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Geofence Alerts Application With GPS Tracking For Children Monitoring (CTS)

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Abstract— Geofence Alerts Application with GPS Tracking for Children Monitoring (CTS) is a mobile application that helps parents to track the location of their child. It provides the parents with the route and real-time location of the children. Parents often face difficulties in getting hold of the whereabouts of their children when they are not in sight. This situation increases the insecurity of parents toward the safety of their children. The first objective of this paper is to obtain a latitude, longitude, and time information of a child's location in real-time using GPS tracker. The second objective is to develop a smartphone application that capable to track the location of children in real-time. The third objective is to evaluate the functionality of the developed smartphone application in tracking children's location. Features, advantages, and disadvantages of three commercialized application are compared to collect requirements for the CTS application. The requirements are then used to design and develop the interface of CTS application using Rapid Application Design (RAD) framework. Three main modules, which are the View Current Location module, View History Route module and Setup Geofence module are proposed for the application. Additionally, a GPS tracker based on Arduino Uno board is developed to provide the longitude and latitude of children's current location. The functionality of the CTS application and the GPS tracker is then evaluated to determined bugs and its usability. It was discovered that CTS is in helping parents to track the location of their child in real-time, view the past route taken by the child, set up geofence area, and receive notification when their child enters or leave the geofence area within the scheduled time.

Keywords—Geofencing, GPS tracker, child tracking, Internet of Things, mobile application

I. INTRODUCTION

It is a parent's worst nightmare when their child does not come home one evening and is missing for several days. The statistic released by the Royal Malaysian Police in 2020 stated that 15,042 missing children's cases are reported between 2011 until 2019 and 363 children are yet to be found [1]. As the number increased, 1523 reported cases happen when parents neglected their children. Make matters worse, parents were unable to track the whereabouts of their children and even get the notification when their children exit the safe place, particularly their school and home. With the advancement of

smartphone technology, a smart location tracking application can be developed and installed to help parents to track the location of their children in real-time [2]. Its portability also facilitates parents to receive immediate notification about their children's activities at any time and take prompt action if any abnormal activity is detected [3][4].

A smart location tracking application utilizes Global Positioning System (GPS) technology to provides children's location and time synchronisation. A GPS device can be attached to the children belonging and use to calculates the latitude and longitude values based on the position sent by the satellites [5]. A smartphone application then acquired the latitude, longitude and time information and generate a map that displays the children's location. Additionally, the application is also capable to display the route taken by the children along with the distance between children's current location and the targeted safe area.

In this paper, the Geofence Alerts Application with GPS Tracking for Children Monitoring (CTS) is proposed with aim to provide parents with the real-time location of the children using their smartphone. Additionally, the application enables parents to set a geofence area of a determined safe place and get a notification when the children enter or leave the area. The application will also notify the parents when their children did not enter the geofence area at the time which set earlier. As information on where the children were abducted or where they had been in the past is important to the authorities, the application is capable to provide the parents with the history route passed by the children within the timeframe set by the parents [6]. All the information displayed on the application is acquired in real-time using GPS technology. This to ensure that the parents and the authorities would have a history or some clues as to who the children may have been seeing before they went missing.

A. Problem Statements

Tracking children whereabouts is the biggest problem faced by the parents in determining the children safety [6]. Additionally, parents are also unable to ensure that their children reach the targeted safe place and helpless in knowing where their children wandered off before the safe place is

reached. If a child went missing, parents do not know where the child is located, this will make the rescue operation harder and clueless [7]. The third problem is parents cannot notice instantly when their children went missing, this may make them miss the golden time to find or rescue their children [7]. The longer it takes to locate the child, the more dangerous the situation of the child may be. If parents notice the missing of their child too late, the child may face danger. To solves the problems, this paper proposes a mobile-based tracking application that uses Arduino tracker to provide GPS location of the children to the parents.

II. RELATED WORKS

This section compares three commercialized tracking applications namely: Yepzon One [8], Jiobit [9], and Relay [10]. The summarization of the comparison is shown in Table I.

Yepzon One is a GPS tracking device that can track the real-time location of a wearer and display it on the smartphone. It will send a notification to the smartphone when the tracking device moves. Yepzon One also allows the users to see the history of where the tracking device has been in a fixed time. The second advantage of Yepzon One is it combines three different tracking technologies. First, the GSM gives an approximate location of the wearer. Next, the GPS provides accurate tracking of outdoor, and Wi-Fi provides tracking of indoor and urban areas. Apart from that, Yepzon One does not support geofence function. Yepzon One only provide simple tracking on the location of the wearer.

TABLE I. COMPARISON BETWEEN YEPZON ONE, JIOBIT, AND RELAY

Feature	Yepzon One	Jiobit	Relay	CTS
Mobile based	Yes	Yes	Yes	Yes
Real-time location map	Yes	Yes	Yes	Yes
Set up geofence	No	Yes	Yes	Yes
History view	Yes	No	Yes	Yes
Device alarm	No	Yes	No	Yes

Jiobit is a small real-time location tracker that provides the live location of the wearer on the smartphone. Jiobit can track multiple children at the same time. Furthermore, Jiobit alerts the parents when children arrive or depart a recorded location. It also has an alarm that can be trigger when it is connected to the Bluetooth. Apart from that, Jiobit also has some disadvantages. The first disadvantage of Jiobit is poor indoor detection. Jiobit is unable to provide an accurate location of the wearer inside a building. The second disadvantage of Jiobit is no location history. Jiobit does not record all the route passed by the wearer, it only displays the live location of the wearer on the map.

Relay is a squared shape tracking device that keeps children to stay in touch with their parents and allows parents to view the real-time location of their children in map form using a mobile phone. Parents can set up multiple specific locations using the geofence function to receive notification when children reach or leave the setup location. In addition, the time and date of when the Relay enters and exits the geofence area will be recorded and can be view in history. Relay does not have alarm implemented but children can press the button in the middle of Relay five times to trigger an emergency alert to the mobile phone of parents. One of the

advantages of Relay is group chat. Relay supports two-way voice. It allows the carrier to chat individually or in a group in real-time.

III. PROPOSED DESIGN

The Geofence Alerts Application with GPS Tracking for Children Monitoring is comprised of a GPS tracker and a smartphone application. The GPS tracker is responsible for sending the location of the children to the Firebase cloud database using the Arduino board and SIM808 module equipped with 2G/3G/4G sim card, GPS antenna and GSM antenna. The smartphone application then acquired the longitude and latitude of the children's location and provide the parents with real-time location tracking along with other functionalities such as geofence setup and time scheduling, alarm, and notification, as well as the history route. The overview of the Geofence Alerts Application with GPS Tracking for Children Monitoring is illustrated in Fig. 1.

A. GPS tracker

The GPS tracker is used to provide the longitude and latitude of children's current location. The tracker comprised of Arduino Uno board, SIM808 module, 2G/3G/4G sim card, GSM antenna, GPS antenna and 9-volt battery. Arduino Uno board is responsible for converting the raw location data received from SIM808 module. The SIM808 module then send the location data to the cloud database using Global System for Mobile (GSM) network. Fig. 2 shows the setup of the GPS tracker.

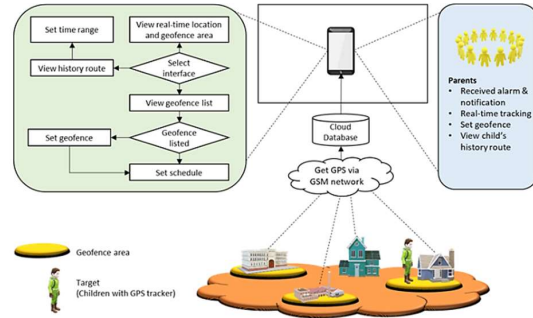


Fig. 1. Overview of the CTS

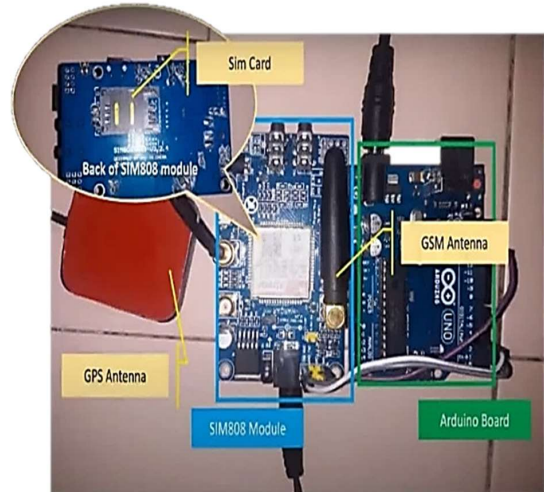


Fig. 2. Arduino Uno board and SIM808 module inside the GPS tracker

B. Smartphone Application

Rapid Application Development (RAD) is used as the framework for the development of CTS smartphone application after considering the application size and the available time constraint. In the first phase, the system requirement are gathered based on the literature study and observation of the similar application. The application design is then established and the application prototype is derived based on the design. In the final phase, the CTS application is tested to determine bugs and application usability.

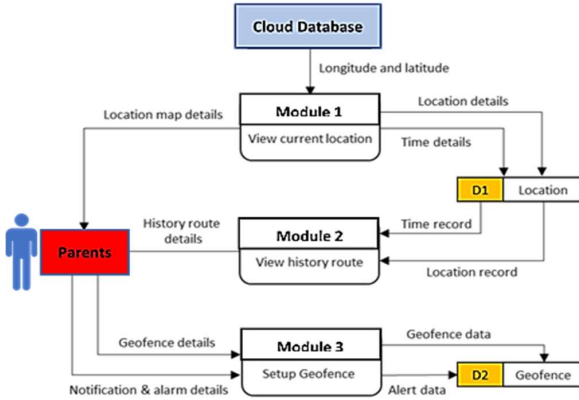


Fig. 3. Data flow of the Geofence Alerts Application with GPS Tracking for Children Monitoring

The smartphone application consisted of three main modules as shown in Fig. 3. The View Current Location module acquired current location data from the cloud database and store the location and time details into the D1:Location data store. This module is also responsible to process the location data and display it on the map to the parent's smartphone. If parents request to view the history record, View History Route module will retrieve past location and recorded time from the D1:Location data store. Additionally, parents can set up a geofence area and the configuration details will be sent to the Setup Geofence module. The geofence data and alarm data will later be stored in the D2:Geofence data store.

IV. RESULT AND DISCUSSION

An experiment is conducted to evaluate the functionality of the proposed GPS tracker and CTS application. During the experiment, the GPS tracker is hold by a child which the child's location is to be tracked in real-time using CTS application.

A. Test of the proposed CTS application

The GPS tracker receives longitude and latitude coordinates from the satellites and send the data to the cloud database using GSM network. The CTS application then successfully retrieved the location data from the cloud database and display the location on user's smartphone.

B. Displaying child's current location on the CTS application

Child's current location can be viewed on the map and marked with a red marker as shown in Fig. 4. The orange circle on the map represents the geofence areas which determined by the parents earlier. As the child that is holding

the GPS tracker enter or exit the geofence area, the CTS application will send a notification to the parent's smartphone.



Fig. 4. Children's current location and geofence areas on the CTS application

C. Displaying child's history route

The CTS application is capable in displaying the past route taken by the child. As shown in Fig. 5, parents can enter the time range either in hours or minutes for the past route that they want to search. As pictured in Fig. 6, the CTS application will then display the past route based on the time range given by the parents. The time range is displayed in the upper right of the interface and the red marker in the map represents the child's current location.

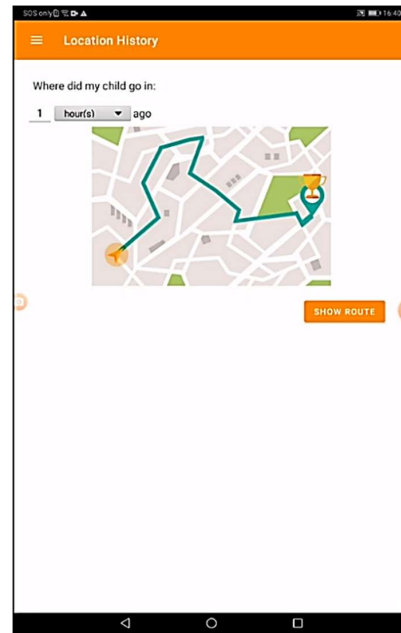


Fig. 5. Time range in Location History Interface of CTS

D. Setting up geofence location

Fig. 7 shows the Setup Geofence Location interface which enables parents to search for a specific safe place location such as school and home. The safe place can then be set as the geofence area.

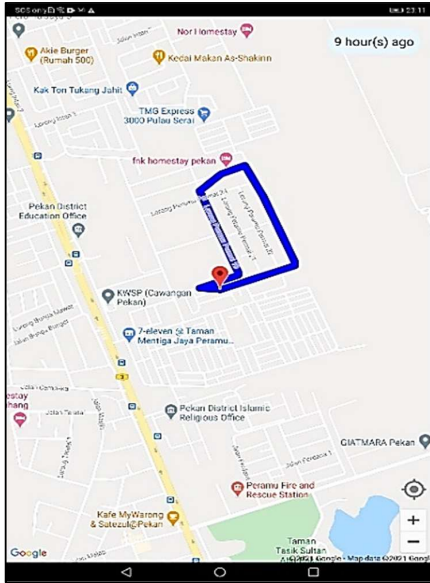


Fig. 6. Child's history route on CTS application

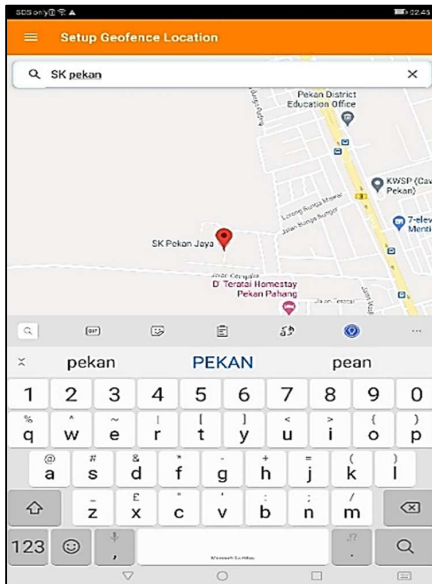


Fig. 7. Finding the geofence area

The geofence area can be named by the parents as shown in Fig. 8. As additional information, the longitude and latitude coordinate are also displayed to the parents. Parents can set the time schedule for the geofence area by which they want their children to present as shown in Fig. 9. During the experiment, a warning notification to the smartphone device is successfully triggered by the CTS application when the child that hold the GPS tracker is not present at the geofence area within the scheduled time. Parents are also allowed to cancel and reset the alarm or even delete the geofence area if necessary.

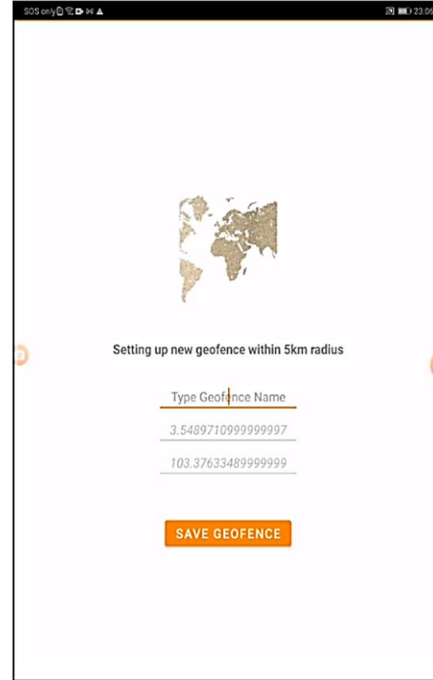


Fig. 8. Save Geofence Interface of CTS

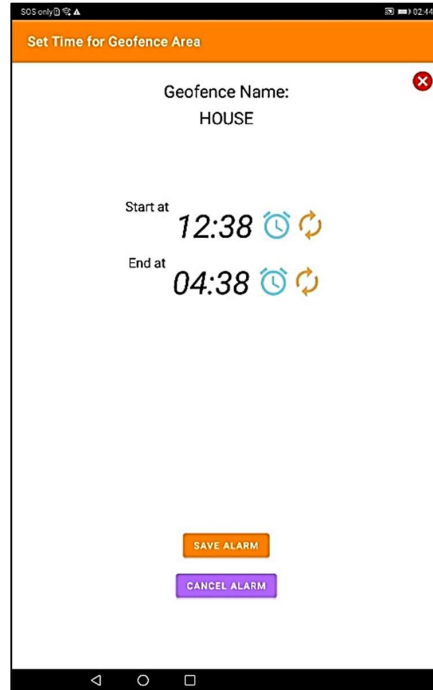


Fig. 9. Setting up schedule for the geofence area

E. Notification

The CTS application is successfully triggered notification and alarm to the smartphone whenever the child that is holding the GPS tracker does not reach the specified location within the scheduled time range. Additionally, the notification and alarm are also triggered when the child leaves or enter the geolocation area. As shown in Fig. 10, a proper message will be displayed to the parent's smartphone when the unexpected event occurs.

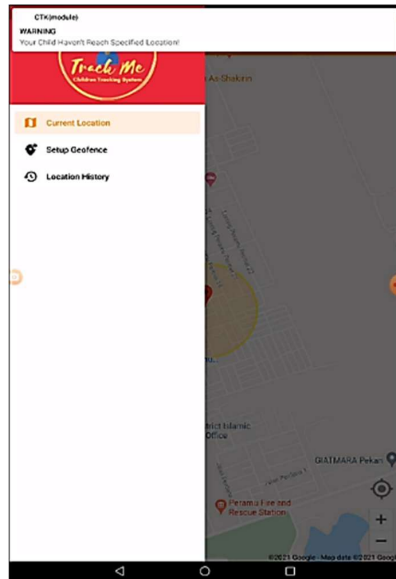


Fig. 10. Notification on the parent's smartphone device

V. ADVANTAGES AND APPLICATIONS

The usefulness and applicability of the Geofence Alerts Application with GPS Tracking for Children Monitoring are summarized in six main benefits as the following:

- Multi-personal tracker either children or elderly with memory disorder.
- The product is bind with the android application and allow real-time GPS tracking.
- Parents can set multiple geofence location and schedule time for children present.
- Parents can get quick alert through notification and alarm on their smartphone when children are moving in/out/did not arrive the geofence area.
- Accurate real-time tracking with the GPS accuracy is approximately within 2.5 meters.

VI. CONCLUSIONS

In this paper, we proposed the Geofence Alerts Application with GPS Tracking for Children Monitoring aimed to provide parents with the real-time location of the children using their smartphone. The proposed CTS application and the GPS tracker was successfully developed and tested. As shown by the results, CTS application is capable in helping parents to track the location of their child in real-time. Additionally, the CTS application allows parents to view the past route taken by the child, set up geofence area to receive notification when their child enter or leave the geofence area and set alarm to warn parents when their child failed to present at the geofence area within the scheduled time.

A. Objective Revisited

This paper aimed to provide parents with the real-time location of the children using their smartphone. The latitude,

longitude, and time information of a child's location are obtained in real-time using the GPS tracker. In this paper, the GPS tracker is developed using Arduino Uno board, SIM808 module, 2G/3G/4G sim card, GSM antenna, GPS antenna and 9-volt battery. The location information is successfully sent to the cloud database using GSM network. The smartphone application that is capable to track the location of children in real-time is then developed and evaluated.

B. Future Work

The CTS application can be further enhanced by adding an alert button to the GPS tracker. In the case of emergency, children can press the alert button and notify their parents using CTS application. Secondly, the GPS tracker can be designed in a form of wearable device. Additional information can be tracked on the CTS application including the children's heartbeat and weather data to improve the safety measure.

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