Interior Vehicle Temperature and Carbon Monoxide Detector for Humans and Pets

Beatrice Smetana
BS in Electrical Engineering
Central Michigan University

Loti Ibrahimi
BSc (Hons) in the Internet of Things
Waterford Institute of Technology

Justin Lizotte
BS in Electrical Engineering
Central Michigan University

I. INTRODUCTION

On average 38 child fatalities occur in the United States from a heatstroke every year, which is about 1 every 9 days [1]. Statistics show that before 1990 there were 17 child fatalities from vehicular heatstroke [1]. Since 1990 there have been 836 [1]. In just 10 minutes after leaving a vehicle, the temperature can raise about 20 degrees [2]. Two-thirds of the heat come within the first 20 minutes after leaving the vehicle [2]. Statistics show that this is a rising concern in the United States.

To help lower the rates of child vehicular fatalities a year the team came up with the IoT device that will notify a guardian as well as take steps to help prevent the vehicle from reaching dangerous temperatures. The concept is to use heat signature sensors to detect if there is a living subject left behind in the vehicle, as well as temperature sensors to monitor the interior temperature of the vehicle.

With this data, the plan is to alert the guardian if they are a certain radius from the car and that there is a living subject detected. Also, if the vehicle is approaching dangerous temperatures, hot or cold, the car will automatically start and run the air conditioning or heat in order to correct the inside temperature. If the guardian is away from the vehicle for a substantial amount of time the authorities will be notified.

II. CONCEPT

A. Research

The proper research was performed to find concepts or systems that incorporate similar design aspects. After finding relative articles, the team moved towards finalizing the concept idea and the design of the system.

From the research and data statistics, the team found out that among the 836 child vehicular fatalities 88% of the children are under the age of 3 [1]. Also in the same research article 55% of the 836 were unknowingly left behind [1]. The data and statistics for the age, and the certain circumstances that the child was left behind in the team narrow down the proper actions and features required for the system.

B. Concept Idea

The idea behind the development is to use the IoT device to sense a living subject that has been left in a parked car. To monitor if there is a living subject inside the vehicle, heat signature sensors will be placed strategically throughout. The heat signature sensors located throughout the cabin working in coordination with pressure sensors located in the seats will be the method to detect a living subject. By sensing body heat from the surrounding temperature and using pressure sensors to detect weight on a seat this data can be used in conjunction with each other to identify possible living subjects. Once the guardian has left the vehicle and moves outside of a 5-meter radius the guardian will be notified.

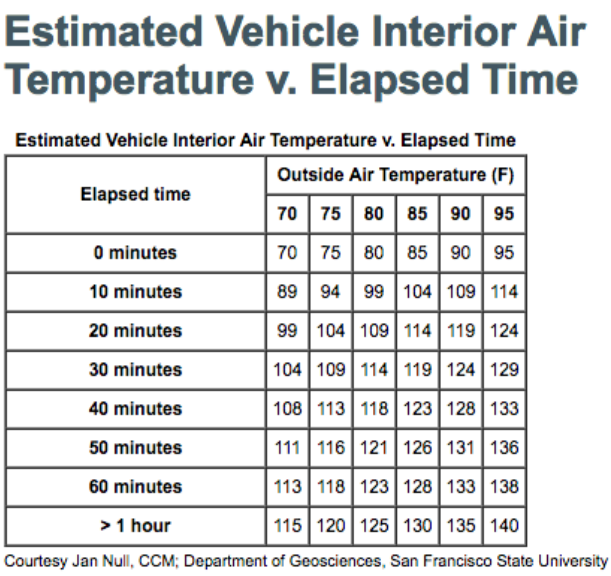
The use of a temperature sensor will verify the internal temperature of the vehicle. With that data, the system will determine if the temperature outside of a safe range for living subjects. The determined safe range for the system will be between the internal temperature of 4-24 degrees Celsius. This becomes an issue in the summer months due to the warm weather conditions. There is also a concern in opposite circumstances, with low temperatures which is why the device will correct for both.

Under normal operating conditions, the system will alert the authorities if the guardian does not re-enter the 5-meter radius outside the vehicle in an hour. If the system malfunctions or cannot protect the living subject from extreme conditions, action will be taken sooner. These cases would involve the car failing to start, running out of fuel, or simply could not reasonably correct the temperature (This could require a secondary range of temperatures to define extreme cases).

Extreme cases would be defined as the vehicles internal temperature fell below 0 degrees Celsius or rose higher than 29-degree Celsius. If any of these extreme cases occurred and the guardian failed to return, the authorities would be notified 5 minutes after the case is first detected.

The other features of the system would also monitor the interior of the vehicle for carbon monoxide. This will be monitored for cases where the vehicle is on and in an enclosed area, such as a garage. In an extreme case scenario, if unsafe levels are reached this will sound a buzzer in the vehicle and send a notification. If a living subject is detected, then action will be automatically taken by contacting authorities to send an ambulance in concern of the health of the passenger(s).

The goal for this development is to lower the amount of child vehicular fatalities each year and to prevent serious injury due to heat stroke, hypothermia, or carbon monoxide. This is being developed to allow guardians to not only react but to have the car take certain measures to correct the situation.



Estimated Vehicle Interior Air Temperature v. Elapsed Time

Elapsed time	Outside Air Temperature (F)					
	70	75	80	85	90	95
0 minutes	70	75	80	85	90	95
10 minutes	89	94	99	104	109	114
20 minutes	99	104	109	114	119	124
30 minutes	104	109	114	119	124	129
40 minutes	108	113	118	123	128	133
50 minutes	111	116	121	126	131	136
60 minutes	113	118	123	128	133	138
> 1 hour	115	120	125	130	135	140

Courtesy Jan Null, CCM; Department of Geosciences, San Francisco State University

Fig. 1. Estimated Vehicle Interior Air Temperature v. Elapsed Time

III. PROJECT MATERIALS

Materials needed for this project will be:

- LEDs
- Buzzer
- Jumper Wires
- Battery
- Carbon Monoxide Detector
- GPRS Module (Cell phone communication)
- Temperature sensor
- Pressure sensor(s)
- Heat signature sensor(s) (to detect passengers)
- Raspberry Pi (for control)

IV. RELATED WORK

Over the past few years, systems have been researched and developed to monitor vehicle conditions and relay that information in an attempt to solve problems of heat stroke and other hazards regarding individuals trapped inside [3-4]. These hazards are explained in more depth above. In conducting research, multiple systems have been found that monitor and correct these hazards in a few different ways. Many of these systems, especially more recently, have incorporated IoT in conjunction with sensors to send alerts to either vehicle owners or law enforcement [3-4].

After consulting these articles, the team found many similar ways of gathering and monitoring the conditions inside of the vehicle. However, these systems differ in how the gathered information is used and sent from these sensors.

In one system proposed in 2017 by Jetendra J. and other researchers [3]. IoT was used to monitor the conditions of the interior and exterior as well as the location of a vehicle. These conditions and location were then sent to a cloud database and alerts were then sent to a G.R.P.S. app relaying the data on the cloud [3]. This flow of the system is very useful for storing data of the conditions as well as alerting the proper recipients. Sending the data to a cloud first allows tracking of the conditions over time rather than just alerting only when there is an undesirable condition. This can also allow the tracking of previous events where undesirable conditions were met or instances of neglect of alerts sent. For the team's system, this information is very valuable to keep track of to identify possible repeat offenders when leaving children or pets unattended in vehicles.

Another benefit from this type of system is having the ability to send alerts to multiple recipients like the mother, father, babysitter, law enforcement, etc. This system utilizes the use of GPS to provide the location of the vehicle being monitored [3]. This information being collected is important when alerting emergency personnel, so they can locate the vehicle. However, this system did not incorporate actions to be taken other than notifications being sent to determine recipients. In certain cases, alerts may not be enough and immediate actions must take place.

One other system proposed by Shyma S. [4] addresses actions to be taken in the vehicle to counteract conditions being monitored. This system used O2, humidity, temperature, PIR sensors to monitor conditions and check for passengers inside of the vehicle [4]. The data collected is then run through a flow of checks to verify if conditions are safe or unsafe and if there are passengers inside. If unsafe conditions and a passenger are detected the system activates a buzzer to alert there is a problem and motors to roll down the windows to introduce fresh air into the vehicle [4].

This system is useful because it takes immediate action in case of unsafe conditions and passengers are detected. This, however, does not address the issue of alerting guardians or law enforcement in case of possible injury resulting from the extreme conditions. Statistics show that cracking of a car window has little effect on the overall temperature of the car approximately it only changes the temperature by 3 degrees [2]. The passenger would still be exposed to very dangerous temperatures which may result in death.

A further issue is with rolling down the windows of the car. It is a step in the right direction to take immediate action, but this action leaves the vehicle and passengers vulnerable to possible theft or other implications regarding security and safety of the passengers inside of the vehicle.

V. RELATED WORK LITERATURE

[1]. KidsandCars [Online] www.kidsandcars.org

[2]. Noheatstroke[Online] https://www.noheatstroke.org/original/

[3]. J. Joshi, V. Gujral, S. Dwivedi, & S. Devarasetty "Vehicle and passenger protection through cooperative sensor based vehicular networking." Proc. of the 2017 IEEE 4th ICSIMA, Nov. 2017

[4]. S. Sasidharan, V. Kanagarajan "Vehicle Cabin Safety Alert System" ICCCI, Jan. 2015