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A mobile monitoring and alert SMS system with remote configuration – A case study for android and the fused location provider

By

Tiago Coelho, Sara Paiva
Instituto Politécnico de Viana do Castelo, Viana do Castelo, Portugal
tiagocoelho@ipvc.pt, sara.paiva@estg.ipvc.pt

ABSTRACT

One of the parent´s main concerns nowadays it to know their children´s whereabouts. Some applications exist to address this issue and most of them rely on internet connection which makes the solution expensive. In this paper we present a low cost solution, based on SMS, and with the ability to remotely configure the child monitoring process. We also present the architecture and the full flowchart of the child application whenever a SMS is received. This case study uses Android and the more recent location API – the Fused Location Provider. For obvious reasons, the security issue has been a concern, which resulted in a configuration module in the child application to specify authorized senders.

General Terms

Mobile development, Tracking and Localization

Keywords

Child monitoring; SMS monitoring; Android track application

INTRODUCTION

Parent´s main concern nowadays, with the increase of several crimes against children, including kidnapping, is to know where they are. Based on this reality, several applications exist nowadays that rely on mobile modules or devices, taking advantage of the increasing use of mobile phones. The system´s architecture of such a solution is mostly dependent on the child´s age, but usually all of them rely on two components: one for the parent and another one for the child. If children are small and always go out with their parents, the main concern is if they get lost in the street, especially in events with a large number of people. In these scenarios, a smartphone is not a valid option as small children do not usually carry a mobile phone. Bluetooth or GPS modules might be a better option in this case. On another hand, if children are old enough to carry a mobile device, most of the equipment have the minimum characteristics – GPS, SMS and/or Bluetooth - to be used in a monitoring system. The use of an internet connection to establish communication in this case is an option but as it makes the system more expensive other solutions exist such as communication via SMS.

In this paper we present a solution to remotely monitor children, using SMS for the communication between child and parent´s applications. The main advantages we emphasize are the lower cost of this solution compared to the ones that rely on an internet connection and the possibility to remotely change the monitoring process. The developed prototype allows three types of remote monitoring: single position, frequency and range. We present an implementation for the Android platform using the most recent location API – the Fused Location Provider.

This paper is organized as follows. In the next section, we present some related work. Next we present the Fused Location Provider and its main functionalities with relevancy for this specific case study. Then we describe in detail the proposed solution as well as the different remote monitoring types supported. Finally we present conclusions and future work.

1. RELATED WORK

Several types of monitoring and tracking systems exist depending on its purpose. Some address solely the location of the child position in general locations [1] [2] [3], other focus on tracking locations in specific areas such as parks [4] while others add the functionality of sending alerts when leaving a certain area [5].

Regarding technologies, one of the most common used for tracking children position is the use of GSM and GPS with smartphones and SMS/Email for the communication between parent and child, such as in [1] [5]. Another approach is followed by the authors in [2], that use GSM, GPS and Bluetooth modules in the child and a smartphone in the parent. The distance from the child is calculated via received signal strength indicator (RSSI). A complementary system is described in [3], which adds a voice module to detect the cry of a child and notify the parents. Another solution using RFID is described in [4].

The architecture presented in [1] uses mobile phones for both the parent and the child. Whenever the parent wants to know the location of the child he sends a SMS and the child´s mobile device processes it, obtaining the GPS signal and replying to the parent also via SMS with the position that can be visualized in a map. The prototype was developed using Android platform.

Wong et al. propose a GPS child care system [2] where the child node consists of a simple circuit that has a Bluetooth module and a GPS receiver and the parent node is a

mobile device that has Bluetooth connection. The GPS is used to determine the child position which is presented in a map in the parent device along with the distance to the child calculated based on Bluetooth using the RSSI. The prototype was developed using Microsoft Windows Mobile.

Another monitoring system is presented in [3], oriented to track the child's movement to and from school and also to capture if the child is crying and inform the parents. The system uses, in the child side, a microcontroller, GSM and GPS modules and a voice playback circuit; in the parent´s hand an android mobile device is used.

An RFID based system is proposed [4] oriented to track a moving child in a wide area, such as a park or mall. The system depend on tag readers distributed around the space and also tags worn by children. A central database and web server receive and save data so parents can locate them.

TrackMeApp is presented in [5] and relies on a mobile phone in each side (parent and child) and uses GPS to calculate the position. The main purpose is to define geo-fence areas as safe, risky and highly risky, where the radius of each are is pre-configured in an admin console using Google Maps. The distance the child is at is calculated using the great circle algorithm. The prototype was developed using JAVA ME platform.

2. FUSED LOCATION PROVIDER

In this section we present the Fused Location Provider [6], the most recent location API for Android which aims to limit the power consumption, improve accuracy and expand coverage. One of the most common tasks when using a location API is to obtain the current position. The Fused Location Provider allows to specify the priority of the request so the platform knows which location sources (Wifi, cell tower or GPS) to use to obtain the coordinates. When using a PRIORITY_BALANCED_POWER_ACCURACY, a precision of 100 meters is achieved, usually obtained using WiFi or cell towers and a low power consumption is required. When choosing a PRIORITY_HIGH_ACCURACY, the most precise location is obtained, with superior power consumption and most likely using the GPS (Global Positioning System). A PRIORITY_LOW_POWER provides an accuracy of approximately 10 kms and the PRIORITY_NO_POWER uses no power consumption at all and becomes dependent of other applications to receive location updates. Another parameter available in the location API is the interval to receive locations. This is particularly important for applications that want to define a monitoring frequency time as no additional coding becomes necessary to control the frequency other than pass to the location request the desired frequency monitoring interval. However, if other applications are receiving location updates at a faster rate, it may also affect our application that starts to receive updates more frequently as the time specified. As this can bring problems to our application (UI or data overflow) it is also important to specify the fastest rate the application can receive and process new location updates.

In order to issue a location request, the interfaces ConnectionCallbacks and OnConnectionFailedListener must be used. The first specify the methods when a client connects and disconnects from the location service and the second defines the method called when an error exists connecting to a client. Whenever a new location is received, the method OnLocationChanged is fired, so the received location can be properly handled.

Another important feature of the Fused Location Provider is the Geofencing API that allows to setup geographic boundaries around a set of locations and then receive alerts or notifications when the user enters or leaves those boundaries, an important feature in almost every monitoring applications. The geofence API allows to specify which type of action the user want to monitor: entering the boundaries (GEOFENCE_TRANSITION_ENTER), leaving (GEOFENCE_TRANSITION_EXIT) or staying (GEOFENCE_TRANSITION_DWELL).

3. PROPOSED SOLUTION

In this section we start by providing a contextualization of the proposed solution. Next we present the architecture and the main functionalities of both child and parent applications. Finally, we detail each of the three remote monitoring types supported.

3.1 Contextualization

The proposed solution was designed for children old enough to carry a mobile device that will communicate to the parent´s mobile device via SMS. The child´s application has an interface, accessible via a login that allows parents to configure the numbers to which the child´s application respond to, preventing unauthorized requests. Besides this, the main role of this application is a background service that captures and handles SMS requests.

On another hand, the parent´s application, that can monitor unlimited children, has three types of remote monitoring capabilities:

- Single position: this is the simplest type of remote monitoring and consists of asking the child for its position and receiving the reply with the GPS coordinates, seeing them on the map for a quicker visualization.
- Frequency scheduler: this type of monitoring allows the parent to schedule the frequency that he wants to receive position updates from the child. To stop the scheduler, a request with frequency zero should be sent to the child.
- Range: this type of monitoring allows the father to define a secure range regarding to the child´s current position and receive an alert if the child leaves it. To stop the range monitoring, a request with zero meters should be sent to the child.

The communication between both applications is made through SMS using pre-defined templates.

3.2 Application Architecture

The architecture of the system and its main components are shown in Figure 1. The system is composed of two mobile applications that communicate via short message service (SMS). The child application also needs to use GPS satellites to obtain the current position to inform the parent application.

Before the system is used, and because of security issues, the parent should configure the child´s application so only authorized people communicate with him. After that configuration is performed, the child does not need to have any kind of interaction with the system. The application in the child´s side runs in background so even if the child is playing

or texting the monitoring process is taking place and handling any requests sent by the parents.

The parent´s application is more complex as it allows to monitor several children. The parent can then choose the child to act upon and the type of monitoring he wants to do. At any time, the parent can access a map to see selected children and their whereabouts.

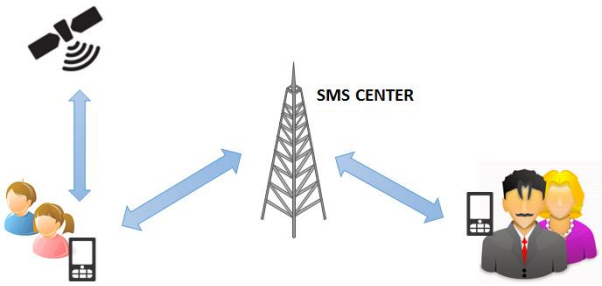

Figure 1. Architecture of proposed system with main components: parent´s and child´s application, an SMS center and the GPS satellite

3.3 Child application configuration

The child application should be configured prior to the system starts being used. The first time the child application is accessed, a pin is asked (Figure 2 (A)) so future accesses to the configuration area are restricted to the parent only. After the pin has been configured, the subsequent logins are only possible after inserting the correct pin (Figure 2 (B)). After the login is successful, the parent has access to the list of authorized senders (Figure 2 (C)). For security issues, the numbers associated to the authorized senders are the only ones which will be processed by the client application. The parent has the possibility to delete or update an authorized

Figure 2. (a) Pin definiton in first access; (B) login in the configuration area; (C) authorized users; (D) options for authorized users; (E) new authorized user creation

sender (Figure 2 (D)), options available through Android context menu [7]. Finally, the parent has the option to add a new authorized sender through the New option of the Android options menu, located in the Action Bar.

3.4 Parent application

The parent application is the one that triggers the remote monitoring process. The application has 5 main sections, as can be seen in Figure 3. The first one presents a map that presents the last positions of the selected child (Figure 3 (A)). The second section presents a list of the children available for monitoring (Figure 3 (B)). The third section allows the parent to send a single position monitoring request, only by choosing the child (Figure 3 (C)). The fourth section relates to the scheduling of a frequency monitoring where the parent needs to select the child to monitor and also the number of minutes that specifies the monitoring frequency (Figure 3 (D)). Finally, the fifth section allows the parent to define a range monitoring, by selecting the child and the number of meters that define the secure area (Figure 3 (E)).

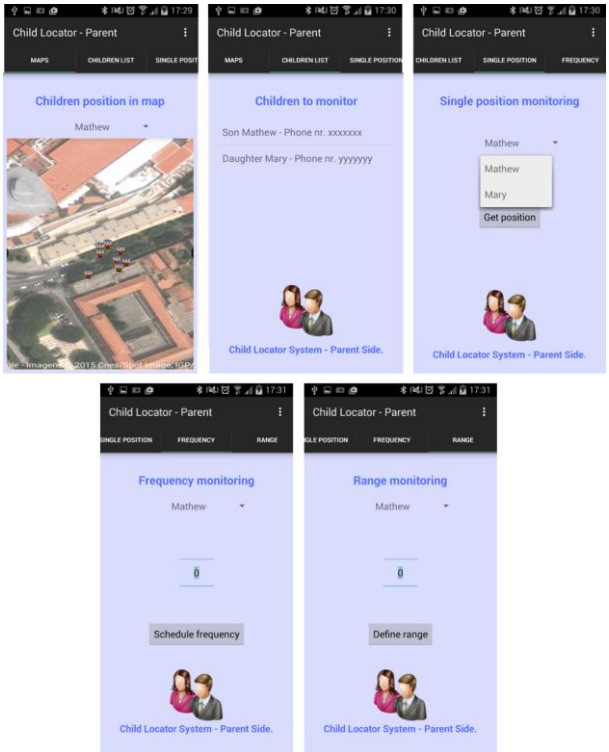

Figure 3. (A) Map with children´s position; (B) list of children the parent can monitor; (C) single position monitoring interface; (D) frequency monitoring interface; (E) range monitoring interface

3.5 Remote monitoring

As afore mentioned, there are three types of remote configuration available in the system. The next sections details each one of them. Figure 4 presents a flowchart of the child´s application behavior when a SMS is received from the parent.

Single position

This is the simplest type of remote monitoring and consists of an SMS sent from the parent to the child with the following format:

OP: SINGLE POSITION

When the child application receives a SMS with this text, it first checks if the person who sent the message is an authorized person in the application. If it is, a location request is issued using the Fused Location Provider on the onConnected method (ConnectionCallbacks interface) with the priority set to PRIORITY_HIGH_ACCURACY. There is no need to specify an interval as in this case were are only interested in one position. As soon as we obtain it (OnLocationChanged method) we stop the request so no more positions are obtained. As soon as the position is obtained an SMS is sent to the parent with the following format:

REPLY_SP:

LATITUDE:<lat>

;LONGITUDE:<long>;

DATE<date>;TIME<time>

As soon as the SMS is received by the parent application, an option to see the location in the map is presented to the parent. The child´s application behavior when a single position request is received in described in Figure 4.

Frequency Scheduler

This type of monitoring allows the parent to schedule the frequency that he wants to receive position updates from the child. In this case, the format of the sent SMS is the following:

OP: FREQUENCY <time>

To stop the scheduler, a request with frequency zero should be sent to the child.

OP: FREQUENCY 0

When the child application receives a SMS with this text, it first checks if the person who sent the message is an authorized person in the application. If it is, and if no frequency request is already in course, a location request is issued with the priority set to PRIORITY_HIGH_ACCURACY, the frequency and the fastest interval set to time.

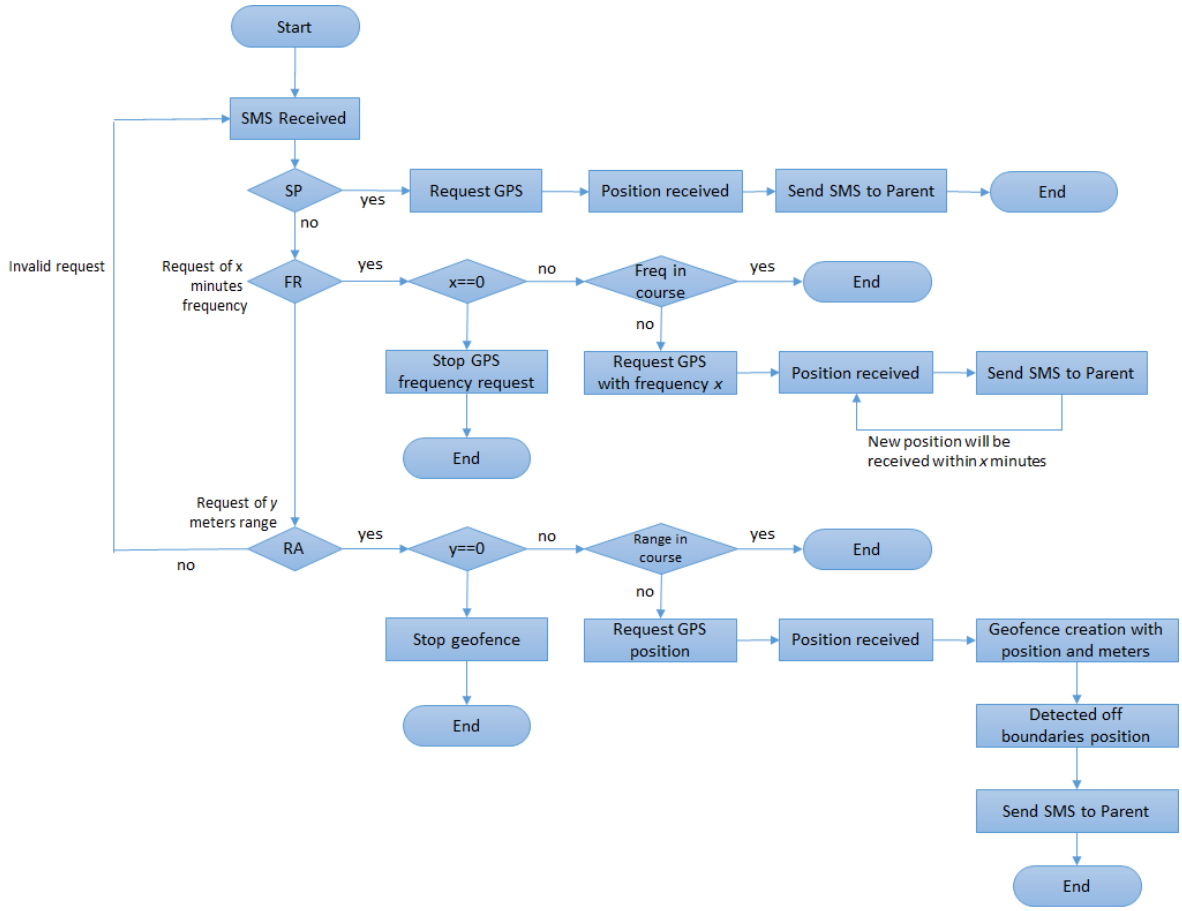

Figure 4. Flowchart of the child application

Whenever a new location is obtained (approximately from time to time seconds) the OnLocationChanged method is fired and an SMS is sent to the parent with the following format

REPLY_FREQ:

LATITUDE:<lat>;LONGITUDE:<long>;

DATE<date>;TIME<time>

Whenever the parent application receives a new SMS, an option to see the location in the map is presented. The child´s application behavior when a frequency request is received in described in Figure 4.

Range

This type of monitoring allows the father to define a secure range regarding to the child´s current position and receive an alert if the child leaves it. When the parent issues a range monitoring it is advisable he first issues a SINGLE_POSITION monitoring so he knows where the children is and be sure that is the position he wants to use as the center of the range. The SMS format for this type of monitoring is:

OP: RANGE <meters>

When the child application receives a SMS with this text, it first checks if the person who sent the message is an authorized person in the application. If it is, and if no range request is already in course, the current position is obtained (as described in SINGLE POSITION) and is then used, together with the meters receives and the option GEOFENCE_TRANSITION_EXIT, to define the region. Whenever the child leaves this area the father receives a notification with the following format:

REPLY_RANGE:

OFF BOUNDARIES;DATE<date>;

TIME<time>

To stop the range monitoring, a request with zero meters should be sent to the child.

OP: RANGE 0

4. Conclusions

In this paper we presented a mobile system to remotely monitor children via SMS and pre-defined templates. The proposed system architecture, developed in Android and the recent location API made available by the Fusion Location Provider, relies on two mobile applications, one for the parent and another one for the child, an SMS center and GPS satellites. The child application, beside initial configuration to define authorized senders, requires no interaction from the child. The parent has control over the remote monitoring process through his mobile application where he can visualize a map with the child last locations, manage the list of children to monitor, and issue three types of remote monitoring types: single position, frequency scheduler and range definition. We also presented the fluxogram that define the behavior of the child application whenever a SMS is received. The security aspect has not been neglected as the child application only handles SMS requests sent by predefined authorized senders.

As future work, we would like to define daily monitoring tasks in order to prevent the parent to send similar monitoring requests every day at the same hour. We assume most of the children this system applies to be in school during the day so with a high rate of probability the parent can schedule a monitoring routing for every day of the week. The child application should have a configuration module so the parent could specify that a single position should be sent from Monday to Friday at 10am and at 3pm and a range monitoring should be defined at 4pm with 500 meters.

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