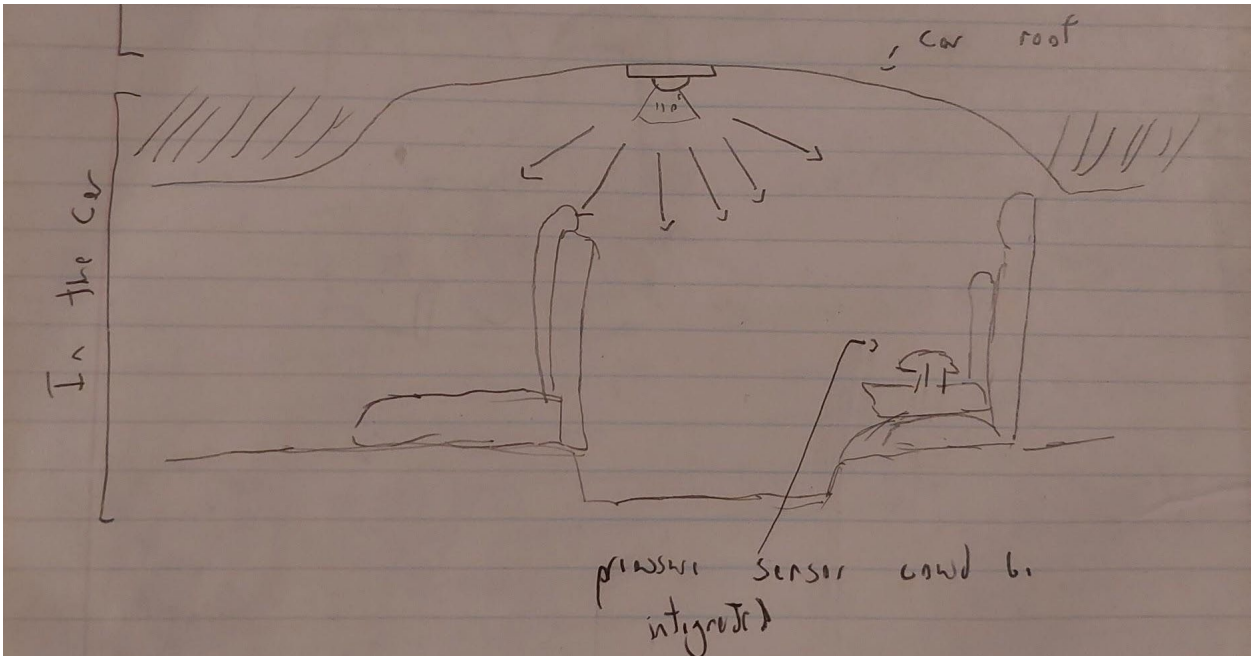
# Concept Analysis

In general, most of the systems required to bring our ideas to fruition are all Arduino based, these systems are pressure sensors, temperature sensor, PIR, CO and sound motion system sensors. These would all be put together in a similar way, the sensor would be connected to the Arduino and then we would code the required functions of the Arduino including ranges and certain base values.

All of the concepts we have listed are great ideas, but some have certain limitations, for example the most cost-efficient option would be a temperature sensor, but the temperature sensor is quite

general when it comes to protecting a child, or the PIR sensor which costs a bit more and requires a bit more coding but ultimately functions a bit better. As you can see, all have some sort of setbacks.

The good part is that these sensors don't need to work independently, it is possible to combine them to get one extremely effective product, of course the most effective product would be one that includes all the sensors, but it would get to a point where that many sensors would become redundant. A good example of combining two of our ideas would be PIR + pressure sensor. This would work well because the pressure sensor can only detect when a child is in the chair and has a very limited range, and as a failsafe or secondary precaution the PIR sensor would act as an overhead surveillance.




In a sort of conclusion, the best option for a product to meet the needs of users and our client would be to make an amalgamation of our concepts that both have their individual functions but as well fix the mistakes of the other systems involved.

# Global Concept

Our goal as a team is to create a final product that is ergonomic and functional. A device that can sense carbon monoxide, as well as the change in temperature, detect if there are any passengers in the car, then notifying a driver who is not in the car is a device that meets the requirements expected through the design criteria. To meet this expectation, the usage of the RFID sensor, PIR, CO, and temperature sensors in our device can save the life of a passenger. The carbon monoxide and temperature sensors are one of the most important sensors as they can detect the change in CO levels and temperature respectively. By incorporating an RFID sensor into the device, drivers can receive a signal when they are away from their vehicles. Since the purpose of our device is to notify drivers of children stuck in vehicles and keep them safe, it is very important to include a PIR sensor, which detects heat signature of a person in the car especially when temperatures are high and the co sensor that detects a buildup of carbon monoxide. Data collected from the CO, temperature, and PIR sensors would be transferred to the Arduino microcontroller which integrates with an RFID and then the driver is alerted.

Pro:

- Detects the presence of a passenger in a vehicle.
- Detects CO levels
- Detects Temperature and heat
- Notifies the driver.
- Adjustable working range
- All sensors can be used together.

Cons:

- Cost
- Signal interference
- Extreme temperatures can affect functionality.
- Limited response time

# References

*RFID - how does it work and how to use it with the Arduino*. Latest Open Tech From Seeed. (2019, November 13). Retrieved October 13, 2021, from https://www.seeedstudio.com/blog/2019/11/04/rfid-how-does-it-work-and-how-to-use-it-with-the-arduino/.

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*CO*-Kidde. (n.d.). *Carbon monoxide levels that sound the alarm*. Kidde. Retrieved October 12, 2021, from https://www.kidde.com/home-safety/en/us/support/help-center/browse-articles/articles/what_are_the_carbon_monoxide_levels_that_will_sound_the_alarm_.html.

# Appendix

Concept 1: Nalida Awog-Badek

Concept 2: Kayden Wang

Concept 3: Owen Haralovich

Concept 4:  Nicole Meouch

Concept 5: Uzochukwu Ekenedilichukwu Ebenebe