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Minimizing Heatstroke Incidents for Young Children Left inside Vehicle

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Abstract. The number of children dying because of heatstroke after being left in the car is worrying. From 1998, there are about 618 children have died in the United State of America (USA) because of heatstroke. It was the leading cause of fatalities in non-crash incident in USA. The same situation also arises in other countries. Life stress is being identified as among the factor that lead to this incident. In this paper, we proposed the used of Android Apps with an Estimote Beacon, a bluetooth device, to warn parents or guardians about their children being left in the car. An alarm will be raised after the parent leaves their children at pre-specified range to avoid any risk of heatstroke from occurring.

1. Introduction

Heatstroke can occurs in hot environments that cause severe elevation in body temperature with central nervous system dysfunction [1]. It can lead to acute condition including combativeness, delirium, seizures, coma and even lead to the death. In USA, there are 618 children have died because of heatstroke [2]. According to the Department of Earth and Climate Sciences, San Francisco State University [2], each year, an average 38 children in the United States alone die from hyperthermia as a result of being left unattended in locked vehicles. In Malaysia, there are four cases of children dying in the car because of the same reason in the year 2011 and 2014 [3].

Usually, a child at the backseat tends to fall asleep in moving car [4]. When reaching at destination, parent can unintentionally forgotten their child who is quiet and asleep at the back and just go out from the car and leave them. In one experiment in [5], using 1 year infant as a subject model, researchers discover that despite the difference in starting temperature and solar radiation level, the model infant experienced heat stroke and demise before 2.00 pm after being left alone in the vehicle from 8.00 am. While this paper is being written, there is another case had occurred in Malaysia where the father only realizes their child was left that the back seat only at 3.00pm [6]. According to the doctor, the child has died because of suffocation. According to [7][8], increasing life-stress level in daily life contributes the rise in the number of cases. It has been a problem in every part of the world [9].

Looking at the statistic and the impact that cause by this incident, it is very paramount to have a system that could remind the parent on this. This research proposes the use of Android apps on smartphone and Bluetooth device for two reasons: (i) it is a common device that owns by almost all parents (ii) the blue tooth connection is free. This paper is organized into the following sections:

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Section 1 is on introduction, Section 2 is on Background, Section 3 is on Implementation, Section4 is Results and Discussion and Section 5 is on the Conclusion.

2. Background

Heat stroke can happen within a very short time frame. An experiment has been conducted to measure the time taken for temperature in the car to rise [10]. It shows that within 1.5 minutes after the car being left, the temperature in car can rise to 30.4^0c. After 8 minutes it will raise to 40.5^0c and this is when heat stroke can occur. The body's temperature can exceeds 40^0C at this temperature level. In 15 minutes it is considered deadly where the body temperature can reach 41.7^0C.

2.1 Related Works

There are number of system has been proposed to solve this problem. In [11], a multi agent system is proposed to monitor the safety of the children in the car. The system includes Coordinator agent, the temperature agent, the GPS agent, the Sound Agent and the Motion Agent. Each agent has their own task such as Temperature agent is to report the temperature inside the car and Motion agent to detect the movement of the baby. When all the agents have done their reporting, the coordinator can decide whether the child is at risk of getting heatstroke. If yes, the coordinator will inform the parent through the smartphone. In another work [8], they used Global System Mobile (GSM) and sensors to inform a real monitoring system detect heat stroke occurrence in a vehicle. The system is powered by solar panel to ensure it always working. There are also other works such as [12] and [13] that aim to avoid a child being left in the vehicle.

2.2 Bluetooth

Bluetooth is a wireless communication that invented a telecommunication vendor Ericson in 1994 [14]. It was intended to replace serial connections in RS-232 cables, It allows up to seven devices to be linked to a master device based on the master and slave concepts [14]. It provides low power consumption, low cost and secure connection [15]. Nowadays all smartphones and notebooks are equipped with Bluetooth technology for ease of communication within short range where it can reach up to 8 meters of coverage area [15].

2.3 Estimote Beacon

Estimote Beacon is a device that connects with smartphone through a Bluetooth connection. It has its own unique ID which can be used to identify object attached to it. It has been used mostly in a shop where it is attached to merchandise and will give a pop-up advertisement when a smart phone that have been installed with the required application approaching. It gives information to the user on the details of the merchandise such as the price, discount and other relevant information. It got its own battery that make the detection range with the smart phone longer. We will use this device to detect a child using a beacon attached to them. Table 1 shows the specification of the Estimote Beacon device [16].

Table 1. Specification for Estimote Beacon device

Feature	**Value**
Frequency range	2400 MHz to 2483.5 MHz
Frequency stability	<=20ppm
Flash memory	256kb
Power Output	4dBm
Bandwidth of emission	500KHz
Sensitivity	-93dBm
CPU	32-bit ARM® Cortex M0

3. Implementation

We proposed two versions of apps. First apps is by using the accelerometer sensor and second is by using the Bluetooth device. Every smartphone is equipped with an accelerometer sensor. This sensor can be used to detect movement by the user. Among the apps that use this sensor is the pedometer application where user can monitor how many steps they have walked. To monitor the children, the idea of the apps is easy, an alarm will be raised when the user start walking. The most critical time is when the parent leaving their vehicle and go to the office. It is very critical if they have forgotten that they still have their children inside the car. The accelerometer sensor will detect the movement of the user and raised the alarm to remind them. The drawback of this method is: the alarm will keep ringing when the user is moving. To solve this, the alarm can be set to be active only at certain time, let say from 7.00 am to 8.00am where it is the time when the parent will arrive at their office. The algorithm is shown in Figure 1.

Algorithm 1: KidCare Alarm

```
1.  Begin
2.  FOR each step
3.  step++
4.      IF ( step > 5 )
5.          Raise alarm
6.      ENDIF
7.  ENDFOR
8.  END
```

Figure 1. KidCare Alarm via Accelerometer sensor

The limitation of the first apps is can be used at a pre-specified time only. In reality we travel not only to the office but also to other place such as supermarket at unspecified time. To overcome this, we proposed the used of Bluetooth device that can connect to the smartphone. The alarm will be raised if the device is located more than a pre-specified range from the smartphone. For the experiment, we use Estimote Beacon as the Bluetooth device. The Estimote Beacon will be attached to the children as shown in the system overview in Figure 2.

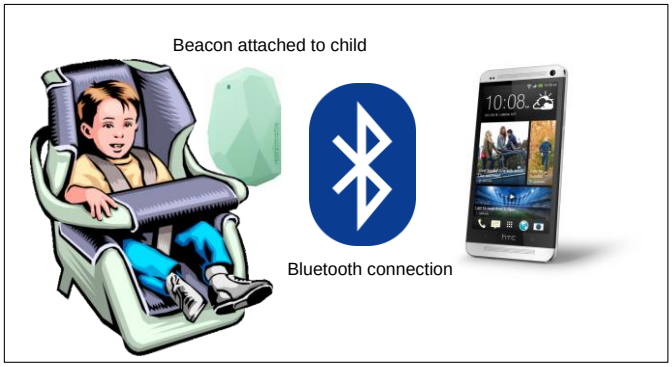


Figure 2. The system connection overview

In Algorithm 2 (shown in Figure 3), for each incoming signal from the beacon, the apps will calculate the distance from the smartphone. If the distance is more than specified threshold, it will raise the alarm. In the algorithm, the threshold is set at 5 meters. By using beacon, the application can be deactivate whenever the children have been sent to the intended place or just leave it open if the children will be with them. In the next section, we will discuss on the experiments results and other usages of the application.

Algorithm 2: KidCare Alarm via Bluetooth
Requirement: Establish Bluetooth connection
Begin
1. FOR each incoming signal
2. IF (signal > 5)
3. Raise alarm
4. ENDIF
5. ENDFOR

Figure 3. KidCare Alarm via Accelerometer sensor

4. Results and Discussion

In our experiment, we use Samsung Galaxy Grand Prime (SM-G530H) that installed with Android OS v4.4.4 (KitKat) and Bluetooth v4.0 A2DP. The smartphone is tested to detect Estimote Beacon detection range under different locations. The result is presented in Table 2.

Table 2. Detection range from different locations

Location of Beacon	Maximum Range
Inside a car (Windows fully closed)	10 meters
Inside a car (windows open)	15 meters
Open space (no blocks)	30 meters
Open space (with blocks)	20 meters

The detection range recorded for the Beacon shows that it is suitable to be used with KidCare Alarm Apps. We do not need a very far distance to give warning to the parent if they left their children behind. Few meters of detection range is enough to make the apps workable. This means that users also have the option to use any other Bluetooth device such as the Bluetooth headset and even the car Bluetooth system itself. Figure 4 shows the interface of KidCare Alarm Apps.

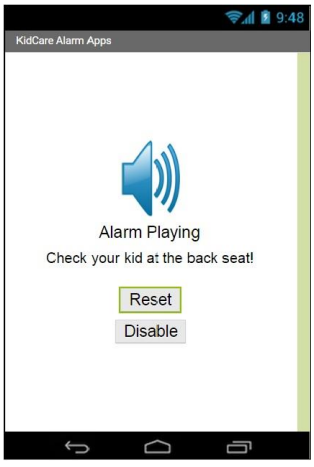


Figure 4. The interface of the KidCare Alarm Apps

The wider range for Beacon also has opened up another usage for the apps: to monitor the distance of the Beacon bearer. There are also many incidents involving children missing while going out with their parent. The parent can be distracted while in shopping complex and left the children unattended. If the beacon is attached to the children, it can give warnings if the child moves to far from them. Another potential application is students monitoring by the teacher when they are on school visit. The number of students sometimes can be too many to be monitored by a limited number of teachers. The

beacon also can be attached to precious items like notebook or tablet so that user will be alarmed if the item is taken away from them.

5. Conclusion

The use of KidCare Alarm apps hopefully can help minimizing the risks of children being left in the car. No wants this kind of incident to happen but sometimes it did happens and prevention is critically needed. The apps are now to be perfected and will be available to be downloaded in near time future. Research is going on to select cheaper device but with the same reliability to be used with the apps to make it affordable to all level of the society. However, the most important thing is parent can cooperate to remind each other especially when involving the life of the beloved family members. For future works, we plan to upgrade the apps to be an Internet-of Things (IOT) application where the user of the apps can connect with each other to remind among themselves if such fatalities is about to occur. It can happen such as user might be distracted and did not look at their smartphone although the alarm has rang to warn them.

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