

Children Tracking System in Indoor and Outdoor Places

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Abstract. The issue of loss or kidnapping children has become unfortunately a widespread phenomenon in many countries. To address this issue, this paper presents a children tracking system. It consists of a small device carried by the child and a mobile application that enables the user to track his child movements by tracking that device. That will be done by using GPS and Bluetooth 4.0 technology to track children in indoor and outdoor locations. For indoor, the application searches for the child by detecting the beacon device using Bluetooth 4.0. And for the outdoor locations, the application uses the GPS/GPRS chip.

Keywords: GPS/GPRS · Bluetooth 4.0 · Beacon

1 Introduction

The issue of missing children in the markets, malls and public places has become a real concern and a major threat to children and their families. Statistics about missing children are shocking. Approximately 100,000 children in Germany, 41,000 children in Canada, and 20,000 children in Spain and Australia are reported missing each year. Also 800,000 children go missing each year in the United States [1]. In India, a child goes missing every eight minutes, 40 % of those children have not been found [2]. Unfortunately, there is a lack of information about the missing children in Saudi Arabia and in the Gulf countries in general, but according to the articles published about this issue, many families have suffered from losing a child and some of them have lost a child for a short duration because he walks away his family and doesn't know his family name, his home address or his neighborhood which delay their return to their families.

To address this issue, this paper presents a children tracking system. It consists of a small device carried by the child and a mobile application that enables the user to track his child movements by tracking that device. That will be done by using GPS and Bluetooth 4.0 technology for tracking the child in indoor and outdoor locations.

For indoor, the application searches for the child by detecting the beacon device using Bluetooth 4.0. And for the outdoor locations, the application uses the GPS/GPRS chip.

The rest of the paper is organized as follows. In Sect. 2, a brief overview of related work is given, followed by the description of the proposed system in Sect. 3. In Sect. 4, results of the usability testing and system testing are discussed. Finally, the Sect. 5 concludes the paper.

2 Related Work

Many systems have been proposed to track and locate children; in some of them researchers use the Global Positioning System (GPS) to locate a child in outdoor places [3–7]. However, GPS and even cell phones are not useful in indoor places. The accuracy of cell phone positioning technology is not sufficient and GPS systems cannot penetrate building and other obstacles. Other systems use alternative technologies for indoor places, such as Bluetooth [8, 9] and RFID [10]. There are many commercial devices used by parents to track and locate their children such as Amber Alert GPS [11], Pocket finder [12], Spark Nano GPS Tracker [13] and iTrail [14].

The proposed and commercialized systems consist of tracking the child's cell phone or tracking the chip carried by the child to locate him. However they are insufficient because they don't support commonly the indoor and outdoor tracking. Furthermore, the size of the tracking device for others systems is not suitable for the child. Also these systems are expensive and not all of them support the Arabic language.

3 System Methodology and Design

The proposed children tracking system consists of developing a mobile application that enables users to track their children movements in indoor and outdoor locations. The child holds a small device and the applications tracks that device. That will be done by using GPS and Bluetooth 4.0 technology for tracking the child in indoor and outdoor locations.

For indoor, the application searches for the child by detecting the beacon device using Bluetooth 4.0. Beacons are small wireless devices that transmit small amount of data to other beacons or smart phones by using Bluetooth 4.0 technology. They consume a little amount of energy, can transmit up to 2.4 GHz Bluetooth signals and serve up to 300 feet space. If the child is found, the distance between the child device and the parent's phone will be displayed on the phone screen. And if the location of the child was not found in the range of Bluetooth 4.0, the application searches the child using GPS/GSM chip. GPS/GSM chip sends an SMS message to the parent's phone containing child location on Google map, and that what we are using for the outdoor locations. Internet connection is not required for all of the services. The architecture of the proposed system is illustrated in Fig. 1.

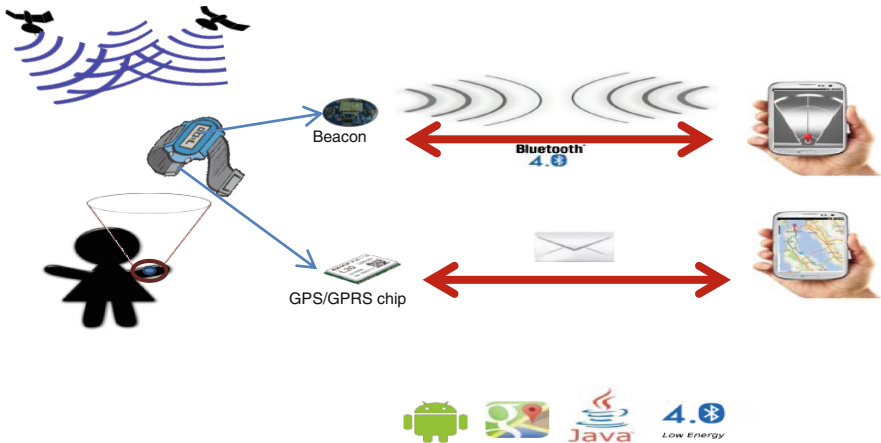


Fig. 1. System architecture

- Step 1:** Search for the child by detecting the beacon device using Bluetooth 4.0. If the child is found, the distance between the device carried by the child and the parent's phone will be displayed.
- Step 2:** If the location of the child was not found in the range of Bluetooth 4.0, the application searches for the child using the GPS/GSM chip, the chip sends an SMS to the parent's phone containing the child location on Google map.

3.1 Flow Chart Diagram

The flow chart diagram, presented in Fig. 2, shows the logical representation of the find function in child tracking system. It starts by searching for a selected device using Bluetooth. After selecting the device, the search starts using Bluetooth first, if the device is found within the Bluetooth range, the location is displayed. Otherwise, if the device is not found, it means that it is out of the Bluetooth range, so the GPS is used in the search process.

3.2 Graphical User Interfaces

When the user runs the application, he can search for his child or one of his children by clicking on the child's profile in the list, as shown in Fig. 3. After clicking on a child's profile, the child's indoor location will be displayed, as illustrated in Fig. 4(a). If the child is out of the range, the user has to click on GPS button, and another GUI is displayed with the child's location on Google map, as shown in Fig. 4(b).

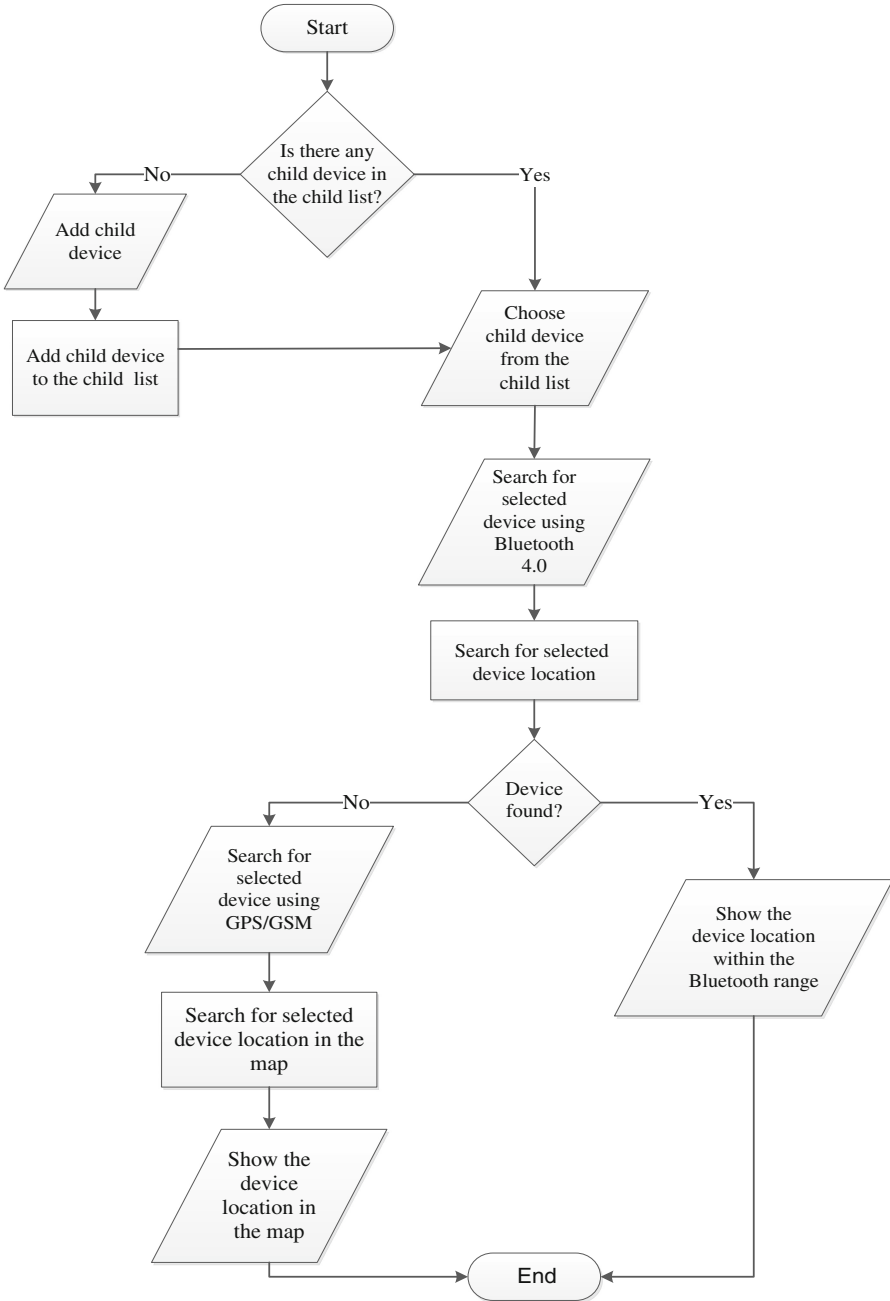
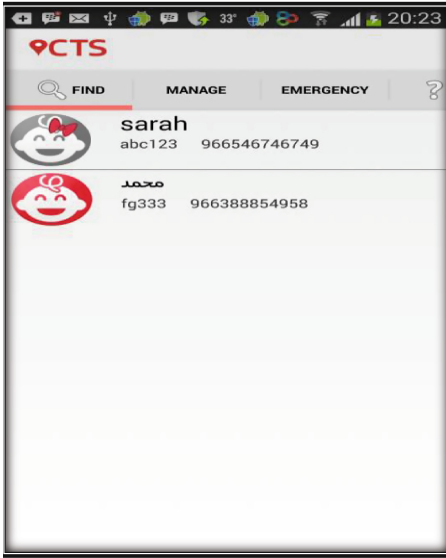
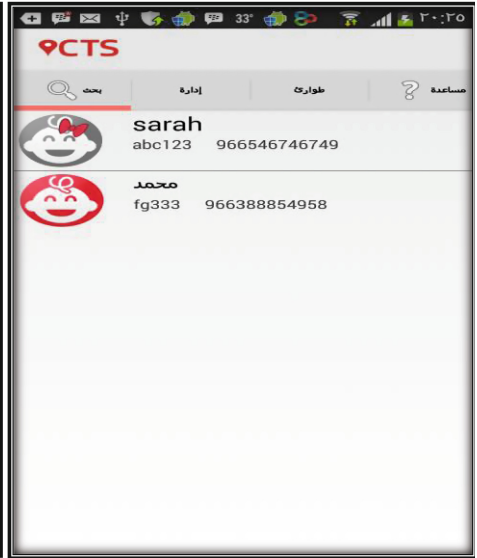


Fig. 2. Flow chart diagram

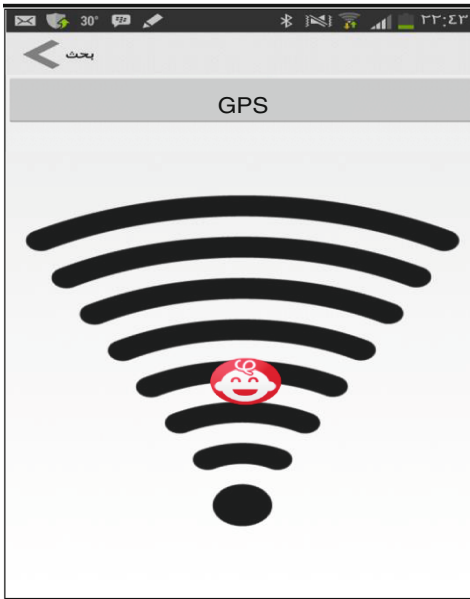


(a)

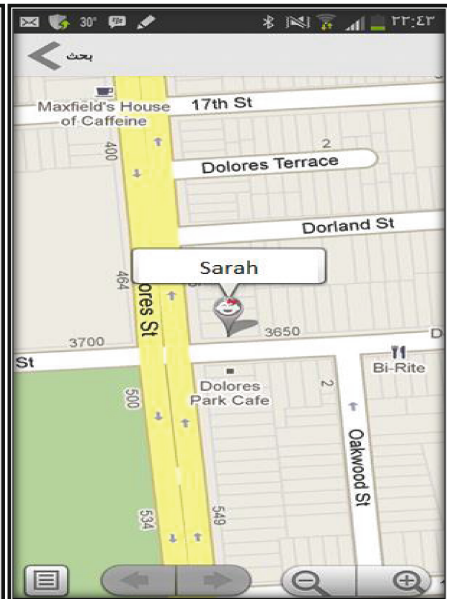


(b)

Fig. 3. Find interface in English (a) and Arabic (b)



(a)



(b)

Fig. 4. Bluetooth finder (a) and GPS finder (b)

4 System Testing

The usability testing of the proposed system was performed by 10 people with different ages; both genders and different level of education. Tasks are given in the Table 1. The goal is to determine whether the application is easy to use and her GUIs are friendly or not. All of users performed the tasks easily and give positive feedbacks.

Table 1. Usability testing results

Task	Comment
View help.	Done correctly
Add child.	Done correctly
Find child using Bluetooth 4.0.	Done correctly
Find child using GPS.	Done correctly
Edit child profile.	Done correctly
Delete child profile.	Done correctly
View emergency information.	Done correctly

On the other hand, the system testing has shown that the proposed tracking system is capable to locate the children, carrying the device, in the indoor and outdoor locations.

5 Conclusion and Future Work

In this paper a children tracking system, in indoor and outdoor places, is proposed. It consists of a mobile application and a small device carried by the child. The mobile application enables the user to track and locate his child by locating that device. That will be done by using GPS and Bluetooth 4.0 technologies to track the child in indoor and outdoor locations. For indoor, the application searches for the child by detecting the beacon device using Bluetooth 4.0. And for the outdoor locations, the application uses the GPS/GPRS chip. The system was evaluated by testing its ability to locate the tracked children with accuracy. The evaluation ended successfully with a very high rate of positive outcomes. As future work, the indoor tracking can be improved by extending the distance covered by the system.

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