# GeoFencing on a Mobile Platform with Alert Escalation – technical development

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**Abstract.** The increasing availability of GPS-enabled mobile devices can utilize position to provide a safer tracked environment allowing vulnerable people to continue with their daily activities, as much as possible. This paper investigates the technology options for alert escalation. The aim is to provide a safety net, without triggering unnecessary alarms. The escalation procedure involves initial speech alert to the user, then a speech and vibrate alert to the user as a reminder; this is followed by a text message to an identified carer if the user has not entered the safe zone. Parameters for alert escalation can be tuned to individual circumstances. The user can seek help at any time by getting directions from the current position to home or by calling a carer. We report on a small technical evaluation (n=6) of the development.

**Keywords:** geo-fence, alerts, escalation, route display.

## 1 Introduction

Due to problems with memory and orientation, older people and people with early stage dementia can easily get disorientated and lost when away from their home. The increasing availability of GPS-enabled mobile devices can utilize position information to provide a safer tracked environment allowing users to continue with their daily activities, as much as possible, thereby providing some reassurance to their carers. This paper investigates the technology options for sympathetic 'geo-fencing' with alert escalation. The aim is to provide a 'safety net', without triggering unnecessary alarms.

Mobile phones have become progressively more important in healthcare and are becoming a method of encouraging better communication between a vulnerable person and their carer. In today's society, we are becoming more aware of the desires of the older population to remain in their own living environment, and for example if they have been diagnosed with early stage dementia. This is also becoming an economic necessity. Dementia is the decline of cognitive functioning such as the ability to think, remember and reason; it adversely affects a person's daily life and quickly excludes them from society. With advances in medicine and technology the proportion of elderly people along with life expectancy is increasing; thus the number of people with dementia is predicted to almost double every twenty years [1]. Non-pharmacological management of dementia increases the burden on those who are taking care of an elderly or dementia suffering relative. Carers often need to assist with activities of daily living as well as being encouraged to promote functional independence of their dependent. The family usually takes responsibility as the primary carer(s), which is often an emotional and stressful task. Being a carer may also have a negative impact on health, employment and financial security. About one third of family carers showed signs of depression, while half reported effects caused by caring to be their major health problem (Alzheimer's Association) [2]. One of the most demanding behaviours to cope with is that of wandering. Wandering occurs because many dementia sufferers have hypertension and feel an urge to walk; roughly 40% get lost [3]. Using mobile phone technology, it is technically possible to provide a safer environment for the person and to assist their carers by contacting them if the person gets lost. By helping caregivers to form a better understanding of when, where and how to intervene, GPS technology could potentially extend the time that a vulnerable person can perform unsupervised outdoor activities [4].

Available applications, usually mobile apps that use GPS tracking were compared for functionality. These were Geofence, GPS TrackingPro, Real Time GPS Tracker (for the Android platform) and Garmin Tracker, GPS Tracker Vismo and Trax (for the iOS platform). Some technical and user disadvantages are:

- Need for external hardware in order to track a user
- No alerts to the user of the technology when they leave a safe area
- Little use of communication to alert family members as to wellbeing
- Limited feedback, e.g. route to get home may not be shown
- Safe areas have to be manually created by the user or carer.

In particular, little attention has been paid to the alert escalation, which will impact significantly upon the usability and hence uptake of geo-fencing applications. The bespoke application to be described in section 2 is called 'GeoCare'; it attempts to address these limitations.

## 2 Implementation Platform and Design

The GeoCare app uses Android version 4.0 [5, 6] or higher and was developed using the Java Eclipse environment. Additional development tools included Google maps Application Programmer Interface (API), Google directions API, Android Preference API, and Android Plot API. As the system uses `LocationClient` that is part of the Google Play Services, the implementation environment must provide both GPS and WiFi connectivity. QR functionality should also be installed to potentially supplement functionality and complement GPS data. Communication via the Internet utilizes HTTP requests and JSON responses. The performance is obviously dependent on the strength and coverage of the GPS signals.

The Geofence (a series of concentric circles) size varies appropriate to individual circumstances and preferences and is entered in a 'settings' file. The app locates the user every 30 seconds (this can also be set as it provides a trade of between time resolution and battery life). The system determines if user has breached the geo-fence. The escalation process is as follows. It uses speech alerts if user has not returned to safe area after the first alert within the `time_1` specified in settings. It escalates by using speech alerts and additional vibrate alerts if user has not returned to safe area after the second alert within the `time_2` specified in settings. The system sends a text message to the mobile number in settings if user has not returned to safe area after the third alert within the `time_3` specified in settings. Diameter of the fence(s) can also be set. A number of options are available should a user get lost. The user can click a button to determine directions from user current location back to their starting location and display them on map. If the environment is enrich with QR codes, then these can be scanned to provide information. A further ‘SOS’ button allows the user to call a designated emergency contact if they get lost or disoriented.

Of course the system will also perform in benign fashion when the user has not got into any difficulty. For example, the system allows the user to share activity on Facebook, Twitter, LinkedIn and via email. This can provide reassurance to the user and their carer.

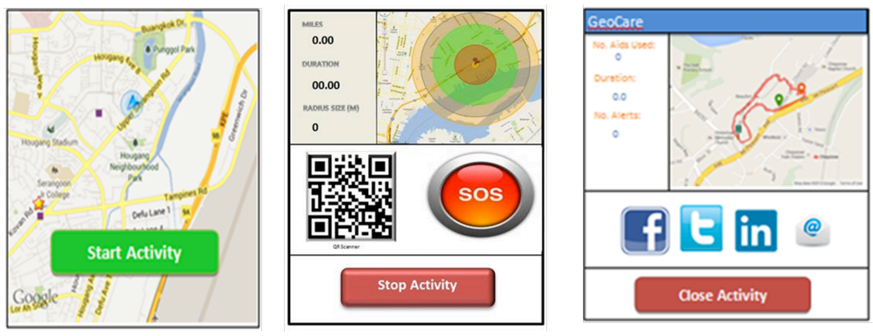


**Fig. 1.** User interfaces to promote user interaction; start of activity, geo-fence perimeters, QR scanner and ‘SOS’ button; feedback and options for sharing activity

Retrieving the weather condition was a lower priority requirement; however it became apparent during implementation that this would make a nice feature. `Openweathermap` offer multiple API’s to retrieve the weather information, To be able to retrieve the weather data from a remote server, the system uses HTTP protocol to connect to the URL to get the data and it reads the JSON response, which is parsed. The `Weather.Java` class is populated with all of the retrieved data.

## 3 Discussion

In order to gauge the usability, functionality and overall rating of the application six users tested the system for technical features. The users were final year Computer Science students (age range 22-25) and hence not representative of the intended user demographic. Thus at this stage we can only claim an initial technical evaluation. Each user was provided with an evaluation questionnaire and informed of the application's purpose and main functionality. Evaluation results from the returned questionnaires are shown in Fig 2.

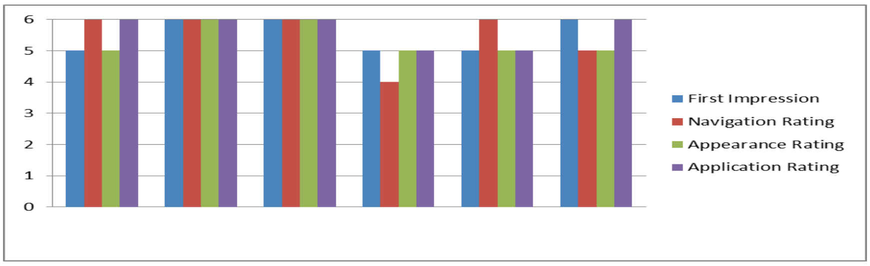


**Fig. 2.** Evaluation (scale 1-6): impression, navigation, and appearance, overall rating

First impressions, navigation rating, appearance rating and overall application rating were evaluated on a scale of 1-6, 6 being excellent and 1 being very poor. As well as the ratings, five out of six participants stated they would use the application and all participants stated they would recommend it to a friend. Of the feedback received, one participant stated that "it was easy to program different settings for different types of patients". One participant encountered a technical problem whereby the application crashed; this was due to the website used to retrieve the weather data has temporarily gone offline at that point. Another participant stated that an icon was used to ensure the user knew their location marker on the map would be useful; this suggestion was implemented for future users.

Technical recommendations for further work include the use of a database to allow the user to query and visualize stored data; functionality to forecast weather; an integrated QR application (rather than the user having to download `Zxing`). Of course further evaluation on the intended population of users (older and vulnerable people and their carers) is fundamental to both the addition of useful features and the acceptance of the technology. An 'in the wild' study with intended users is necessary to validate the effectiveness of our escalation strategy. There are ethical issues to the deployment of such technology, which must be addressed to pursue this. Further work can also be undertaken on a more intelligent approach to escalation, which determines actual street topography, and if the user is moving towards home.

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