Smart System to Prevent Child Vehicular Heatstroke

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***Abstract*— This project is a microcontroller based system to prevent children from being left unattended in a hot vehicle. Some products claiming to help prevent vehicular heatstroke are available, but they are marketed to end users rather than to automotive OEMs. The undergraduate engineering students created a system to raise the parent's awareness and trigger multiple alarms to prevent this situation from occurring. The circuit reads the voltage from the car battery/alternator to see if it is running and uses pressure sensors to detect if a child is in the car-seat. The system sounds an alarm through a local speaker and uses a Bluetooth connection to a smartphone to give a secondary alert in case the parent leaves the child unattended. The Bluetooth connection is not limited to phones, and could be easily integrated directly into the car's onboard computer with the help of OEMs.**

Keywords: Vehicular heatstroke, Bluetooth, microcontroller

I. Introduction

Since 1990, at least 775 children have died of vehicular heat stroke [1]. It is the leading cause of non-crash vehicle-related fatalities for children of age 14 and younger according to the National Highway Traffic Safety Administration [2]. The goal of this project was to develop a system to reduce child vehicular heatstroke using an alert system. As with any engineering venture, safety was the number one concern. The system needed to work for the standard weight/height range of car seats and provide multiple channels of communication. The design had to be reliable, robust, and as inexpensive as possible. The prototype needed to be modular and work in the test vehicle without permanent modification. The system also needed to be generic and expandable enough so that a variety of OEMs could adopt the technology.

II. Design Elements

The system design involved three key elements:

1) Identifying if a child is seated in the car seat: To detect the child, the group thought of proximity sensors, pressure sensors, and a camera with facial detection.

2) Determining if the car is running: To check if the car was running, the students proposed reading the battery voltage, using GPS/accelerometer data to check relative position changes, and temperature sensors to check a difference between indoor and outdoor ambient temperatures.

3) Triggering an alert based on the collected and analyzed data: For the alert system, the group suggested a localized alarm, smartphone notification, and an OnStar integration.

Fig. 1 below shows the block diagram for the system.

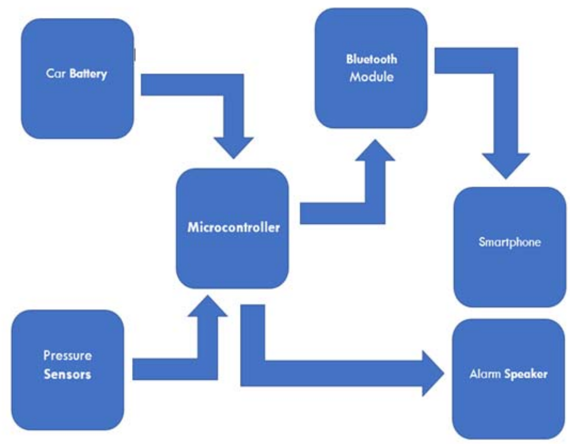

Fig. 1. Block diagram.

III. Prototyping

After selecting the solution, an Arduino Uno microcontroller board, HC-05 Bluetooth module, and force sensors were used to develop a prototype. Using the observed operating voltages for various makes and models of vehicles, the group used the microcontroller's ADC to read the voltage value from the car's 12V power socket. Since the selected microcontroller only works with 0-5 Volt inputs, the 12-14 Volt reading from the car battery was scaled down using a voltage divider circuit. The force sensors worked by giving varying electrical resistances based on how much force was applied. Voltage dividers were used with the force sensors to let the microcontroller read a voltage that varied based an environmental input. The alert system pulsed a square wave through a piezoelectric element to give a gentle reminder that the car had been shut off with a child still sitting in their seat. This alarm would be like the chime given by vehicles when the lights are left on, or the seatbelt is not fastened. After a grace period, when it is assumed that the parent had walked away from the vehicle, the system sends a loud, more noticeable alert through the speaker that simulates setting the car's alarm off. During the loud alarm, a message is sent over Bluetooth to the caregiver's phone to alert them that they left their child in the car. If the caregiver walked out of Bluetooth range with the child still in the seat, the application would still give them the alert. The group conducted tests with their prototype, a 30-pound toddler, a car seat, and a test vehicle. The system was successful in triggering the alerts at the correct times without any false positives. After testing was complete, the group refined the design and made a PCB layout for the circuit. The final design uses an Atmega328 microcontroller because it uses the same development ecosystem as the prototype, but has reduced cost and power consumption. The full breadboard layout, block diagram (Fig. 2), circuit schematic (Fig. 3), and PCB design (Fig. 4) are shown below:

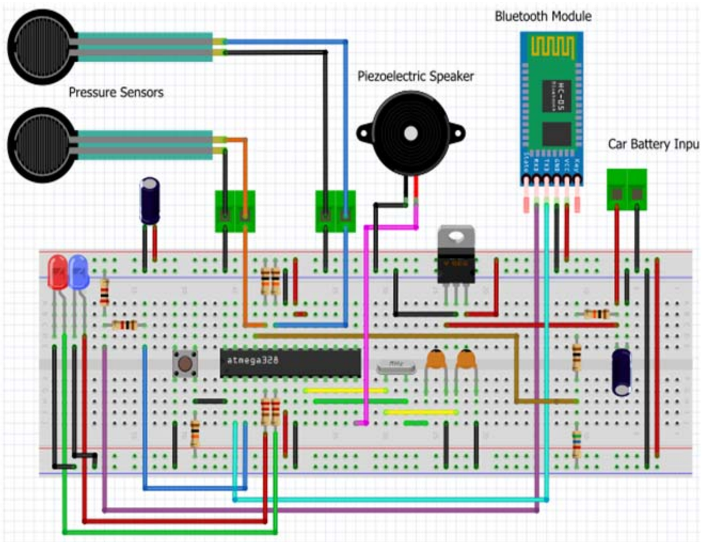

Fig. 2. Breadboard layout.

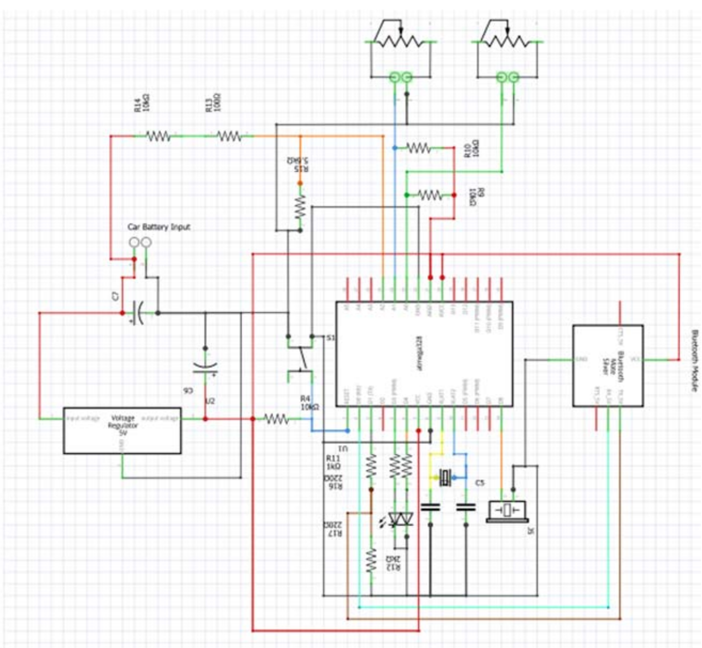

Fig. 3. Schematic.

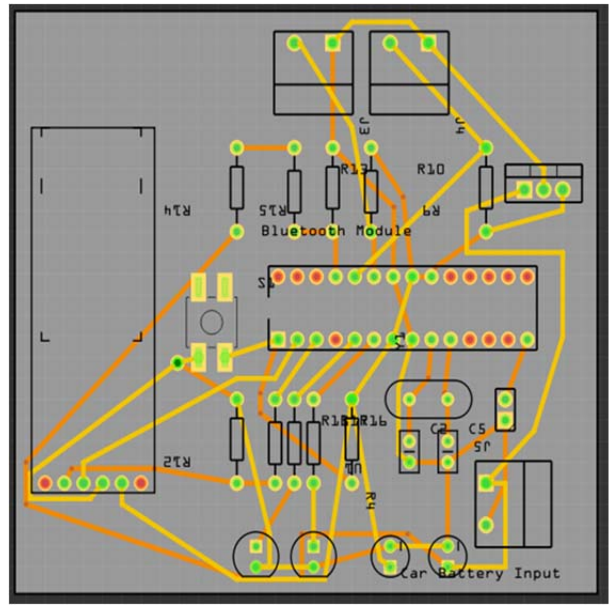

Fig. 4. PCB design.

IV. Results

The prototype was installed and tested for performance using a Clek Foonf car-seat in a Dodge Caliber. The performance was tested in real world scenarios and found satisfactory. Additionally, the system relayed the alarm to the Android smartphone of the driver along with gradually increasing intensity of the car alarm, successfully created a smart product to help eliminate vehicular heatstroke of children. The students used their collective background knowledge of circuit theory microcontrollers to complete this project.

V. Conclusions

The project was a success, and an inexpensive microcontroller based system was a good solution to the problem. The system prototype was good for creating the control logic and verifying that the system would work correctly. The system could be improved by using passive pressure sensors in the car seat and using the vehicle's built-in control system to detect a child in the car seat. The car could turn on the pressure sensor using RF, so that the car seat doesn't require a wired connection for sensors. The next logical step is to get car seat and automotive OEMs involved and create a standard so that any car in the future can detect a child in any car seat. This safety feature is necessary, and a call to action is necessary to make this feature as mandatory as seatbelts.

ACKNOWLEDGEMENTS

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REFERENCES

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