

Easy Tracking System: a Valuable Outcome of a Student Capstone Project

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Abstract

Easy Tracking is a unique and an innovative tracking system that uses Bluetooth, Short Message Service (SMS), Global Position System (GPS), and Google Map technologies to develop a new mobile application. This system helps to keep monitoring of someone's personal belongings or loved ones (children or pet). The application utilizes the Java programming language and Android platform. It can be installed on any mobile device including smart phone, laptop, iPad, etc. This system is appropriate for tracking missing luggage, car, child, and pet in a cost effective manner. It can also be applied to monitor elderly patients in a nursing home and children in a daycare. In this project, a prototype was developed and tested for validating the proof of concepts by using two Bluetooth enabled mobile devices. The prototype was able to monitor a child's movement within 10 meters from the parents. Bluetooth technology was used to establish a short range wireless communication channel between two mobile devices. In this case, two smart phones were used (one for the parent and one for a child). The GPS technology was used for determining the exact locations and distance between these phones in real time and SMS technology was used for delivering this valuable information. The prototype was demonstrated and project findings were presented to a Faculty Judging Panel of three external and two internal judges. The overall quality of the project was found to be satisfactory and rated high.

Key Words: Android, Bluetooth, GPS, Mobile App, Smart Phone, and SMS.

Introduction

In this advanced technological era, wireless communication is one of the fastest growing technologies which is being applied to almost all areas of our daily life. Wireless systems are most commonly used at the present time since these systems are widely distinguished in its varieties in the form of handsets and internet distributors. So, these are easy to use and cost effective. Basically, this project of Easy Tracking system is based on the use of wireless technologies (Bluetooth and GPS) incorporating Java programming in the Android environment. The benefits of this wireless system are many such as cost effective, user friendly, accurate measurement, and fast communication compared to other tracking systems. This proposed system will help keep track of children within a limited area from their parents avoiding a traditional leash which is commonly seen in many busy airports, shopping malls, stadiums, parks, etc. A typical diagram of commonly used system (using a leash) is shown in the Figure-1a and a block of the proposed system using wireless technologies is shown in the Figure-1b.



Figure-1a: Mother controls a child with a leash



Figure-1b: Easy Tracking Interconnection

In this project, short range Bluetooth radio channels and GPS technologies were used to connect two smart phones for tracking their locations within a limited range (see Figure-1b). The functions and operational procedures of Bluetooth and GPS are described in the literatures¹⁻⁷. A Bluetooth and GPS enabled Android phone is used as the main unit called ‘parent phone’ which is programmed with a software application (Android app). The parent phone stays connected with the sensor unit, called ‘child phone’, to keep tracking the child phone’s location continuously by using SMS.

The proposed system utilized the Bluetooth technology to maintain the concavity between two phones to stay in a short range (less than 10 m). A software application based on Java programming was developed and installed on the parent phone to check the connectivity and position of the child phone regularly. GPS technology was used in this project to check the exact position of the child phone. Once the child phone goes out of range (more than 10 m) then connectivity of this system gets terminated and initiates an alarm in the parent phone in the form of vibration and ringing. This way parents can start looking for their missing child immediately in an efficient way. There are many other tracking systems available in the current market, but this proposed Easy Tracking system has some extra merits. Table-1

exhibits a comprehensive comparison of other existing systems similar to the proposed Easy Tracking system.

Table-1. Comparison of Other Similar Products

Features	EasyTrackin g App	Toddler Tag Child Locator	Spy Mini GPS tracking Device	LOC8TOR Lite	GT30	ST-2011
Tracking Using GPS	Yes	Yes	Yes	No	Yes	Yes
Tracking Using GSM	No	No	Yes	Yes	Yes	Yes
Tracking Using Bluetooth	Yes	No	No	No	No	No
Tracking Accuracy To Target's Location	10 Meters	8 Meters	5 Meters	5 Meters	6 Meters	5 Meters
Battery Life	6-12 Hours	6 Months	6 Months	6 Months	55 Hours	48 Hours
Price	Less than \$15	\$44.90	\$54.58	\$73.90	\$106.66	\$149.35

Methodology

In order to implement this proposed Easy Tracking system, it was needed to integrate both hardware and software. Following is the list of hardware and software requirements:

- i) Hardware requirements: Two Android smart phones equipped with Bluetooth, GPS, and SMS.
- ii) Software requirements: Java programming, Eclipse editor, Android Operating system.

The goal of this project was to design and develop a tracking system using wireless technologies in order to monitor a child's movement in a busy area. This was being done by establishing a short-range wireless link between the parent and the child by pairing of two Android phones. Figure-2 shows the block diagram of this proposed system.

In this project, a set of new Mobile Apps was developed using J2E java codes. Interfacing was developed by using XML codes, Bluetooth connectivity and alarm applications were developed using Java codes and the GPS location program was also developed using Java⁹⁻¹³.

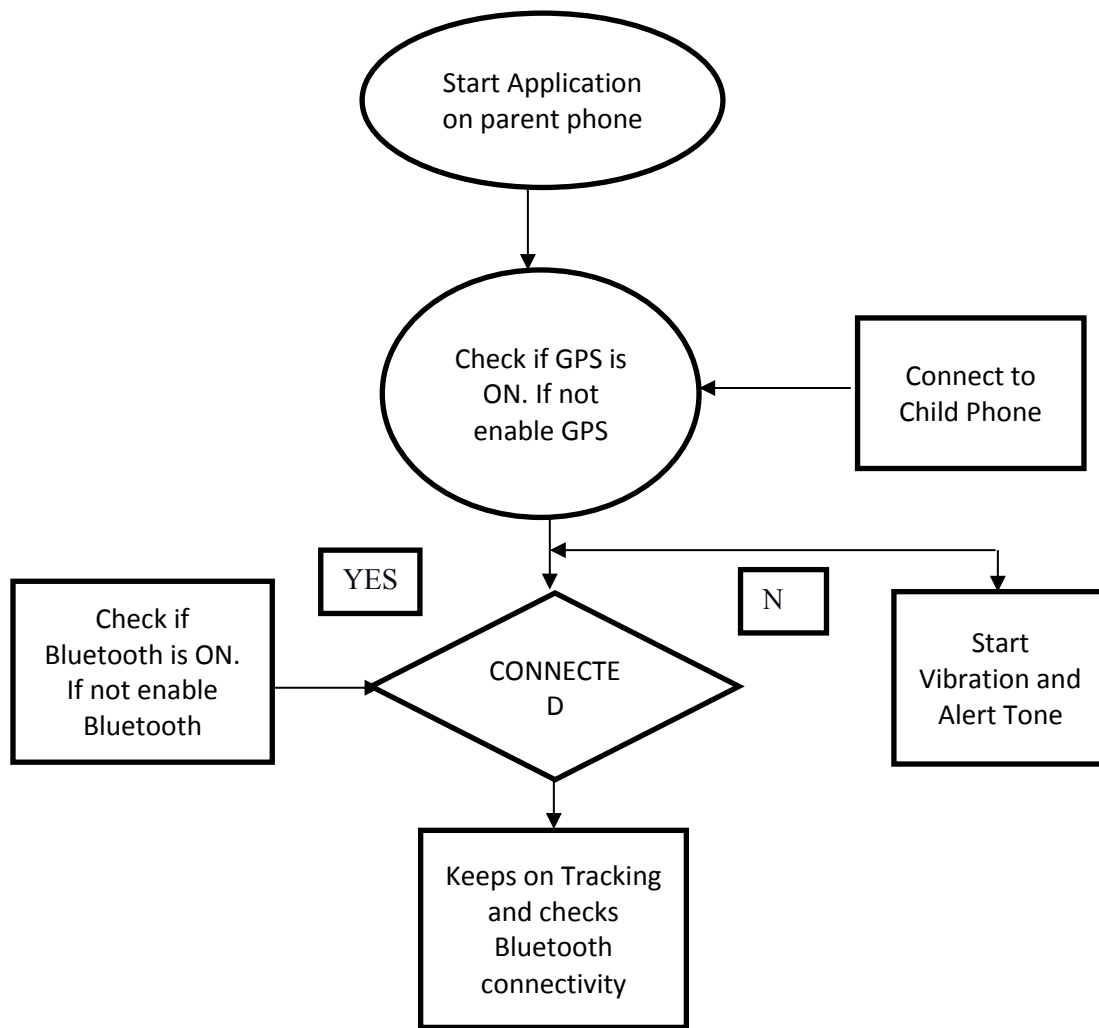


Figure-2: Block Diagram of Easy Tracking System.

Validation of Easy Tracking System

In this project, an additional thorough investigation was conducted using a software (inSSIDer) to test and evaluate the performance of this newly designed and developed tracking system both indoor and outdoor. The distance at which the Bluetooth pairing is disconnected is taken as a parameter in this study. The pairing distance was measured under different RF conditions from different angles. Some quiet and noisy locations were selected for this investigation. Table-2 shows some of these selected locations in San Diego, California and the measured Bluetooth connectivity distances.

Table-2: Selected Locations and the Measured Bluetooth Connectivity Distances

DIFFERENT LOCATIONS	WITHOUT OBSTACLES	WITH OBSTACLES
QUALCOMM STADIUM	9 M	8.9M
DOWN TOWN SAN DIEGO	8.7M	8.55M
NATIONAL UNIVERSITY INDOOR	8.8M	8.7M
NATIONAL UNIVERSITY OUTDOOR	8.9M	8.85M
MISSION VALLEY MALL	8.7M	8.6M

Figure-3 shows a graph that illustrates the distances, locations, and barriers between the parent phone and the child phone. Parent phone is located at the center of the circle and the child's phone can be anywhere in the graph. Once the child phone goes out of this circle then the parent's phone will start vibrate and display the distance and direction of the child phone's location.

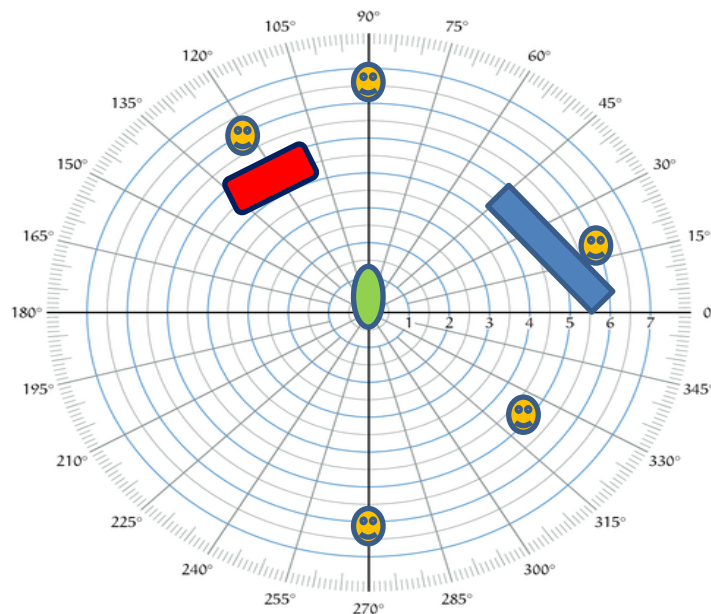
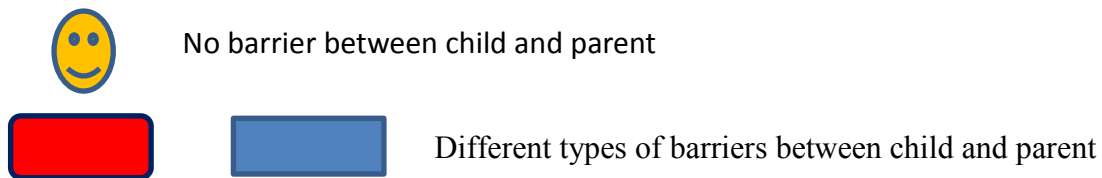
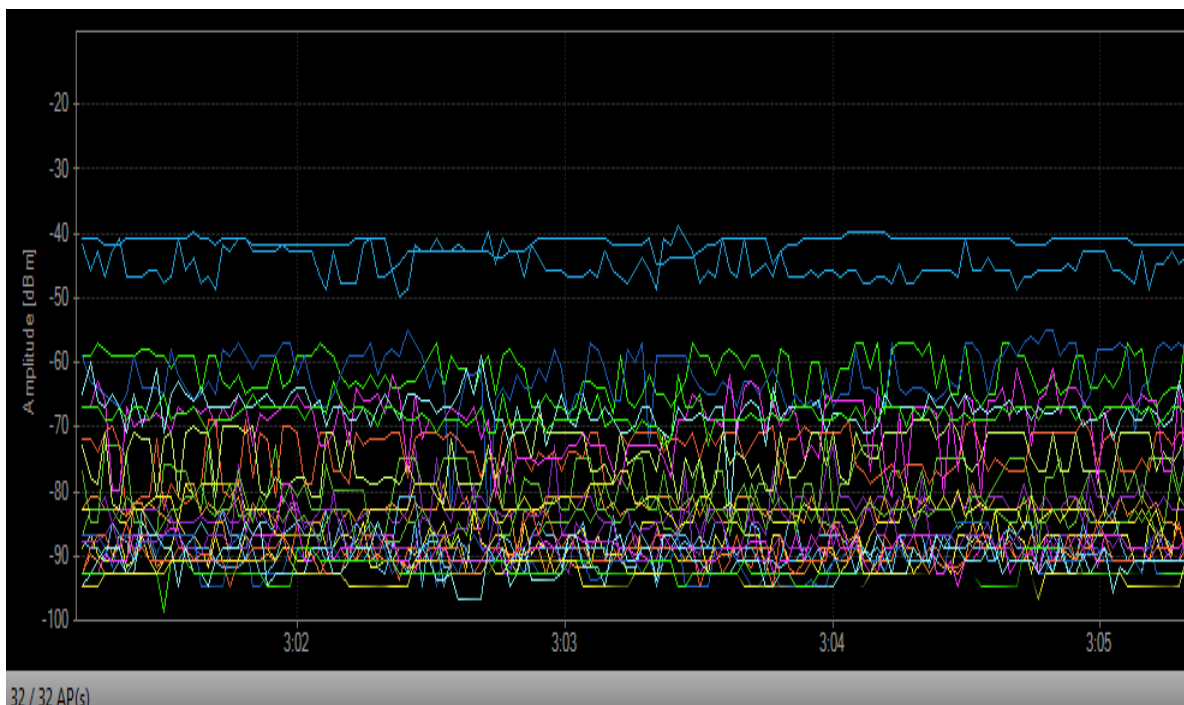


Figure-3: Locations, Distances and Obstacles between Two Phones

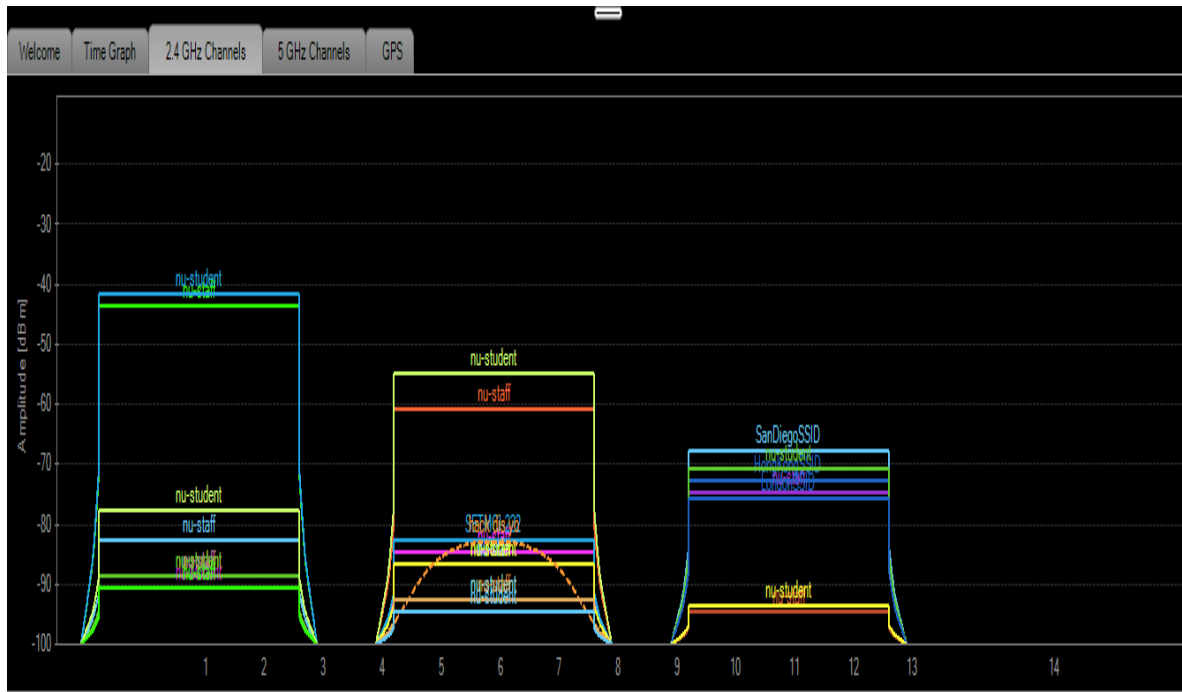
inSSIDer

inSSIDer is a Wi-Fi network scanner software⁸. This software was used to check and evaluate various RF conditions under which this experiment was conducted. The inSSIDer is capable of:

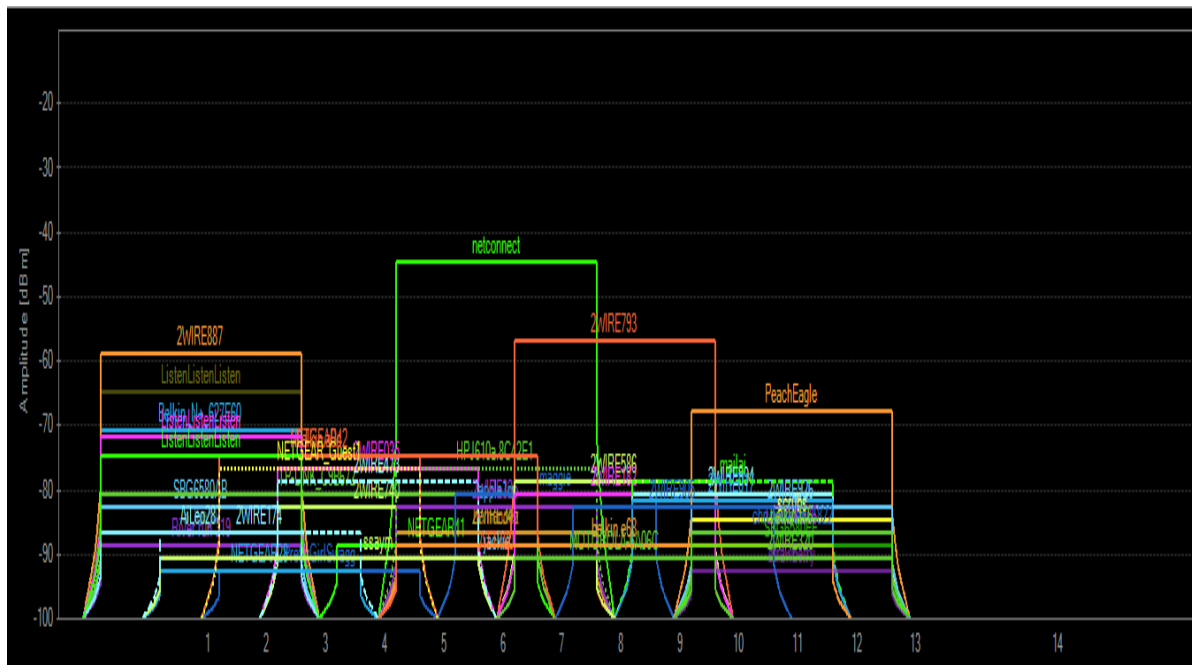
- ⊙ Working with the internal Wi-Fi radio system
- ⊙ Collecting DWi-Fi network information (e.g. SSID, MAC, access point vendor, data rate, signal strength, and security)
- ⊙ Determining the graph signal strength over time
- ⊙ Showing how Wi-Fi networks overlap.
- ⊙ Comparing graphs between the signal strength and time domain.
- ⊙ Showing the signal strength v/s channel plot as well.



a) Signal V/S Time Plot



b) RF Conditions Checked at National University (quiet location)



c) RF conditions at Qualcomm Stadium (noisy location)

Figure- 4. Snapshots of Experimental Observations

Figures- 4 a, b & c show a set of snapshots of experimental data. Here a comparison study was done by using two frequency plots 1) National University (quiet) and 2) Qualcomm Stadium (noisy). It is observed from these two plots: Figures-4b & c that RF signal is brighter in noisy location than the quieter location. It was also further observed that the Bluetooth connectivity distances become slightly short with the increase of RF signal noises. From these experimental observations, it is clear that the Easy Tracking system will always be able to detect child's location under any RF conditions and physical barriers.

App Operational Process

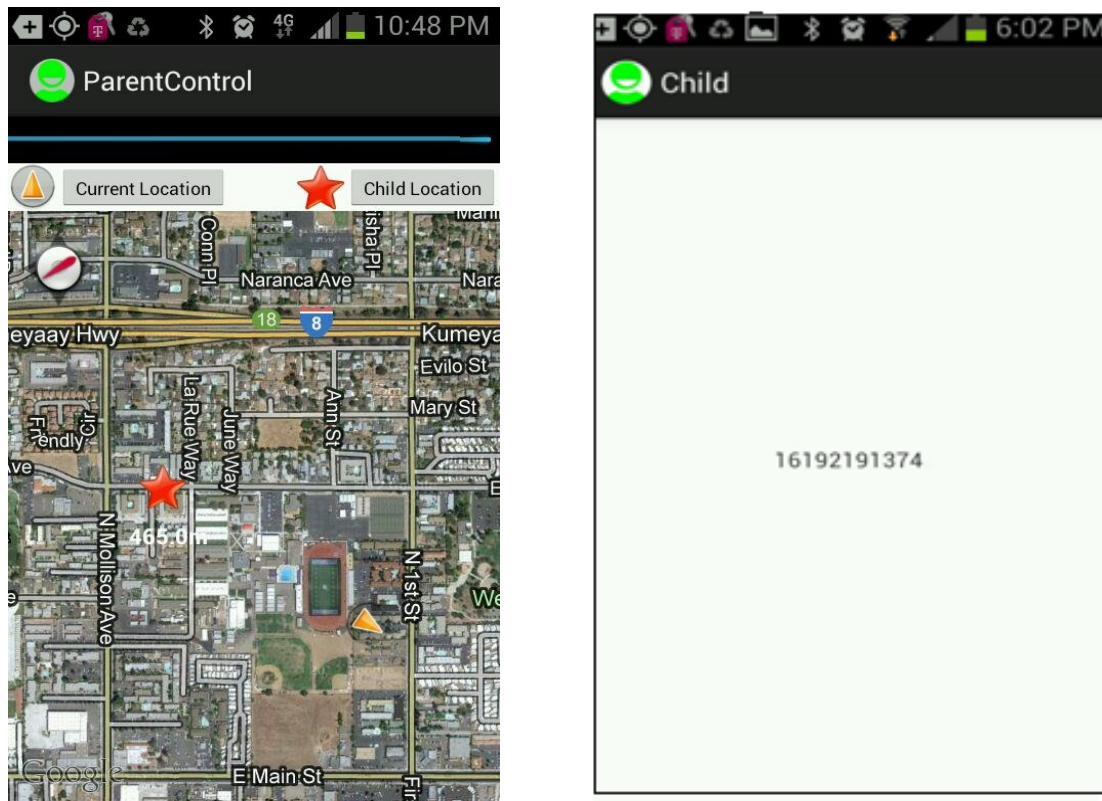
Easy Tracking involves proximity gathering information using Android application. Bluetooth was selected as it has wider applications in cell phones and its short coverage helps to reduce the sample pool detection. Other factor that drives the selection of Bluetooth is the power efficiency. Easy Tracking deals with proximity detection. Mobile phones are using this technique for many applications. For example, as we bring the phone closer to our ears (body) the sensor in the phone detects the proximity with the body and dims the background light. It uses GPS to get the location information, Bluetooth for the pairing and SMS to aid the transfer of information regarding GPS. The app has to be started only once, and it keeps on tracking the child by working in the background. The distance between the parent and child is shown in the app at the parent control phone.

It is commonly observed that all smart phones available today are equipped with Bluetooth. That was the main reason it was employed in our application. The parent phone is coupled with the child phone using Bluetooth. The coupling ensures connectivity is established between the child and parent until it is within the range. When the child phone exceeds the connectivity range, coupling is disconnected and an alert in the form of vibration and ring tone starts on the parent phone. If the child comes back into the range the vibration stops.

Most of the mobile phones in today's market are also pre equipped with GPS service. GPS is an important part of our application as it is used to track the child's location. SMS service was used to receive the information about the child's exact position from the child phone. An SMS is sent to and from the parent and child phone every 5 seconds so that the location can be received at the parent phone through the service provider. The GPS map on the parent phone uses two different pointers for the locations of the parent phone and the child phone. An arrow on the map was programmed to show the direction of the child phone location.

Snapshots

Snapshots below (Figure-5) provide the interface photos of Parent and Child phones.



a)Interface Showing Location Of Parent and b) Child Phone Paired With Parent Phone
Figure-5: Parent App Showing the Location of Child with the Distance and Direction

Future Works

The concept of Easy Tracking system is applicable in many other areas including but not limited to the following applications: 1) Social networking- track all the other mobile phone whose Bluetooth mode is switched on, 2) Baggage- track the checked in baggage at the busy airports, 3) Car- track the location of a parked at a big parking lot, 4) Blind Person –help to walk a blind person on the street, 5) Pet- track the movement of pets, and 6) Daycare – track the movements of children in a daycare.

Assessment of Program Learning Outcomes

This project was designed and developed by a group of graduate students at National University under the guidance and supervision of a faculty member. The project was completed within three months. Students applied their theoretical knowledge gained from the Master of Science in Wireless Communications program to design a practical application of the

field and build a prototype for proof of concept. All students in the program are required to complete 10 courses and two Capstone Project courses in order to receive an MS degree in Wireless Communications. In this project, students validate their proof of concepts by building a prototype for demonstration. Students are required to make a formal presentation, a prototype demonstration and submit a written report to the Faculty Judging Panel of five members (two faculty and three industry practitioners in the field). This project was evaluated by the panel using a set of rubrics for all these three phases and received very high scores. All students successfully fulfilled the degree requirements and started working in the field.

Conclusion

Ultimately this project was done to help parents to keep tracking their child's movement constantly in a busy location. The idea behind the Easy Tracking system was extracted from tracking parcels in the past. We made this project more realistic and usable by allowing people to track their precious ones using their phones without importing any other separate devices. This was done by the use of one smart phone on the parent side and another smart phone on the child's side. Of course, we implemented a smart phone on the child's side for convenience and due to time shortage for this project. However, this can be implemented through a compact and cost effective device containing a Bluetooth and GPS chip attached to the child and this idea will be considered for the future work. The tracking process starts by enabling the parent's GPS and Bluetooth services and getting them connected to the child's phone, where these settings should be enabled on the child's phone as well. Once the child goes out of range of Bluetooth, the parent's phone will start vibrating and ringing, then it will locate the child's phone through GPS. It is very convenient for parents to have an application like Easy Tracking to track their children and belongings rather than the use of any other hardware.

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