Research Article

SMART ASSIST CHILD CAR MONITORING WITH NOTIFICATION AND ALERT

Eliza Annis Thangaiah [1*], Azryna Azlen Mohd Nordin [2], Dayangku Nurhayati Awangku Morni [3], Irfan Haziq Muhammad Fauzek [4], Muhammad Faris Ikhwan Mohd Firdaus [5]

[1] Kolej Vokasional Shah Alam; elizaannis@moe.edu.my
[2] Kolej Vokasional Shah Alam; azrynaazlen_kvsa@moe.edu.my
[3] Kolej Vokasional Shah Alam; dayangku_kvsa@moe.edu.my
[4] Kolej Vokasional Shah Alam; m-4198594@moe-dl.edu.my
[5] Kolej Vokasional Shah Alam; m-2916359@moe-dl.edu.my
* Correspondence: elizaannis@moe.edu.my

Abstract: *Children getting trapped in vehicles and suffering from heat strokes is an issue that has been encountered for decades, and some even lead to death. Thus, the development of Smart Assist Child Car Monitoring (SACCM) based on the ESP 32 Camera Module and microcontroller gives awareness to parents or guardians of their child in the car if they are left without supervision. This work aims to prevent human deaths due to in-vehicle heatstroke by creating an autonomous monitoring and alerting system that would notify vehicle owners about any passenger, particularly children, left unattended. The project integrates sensor technology and an alert notification system that can notify if there is a movement of living things (children) in the car through the Short Message Service (SMS), the Telegram application and phone calls. A total of 31 respondents were involved in reviewing the SACCM. The findings indicate that SACCM could identify the child in the car in case the parents forgot. The responses for all the questions received were above 90%, which indicates the project is well received and functioned as described. They responded that alerting the parents could help parents to be aware of their children's presence. It is hoped that SACCM early notification could notify parents quickly and save lives. We plan to handle call notifications and send messages to the secondary guardians in the future and use the 360-degree camera for a wider angle of observation.*

Keywords: car; monitoring; child.

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1. INTRODUCTION

News of children left in cars and leading to death has been in the headlines for years. The situation where a child is forgotten in a parked vehicle is known as Forgotten Baby syndrome (FBS) (Anselmi et al., 2020) or forgotten in-vehicle syndrome (A. Hazizan et al., 2019). The website noheatstroke.org reports 968 heatstroke cases in 26 years in the United States of America (USA). More than half of the deaths (55%) are children under 2 years of age. Children have lower heat tolerance compared to adults; thus, they are exposed to danger quickly (Barekey et al., 2008). Figure 1 shows the child deaths in the United States of America from heat stroke in cars from 1998 to 2023.

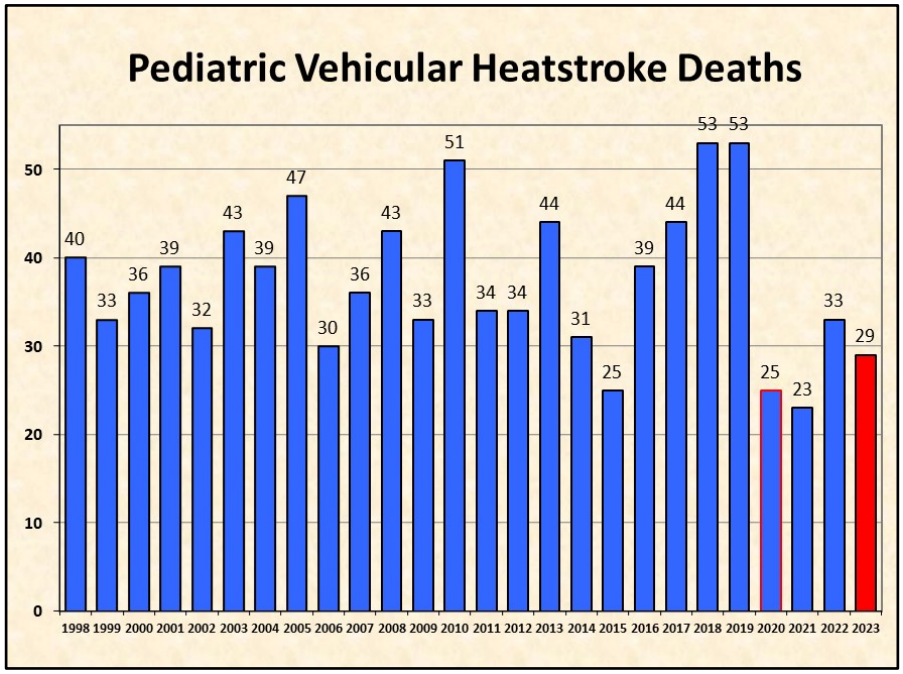

Figure 1. Child deaths in USA for heat stroke in cars from 1998 to 2023 *(www.noheatstroke.org)*

Where else in Malaysia, in a recent case, on the 1st of February 2024, a five-year-old girl was found unconscious after the mother left her unattended in the car and went to work (Norzamira, 2024). In another case, a father forgot to send his child of the age of 16 months to nursery. Similar cases like this took place over the years. Table 1 shows the cases reported in the newspapers in Malaysia from the year 2018 to 2024 (Mohd & Mohd, 2018; Norzamira, 2024; Radhi, 2019).

Table 1. Child deaths in Malaysia for heat stroke in car from 2018 to 2024

Year	Child age	Reason	Duration in the car
2024	5 years old	The mother accidentally left the child	4 hours
2023	16 months	The father forgot to send it to the nursery	7-8 hours
2023	8 months	The mother accidentally left the child	10 hours
2019	3 years old	The grandfather forgot the child in the car	2 hours
2019	2 years old	The mother accidentally left the child	2-3 hours
2018	2 years old	The mother accidentally left the child	4 hours

Based on Table 1, most of the cases involve children below 2 years old. All the reported cases resulted in the death of the child. From the reported cases, five of the cases involved parents who were working and forgot the child was still in the car, and they went to work. Most of them only realize the child is missing after a few hours and find the child is already unconscious and needs medical treatment and eventually death. The case of the death of a child trapped in a vehicle due to heat stroke is a situation called Pediatric Vehicular Heatstroke (PVH) when their body temperature reaches a level above 40 degrees Celcius. Overall, the number of cases does not seem to be declining much, which shows the awareness of kids being left in the vehicle is still high and thus should be given due attention to overcome. In Malaysia, death like this would be convicted with Section 31(1)(a) of the Children's Act 2001. If found guilty, he/she could be fined not more than RM50,000, imprisoned for not more than 20 years, or both.

Research has been ongoing to lessen the number of cases of these incidents by creating products that could alert parents. Xu et al. (2020) used Wi-Fi multipath propagation to detect the dynamics introduced by child movement or breathing; meanwhile, Azhar et al. (2022) used infrared and audio sensors to identify humans in the car when the engine is turned off. Global System for Mobile Communication (GSM) seems to be used in many projects to alert drivers (KS Bharadwaj et al.,2021; Hazizan et al., 2019; Rosnee et al., 2021).

Thus, the purpose of this paper is to build a system called Smart Assist Child Car Monitoring (SACCM) that can detect and notify the movement of living things in the car to prevent users from leaving children in the vehicle during the driver's absence. Table 1 shows the comparison between SACCM and other devices developed previously.

Table 1. Comparison between SACCM and other devices.

Author	Year	Device	Device (SACCM)
A. Hazizan et al.	2020	Arduino, GSM Module	GSM SIM900A v 3.8.3, ESP-32 Camera Module, Reset Button
D. Sugumar et al.	2020	IoT, GSM Module	
Paolo Visconti1 et al.	2020	Arduino	
Arakawa, T.	2021	Heartbeat Sensor	PIR Motion Sensor, Car Seat Pressure Sensor Pad
Hina Alam et al.	2023	Temperature Sensor	
Paolo Visconti1 et al.	2020	RF Sensor	
Hina Alam et al.	2023	Rasberry Pi, Node MCU ESP 8266	Node MCU ESP 8266, Buzzer

2. METHOD & MATERIAL

SACCM uses the car seat pressure sensor to detect whether the driver's seat has been occupied. The data collected by these sensors are used for purposes such as occupant detection, child safety, comfort features and passenger monitoring in vehicles. The next important device included in SACCM is the Passive Infrared (PIR) Sensor to detect human presence through movement and temperature, utilizing four pyroelectric elements wired in parallel. PIR has been applied in a variety of applications, including smart homes, smart cities, and biomedical applications such as resting heart rate estimation and epilepsy seizure detection (Abedi et al.,2021). When there is a significant change in infrared radiation between the elements, the PIR sensor will be activated, providing a quick response to changes in the environment.

Next, the NodeMCU is an open-source platform that uses an ESP8266 Wi-Fi chip with TCP/IP protocol. SACCM is also included with a buzzer for early notification as an alert. Given that people are progressively linked to their smart devices these days, it is worth investing in a setup that could save a child's life by sending messages as an alert.

The other hardware modules used to develop SACCM as presented in Table 2.

Table 2. SACCM Hardware Module Function.

No	Name	Description
1	PIR Motion Sensor	To detect movement
2	ESP-32 Camera Module	To capture and send images to Telegram
3	Buzzer	To alert the driver and people around the car
4	GSM SIM900A v 3.8.3	To send messages and make phone calls
5	NodeMcu ESP 8266	As microcontroller
6	Reset Button	To activate and turn off the buzzer
7	Car Seat Pressure Sensor Pad	To detect the driver's weight in the driver's seat

Figure 2 shows the SACCM in a casing, and Figure 3 shows the SCAMM in a circuit drawing connecting all the hardware modules. SACCM was placed in a casing to secure the hardware components.

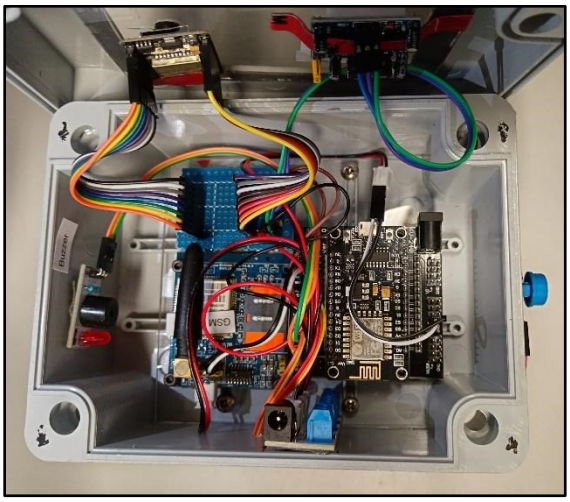

Figure 2. SACCM in the casing.

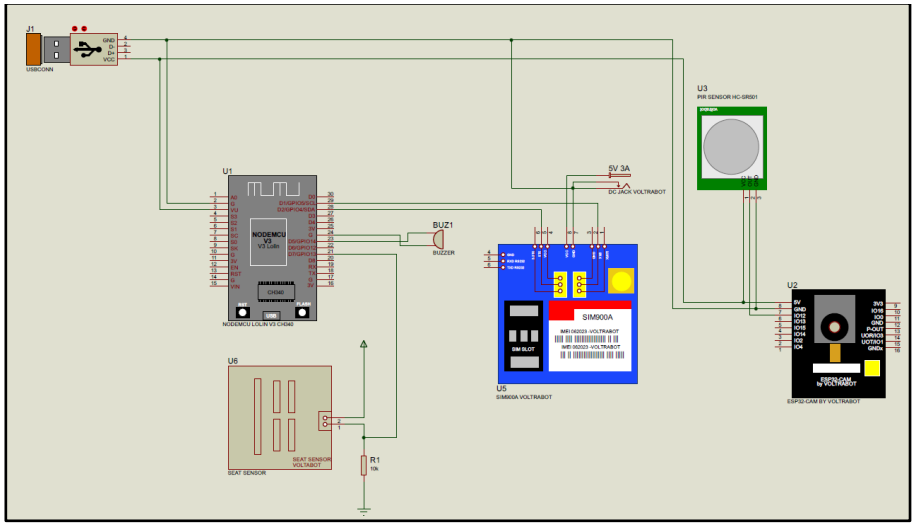

Figure 3. SACCM circuit.

Figure 4 shows the position of SACCM in the car during the testing in the Proton Saga Iswara. SACCM is placed on the window behind the driver's seat. The positioning of the SACCM to enable motion detected in the backseat since most of the cases involved childeren being left at the back of the car. The buzzer will ring after ten (10) seconds after the driver gets up from the driver's seat. This is to indicate the absence of the driver in the car. The coding configuration was developed using C/C++ language.

Figure 4. SACCM in the vehicle.

Next, the buzzer will ring when movements are detected, and an alert notification, "ALERT! Person in the car", will be sent to the driver, as in Figure 5. Besides, the image captured would be sent to the Telegram application, as in Figure 6. The message would be sent repeatedly every time movements are detected. The notifications only stop when the driver comes to the car and presses the reset button on SACCM. As a precaution, in case the parents did not notice the messages, a call would be made to the driver, as in Figure 7.

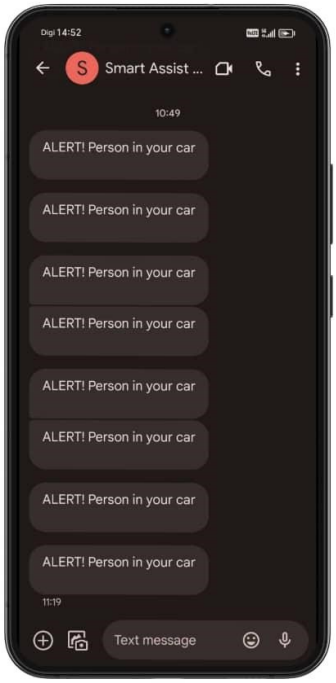

Figure 5. Notification message to the driver.

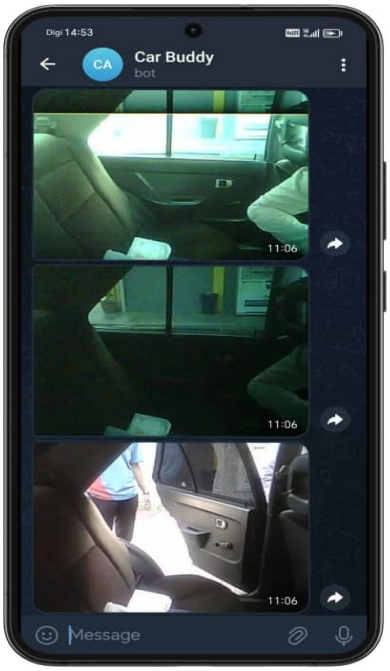

Figure 6. Picture notification sent to Telegram.

Figure 7. Calls were made to the driver.

In a nutshell, SACCM is a project developed to alert parents in case children are accidentally left in the car. It integrates sensor technology, a buzzer as an alert, and an alert notification system via short message service, a Telegram application, and phone calls. After SACCM was developed, it was tested in the car, and it proved to function as intended.

3. FINDINGS

Smart Assist Child Car Monitoring (SACCM) is a very useful product for ensuring the safety of a child trapped inside the car while their parent is not around. Product testing was handled after it was developed and to test the functionality. After the testing process, researchers handled surveys to test the functionality of SACCM. We managed to collect surveys from thirty-one (31) respondents. Responses from users are beneficial for possible improvements that can improve the quality of this product to work better and more efficiently.

Table 3. Survey results.

No	Item	Percentage (%)
1	Parents less worry	93.5
2	Alert notification system worked	100
3	Product easy to manage	96.8
4	Product effectiveness	94.73

Table 3 shows the overall results from the respondents for four questions asked of them. All the questions recorded responses higher than 90%, which indicates positive satisfaction from the respondents. The respondents agreed that this product helps lessen parents' worries if they accidentally leave their kids in the car. In addition, respondents believe that SACCM is very easy to manage and suits the needs of working parents out there. Last but not least, it can be concluded that the functionality of this SACCM is in good condition and able to operate correctly.

4. DISCUSSION

This SACCM consists of a motion sensor, camera, buzzer, GSM module, microcontroller, reset button, and pressure sensor pad. It can notify drivers via buzzer sound, message and picture notification, and calls. As it is still in the early stages, SACCM is placed at the window to detect movement. This placement would not be suitable in the long run, as it disables the usage of the window. Besides, one of the comments in the review was the size of of SACCM. It is recommended to fit it in a smaller box. Other than that, SACCM itself can provide a secure system for the safety of children. The alert notification is very useful to ensure the safety of the child who is trapped or forgotten inside the car. Parents will be aware of the presence of their children inside the vehicle. By using SACCM, death cases due to this situation could be avoided. Besides, the development of SACCM involved simple components that can be found in the current market.

5. CONCLUSION

The SACCM project may not provide an absolute solution to the problem, but it is an excellent initiative to solve the issue of parents leaving their children in the vehicle. The statistics provided in the introduction show the urgent need for an effective solution. A high percentage of the cases indicate that parents do not leave their children knowingly in the car. Thus, the development of SACCM would be beneficial to parents who have younger children, especially. The seat pressure in the driver's seat could detect the absence of a driver, and when there is movement in the car, messages are automatically sent to the driver.

However, certain improvements could be made to SACCM such as increasing its accessibility to users more widely. This project could also use features such as viewing inside the vehicle live. Besides, the use of a 360-degree camera could overcome the shortcomings in image quality and include more viewpoints. Next, the placement of SACCM at the window would not be suitable for the long term. A more appropriate location could be behind the dashboard or the top of the car's roof. Overall,

the project's approach of using sensors and warning notifications, is a positive step in addressing the problem and helpful solutions for parents.

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