

A Review of Unattended Child Presence Detection System for ASEAN NCAP Safety Rating

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REVIEW

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Abstract – Safety aspects in the automotive industry have undergone various enhancements but there is still much work to be done pertaining to the safety of stationary vehicles. As ASEAN inches toward becoming a developed region, children are increasingly being moved around every day in automobiles almost exclusively. There are few studies conducted to address public awareness regarding safety of child passengers in vehicles in Southeast Asia. In certain cases, children are deliberately left behind in parked automobiles. On the basis of a case study data as gathered by Null (2016), about half of all children's heat stroke casualties in vehicles were due to parents leaving a child unintentionally in the car, while approximately 29 percent were due to children amusing themselves in parked vehicles, and another 18 percent were due to children being left intentionally by their caretakers. Admittedly, vehicular hyperthermia and heatstroke have devastating effects on a child being locked in a car. This study aims to assist in the development of a protocol for ASEAN NCAP Roadmap for the COP (Child Occupant Protection). In the second portion of the study, a technique will be developed for building a system to identify and respond to unattended children. This inexpensive technique will increase safety of vehicles in ASEAN countries.

Keywords: Child presence detection, safety design, ASEAN NCAP, Child Occupant Protection (COP)

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1.0 INTRODUCTION

Injuries as well as deaths related to automobiles is a troubling issue worldwide. In the automotive domain, the safety aspects have been tremendously enhanced, but much remains to be done in the area of stationary vehicle safety. Vehicular hypothermia and heatstroke bring devastating effects to a child locked in a car. Though it is an unimaginable nightmare for the parents, the situation has been reported many times. Sadly, as revealed by the organisation for

safety, Kids and Cars (2010), 37 small children lose their lives on average due to being locked in the car. These involved events where a child locked himself or herself accidentally in an automobile or its trunk, was forgotten by parents in a car, or in a few instances, was left intentionally in the car.

These events bring about awareness in the society regarding entrapment of children in a car. Still, there have been 117 passenger entrapment casualties reported (Hardie & Gamber, 2004). Thus, it is imperative to design safety techniques which focus on the child seat (or passenger compartment) to reduce cases of injury or death in non-traffic accidents involving children, which in this case is due to children entrapment. In the stationary car deaths, most of the children are below 5 years old, with a majority of them left unattended. In addition, 45% of them were discovered wearing seat belt in the passenger seat. In some cases, the cause of death was due to lack of oxygen in the car. The reaction of the body to extreme heat is a complicated biological process which depends on various factors and will likely result in a heat-related death.

In 2014, at least 30 children were killed due to heat stroke in a locked automobile as per the data gathered by a San Jose State University researcher (Null, 2016). Null stated that between 1998 and 2014, an average of 38 children have been killed every year due to heat stroke in a locked automobile in the USA. In addition, NHTSA review of non-traffic instances in 2007 discovered that heat stroke (hyperthermia) was the 3rd most common non-traffic automotive-related fatality cause for children aged 14 and below (NHTSA, 2009).

In certain cases, children are deliberately left behind in parked automobiles. On the basis of a case study data as gathered by Null, about half of all children's heat stroke casualties in vehicles were due to parents leaving a child unintentionally in the car, while approximately 29% were due to children amusing themselves in parked vehicles, and another 18% were due to children being left intentionally by their caretakers (Null, 2016).

There are reports regarding similar cases in Malaysia. In a recent event, a 2-year-old girl was killed after she was left in a car at an outdoor parking space. A 5-year-old boy left in his mother's automobile for nearly 6 hours was found unresponsive. He was pronounced dead after being brought to the hospital although a high body temperature was not reported. The preliminary weather investigation for that duration showed that the outdoor temperature was between 24 and 31°C (Hisham et al., 2015). Such a tragic incident (among several others) reminds us of the danger of leaving children unattended in locked cars.

As Malaysia inches toward becoming a developed country, children are increasingly being moved around every day in automobiles almost exclusively. There are few studies conducted to address public awareness regarding safety of child passengers in vehicles in Malaysia. There have been articles and announcements in the newspaper and other print media, as well as internet, radio, TV announcements promoting safety of automobile users and reminding us to use seat belts, helmets and reflective clothing. Nevertheless, a common observation is that not all Malaysians abide by the law (Sivasankar et al., 2014). Because of the increase of automobile in Malaysia, it is important to carry out a comprehensive analysis of interventions so as to enhance children's safety in the automobile (Kulanthayan et al., 2010).

There is a greater surface area to body mass ratio in children, which causes more absorption of heat in extreme weather conditions. Their smaller volume of blood limits their capacity to transfer heat from the centre to their edge, from where the heat can be transferred

outside. Another major difference in children with regards to thermal regulation is the mechanism of sweating, which is not as effective in comparison to adults (Falk, 1998). These parameters lead to children being highly prone to developing hyperthermia in hot weather, especially in a locked automobile.

2.0 MALAYSIA DEMOGRAPHIC RELEVANCE TO CHILD PRESENCE DETECTION

Comparing both local and global incidents, there exists a slight difference. In a majority of global cases, most of the children were left unattended in the passenger seat in comparison to the local incidents. This probably stems from the lack of a policy in Malaysia regarding the use of CRS for children. It has been established that child control law can effectively increase the child seat use (Paiman et al. 2018). In New Zealand, the induction of laws regarding child seats has increased its use by 15 percent, and resulting in 89 percent use of child seat by 2015 (New Zealand Ministry of Transport, 2017). In Australia, introduction of these laws has triggered an increase of 99 percent use of child seats (Brown et al., 2010).

In certain western countries, it is mandatory to use child seats for children in a car. Moreover, there are laws regarding this problem. California was the earliest state to make compulsory the use of child restraint system for children up to 6 years old, or weighing up to 60 lbs. Earlier laws stopped at 40 lbs. or age four, leaving a gap of “forgotten kids,” or those too big for forward-facing or rear-facing car seats, yet still considered small for the automobile’s standard lap and shoulder belts (Paquin et al., 2002).

Thus, it is a good idea to devise safety equipment which aims at the child seat (passenger compartment) to reduce injuries and deaths caused by fatal non-traffic occurrences involving children, or incidents of child entrapment. As stated by McGeehin and Mirabelli (2001), most stationary vehicle-related deaths involved children who are under 5, and most of them were left unaccompanied with 45 percent discovered still with their seat belts on. In certain cases, their death was due to lack of oxygen. The reaction of the body to extreme heat is a complicated biological process which depends on many factors, and eventually results in a heat-related death.

Later in 2011, NHTSA began reviewing prospective technology-based solutions for the problem of forgotten children by sponsoring a research to evaluate the current situation and assess available electronic devices to alert the caretaker when a child is locked in an automobile. NHTSA identified more products which are intended to avoid children being forgotten that were introduced in late 2014. Moreover, several of the products which were earlier assessed have undergone improvements by the manufacturers in terms of their performance.

3.0 SAFETY AWARENESS WORLDWIDE

These cases bring about an increase of awareness about child entrapment incidents worldwide. There are laws in some nations regarding the awareness of child safety. The current information on all laws regarding child seats in the USA is updated by Insurance Institute for Highway Safety (IIHS) and can be accessed at www.iihs.org/laws/ChildRestraint.aspx. Even though the laws are to ensure the suitable use of all sorts of child seats (e.g. belt positioning booster seats and CSSs), the modified laws commonly became popular as “booster seat laws.”

Outcomes of further studies of the relation between a booster seat law and the changes in the use of child seat in US suggested that laws intended for children between aged 4 to 7 increase the child restraint use by 39 percent among children in this range of ages (Winston et al., 2007). A focus-group review of offenders of California's law of child seat revealed that several complex aspects influence consistent child seat use (Agran et al., 2004). When the study was conducted, the California law necessitated children below 4 years old and weighing less than 40 lbs. to be appropriately secured in a child seat that fulfils federal standards. Parents who breached the law gave several factors, which included unsolicited access to an automobile, trip conditions, style of parenting, and refusal of the child, which affected child seat use. Parents who had been fined for not securing their kids were mandated to attend a class on child safety in a car. It was found to be more beneficial and increase their knowledge regarding issues of child passenger safety in comparison to only punishing them with a fine (Agran et al., 2004).

In developed nations, due to the upsurge in accidents related to child in a car, there have been calls to modify safety policy so as to immediately reduce the amount of automobile accidents as well as deaths. As a consequence, a high number of laws and regulations were passed like compelling motorcycle helmet use (1973) and superior design criteria (1977 and 1980); strict competence examinations, and decreasing the duration of provisional licence validity (1982); and limiting the engine capacity for vehicle learners (1983) (Chesham et al., 1993). Because of an increase of automobiles in Malaysia, it is essential to perform a comprehensive analysis of the interventions so as to enhance the safety of the child passengers (Kulanthayan et al., 2010).

4.0 THE ISSUE OF CHILD DETECTION AMONG NCAPS

The issue regarding public awareness of safety has raised alarm among the NCAP community. The inability of a child to get out of the vehicle without any help combined with low tolerance for extreme temperatures necessitates that children must never be left unaccompanied in a car (Euro NCAP, 2015). As per Euro NCAP roadmap 2025, a technical solution would be introduced and shall be employed by 2022 to track a child in a car and notify the owner of the car or emergency facilities should the circumstances become harmful. Euro NCAP will compensate the producers that provide these solutions as standard. Currently, this safety issue is also dealt with in other NCAPs such as ASEAN NCAP.

5.0 TYPE OF CHILD PRESENCE DETECTION

Smart system for safety seat is equipped with air vents, occupant sensors, thermistors as well as logic controller. The number of child deaths in this region due to being left unattended in the car has motivated the analysis and development of a smart system for safety seat. This system is proposed to save lives, raise awareness of safety of a parked vehicle, and bring about awareness among the caretakers regarding the requirement of safety devices in case of entrapment. Such a system could motivate further research of entrapment incidents, clearing the way for innovative approaches for ground vehicle safety. Because of the non-chaotic characteristic of static automobiles and the comparatively simple way in which kids get entrapped, these lifesaving techniques should be more efficient. In general, the equipment and the smart safety seat system for child restraint may avoid deaths due to entrapment.

The designed system for smart safety seats for child restraint utilises an intuitive technique to alert the driver when a child is locked in a car. The introduction of automobile

mechatronic systems for transmission, engine, and chassis control has facilitated improved vehicle performance, enhanced fuel economy, decreased tailpipe emissions, and enhance occupant safety (Barron & Power, 1996). One of the enabling innovations is the availability of affordable electronic devices, automotive sensors, and actuators which can be added for real-time tracking and control (Chowanietz, 1995). The elements of the simple system for smart safety seat have been discussed individually. An indicator embedded in the child seat alerts the driver regarding the occupancy status of the seat. If the seat is occupied, the driver can check the local temperature through a sensor and determines the level of danger to the passenger. In case the controller comes to know that the passenger is exposed to high temperature, it works as a suitable alarm. A warning can also be given if the temperature rises too fast. This danger level is confirmed from gathered empirical data.

There have been several research works on this subject in recent years. In the design patented by Morningstar (2007), the alarm system will warn the parents instantly when the child is left inside the car. As displayed in Figure 1, as soon as the driver opens the seat belt, the automatic system will test the pressure pad or a protected child side lap belt in order to check whether the child is still in the seat or not. If the child is still seated, the system will alert the caretaker instantly. The alarm would also contain a calm audio like a lullaby, a story, or a song. The system can be combined with the OEM elements to give an alert escalation procedure using a vehicle alert, a local alert, a Wireless alert as well as a particular 911 alert.

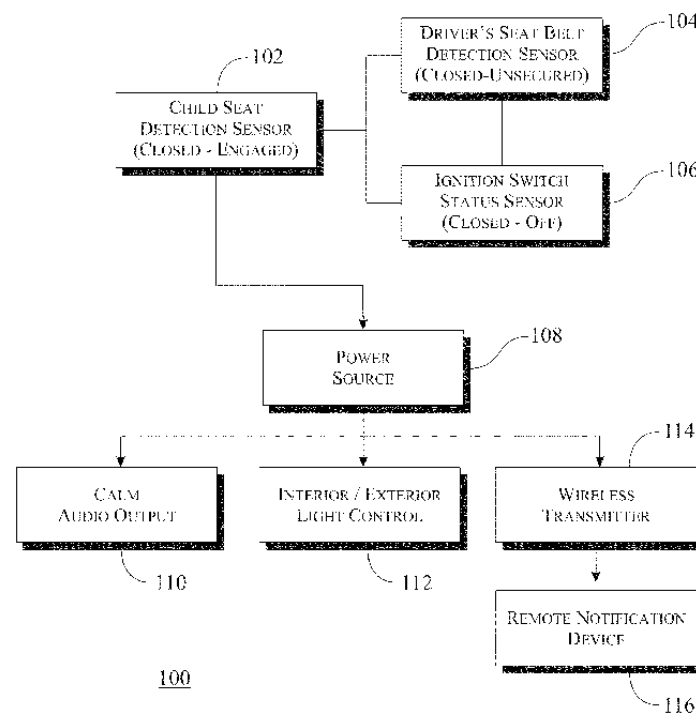


Figure 1: Block Diagram of the warning system by Morningstar (2007)

For Owens (2008), the task is performed by using the sensor for presence which checks the child's presence in the child seat, whereas the sensor for proximity measures the approximate distance between the child seat and the wireless receiver. If the sensor for proximity detects that the distance is large and the child is still in its seat, then it will transmit a warning to the wireless receiver to generate an alarm to inform the driver or the parents. With a thermoelectric and unit for temperature control added in the equipment, it senses the

temperature to make sure that it is safe for the child. This equipment can decrease heatstroke risk among children. All the sensors and the details of the sensors were displayed in the Figure 2 and Table 1.

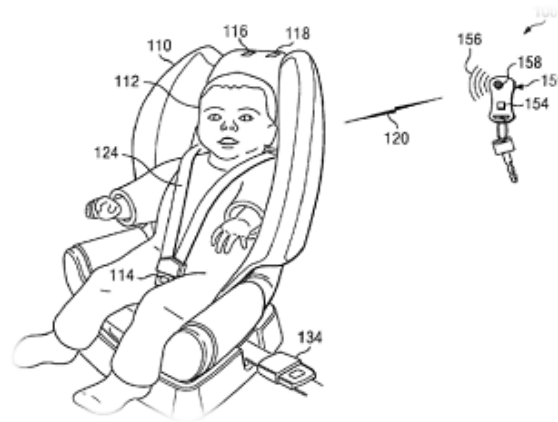


Figure 2: Layout of child safety seat system equipped with sensor and notification setting proposed by Owens (2008)

Table 1: Details of numbering in Figure 2

No.	Details	No.	Details
110	child safety seat	124	a restraint
112	a child	134	seat belt of vehicle
114	presence sensor	150	wireless receiver
116	proximity sensor	154	proximity sensor
118	a transmitter	156	an alert
120	wireless signal	158	a speaker

In the research of Davisson et al. (2011) as displayed in Figure 3, the warning system is developed to detect the presence of child in the seat and alerts the caretaker, or when the caretaker has reached an unacceptable distance from the car, or there is an increase in the temperature inside the car to an undesirable amount. The system for child seat presence detection has a remote unit for the caretaker and another unit fixed to the child seat which is in contact with the remote unit. As the caretaker gets to a distance which is out of range, the base unit and the remote unit are activated through an alarm.

The remote and the base units can be designed to detect and interact with one or more remote units. Similar to the earlier design, a sensor for temperature is added into the equipment to track the temperature inside the vehicle. In case the temperature is increased above the tolerable amount, the base and the remote units' alarm will be activated. This design is convenient, light-weight, and is easy to transfer from one car to another.

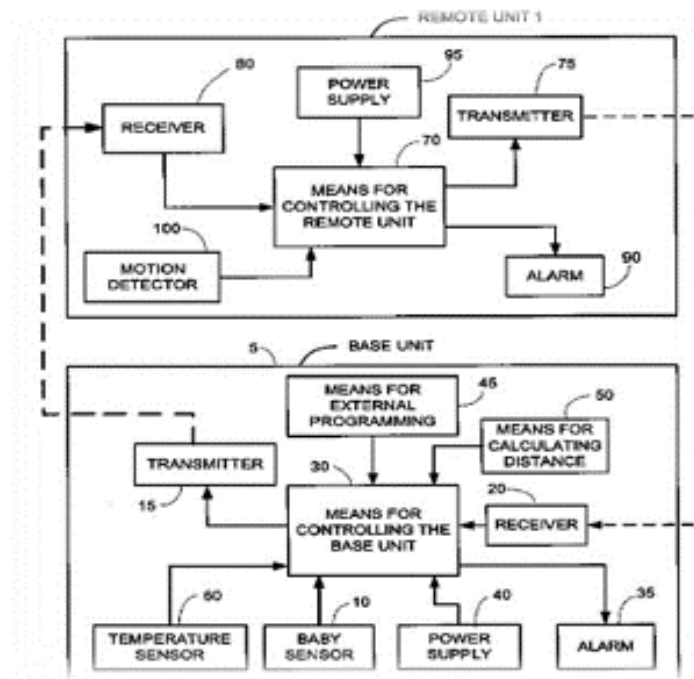


Figure 3: Block diagram of the baby seat occupant detection system comprising one remote unit and one base unit, by Davisson et al. (2011)

Hashim et al. (2014), on the other hand, has designed a system as shown in Figure 4 which detects any movement and sound in the vehicle when the child is locked behind, and sends an alert through SMS (Short Message Service).

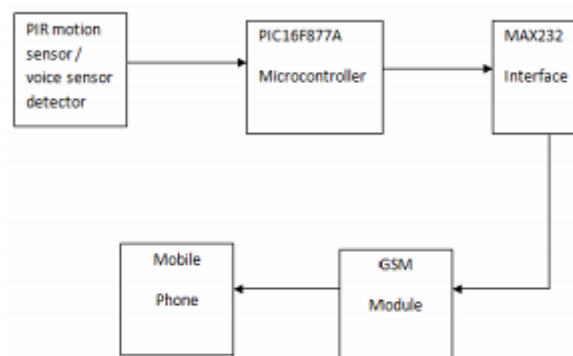


Figure 4: Detection system flow diagram by Hashim et al (2014)

As shown in Figure 4 above, this system includes two operational parts, namely software and hardware. A microcontroller, a GSM module and a motion detector are the primary elements employed in this design. Warnings are given when voice or motion is sensed. The microprocessor receives the signal automatically from the detectors and shall instruct the GSM module to send an SMS to the caretaker's device.

However, it should be noted that the majority of the reviews looked at the warning system with sensors that sensed the presence of a child in the vehicle. Besides the fundamental investigation (as discussed above), the integration with the present technology to make it more portable and user-friendly has not yet been exhaustively examined.

6.0 MOVING FORWARD

Safety on the road is a responsibility that has to be shared by everyone. At the same time, the government is also responsible. Though the government is not to blame for any mishaps on the road, its responsibility concerning the road safety is not to be undermined (Eureka Africa, 2018). As far as this issue is concerned, it is absolutely necessary to establish safety procedures, systems and framework regarding Child Presence Detection System in a country. Every country needs the necessary safety policies to make children's safety a certainty and the government of the day is responsible to create legislations, policies and regulations to prevent these incidents. Policies, regulations and laws are ineffective if they are not followed and enforced. That means the administration, security systems, law enforcement department and other agencies must implement the policies in order to ensure road safety (Peden et al., 2004).

According to the Transport Safety Council of Europe (2001), road safety management is viewed almost entirely as a matter of the government, especially that which should be handled by the Transport Ministries. The governmental administrative department has to provide vision, policies and strategies at regional, national and global level through legislation and regulations to ensure public safety. In certain areas, private firms have fundamental obligations and their activities can add value in several ways. The stimulus of the market forces to accelerate, follow or enhance legislative requirements is just one instance. However, a simple fact is that an integrated approach between the private and the public sector at all levels can prove to be of potential.

Absence of awareness and knowledge regarding the safety of the child passengers has proved to be the most significant factor with respect to the low use of children safety seats. Effective interventions are therefore required without delay to improve the awareness of parents prior to the enactment and implementation of the relevant laws. It is the responsibility of the parents to ensure the safety of their children (Liu et al., 2016). Each year, there are cases of children who die or are severely injured on the roads – mostly since they are not adequately secured when travelling in a car (WHO, 2015). Parents are required to understand the regulations and provide the best possible safety for their children. It is also the responsibility of the parents not to leave the children unattended in a car, even for a short while. As mentioned by NHTSA (National Highway Traffic Safety Administration), when the temperature is 90 degrees outside, it takes only 10 minutes for it to reach 109 degrees inside the vehicle which can prove to be fatal. On average, 38 children die every year in hot cars from heat-related deaths when they are locked inside. On a clear 70-degree day, it takes only 30 minutes for the temperature to rise to 104 degrees inside a car. After an hour, it can touch 113 degrees.

7.0 CONCLUSION

This paper has discussed the issues regarding child car passengers. If we compare the current laws in New Zealand, the UK, the USA, and Australia, it is apparent that there are differences among these nations. The law is not always able to determine the result of how drivers or parents safeguard their children. They also require suggestions regarding the safety of children travelling as passengers in a car. These suggestions are comprehensive and will often improve child safety a bit more than is demanded by the law. In all these nations, both the laws and the recommendations have been introduced regarding safety of children. However, currently there are no consistent laws and regulations to ensure child safety.

Awareness programs for parents (in the form of counselling) about road safety must be conducted and relevant literature must be provided. This includes knowledge regarding the possible dangers of heat related incidents. As a matter of fact, such incidents are mostly accidental and legal steps may not prove to be effective.

In summary, the use of a system for detection of child presence can be the key to reduce the risks of children being left unattended in a car. The system is aimed at the prevention of such undesirable incidents. In this research, it is clear that ASEAN NCAP evaluation of the System of Child Presence Detection is absolutely necessary and the relevant system must be made compulsory in the ASEAN region. Also, the System for Child Presence Detection must be put into practice as soon as possible.

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