GuideMe: an outdoor/indoor navigation app based on the i-locate open toolkit

Daniele Miorandi[1], Erinda Jaupaj[1], Carlo Caprini[1], Andrea Zito[1], Rossana Bartolacelli[1], Iacopo Carreras[1], Angelos Anagnostopoulos[2], Anestis Trypitsidis[2], Marc Bonazountas[2], Giuseppe Conti[3], Stefano Piffer[3], Nicola Dorigatti[3], Tao Feng[4], Joran Jessurun[4], Theo Arentze[4]

[1] U-Hopper srl, v. A. da Trento 8/2, 38100 - Trento, Italy. Email: {name.surname}@u-hopper.com

[2] EPSILON International SA, Monemvasias 27, 15125 Marousi, Greece. Email: bonazountas@epsilon.gr

[3] Trilogis Srl, Via Zeni 8, 38068 Rovereto (TN), Italy. Email: {name.surname}@trilogis.it

[4] Eindhoven University of Technology, Vertigo 8.16, 5600MB, Eindhoven, The Netherlands. Email: t.a.z.arentze@tue.nl

Abstract

GuideMe is an outdoor/indoor navigation app for Android. Based on open standards (e.g., indoorGML) and open data (from OpenStreetMap), it was built using the open source i-locate toolkit, which allows researchers, Web entrepreneurs and innovative startups to quickly and easily design and deploy indoor/outdoor location-based services. The GuideMe app provides end-to-end routing and turn-by-turn navigation through outdoor and indoor environments. Different positioning technologies are supported for both the outdoor and indoor parts. The app is released under an Apache v.2 license, leaving it open for the community to extend and enhance it.

Keywords

navigation, routing, indoor, indoorGML, i-locate

1 Introduction

Outdoor navigation services can nowadays be considered a commodity. Boosted by the ubiquitous adoption of GPS technologies in smartphones and by the emergence of popular mapping service, a large number of applications supporting routing and turn-by-turn navigation have been developed for various platforms.

But what about indoor environments?

The lack of a widely adopted standard for the representation of indoor spaces and the inherent difficulty in achieving accurate indoor positioning have long made this unfeasible. The recent emergence of a number of indoor positioning technologies and the arising of the indoorGML standard[1] are now changing the picture.

---

1 http://indoorgml.net/

The i-locate project[2] is a cooperative R&D&I endeavour whose mission is to develop an open source toolkit for fostering the creation of an ecosystem of indoor/outdoor location-based services. One of the services developed is GuideMe, an app for indoor/outdoor routing and navigation. The app is released as open source under a permissive license (Apache v.2) and is released to the community for being enhanced and tailored to specific service needs.

The remainder of this paper is organised as follows. Sec. 2 introduces briefly the i-locate toolkit. Sec. 3 presents the GuideMe app. Sec. 4 concludes the paper.

2 The i-locate toolkit

The i-locate toolkit is a flexible, open and extensible middleware meant to facilitate the development and deployment of location-based services by providing standardised interfaces and open-source technology enablers.

2.1 Architecture

The toolkit is based on a layered architecture, whose high-level logical structure is reported in Fig. 1.
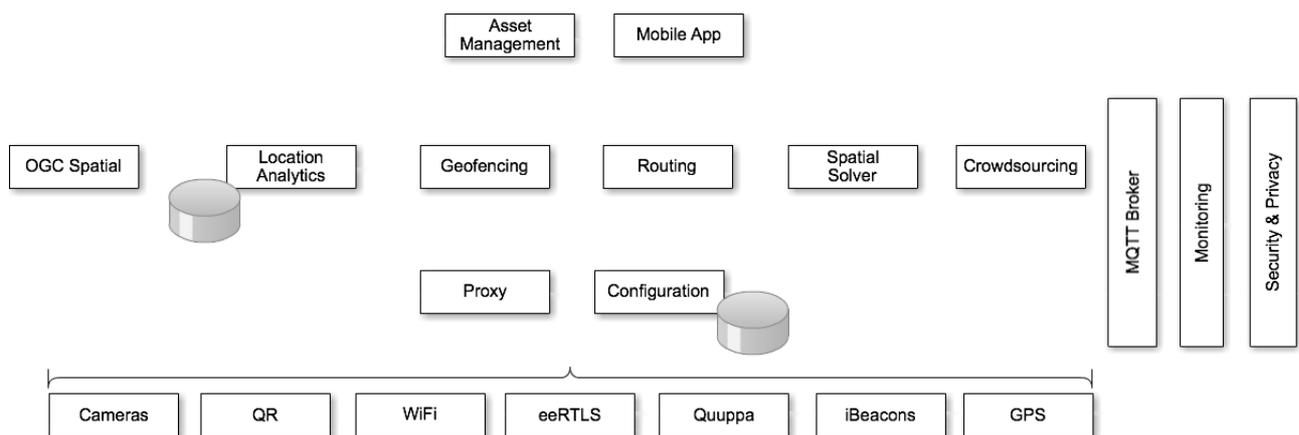

Figure 1: i-locate toolkit architecture (logical view).

The toolkit includes the following components:
- Core localization services
  - Proxy: represents the unique entry point for LBS enablers to get localization data about system entities. It connects with a number of positioning technologies, including WiFi, Quuppa, eeRTLS, cameras etc.
  - Configuration: provides access to additional information of specific devices within various indoor localization technologies like battery status or firmware revision etc.
- Generic LBS Enablers:
  - Spatial solver: the module provides an interface to the Open Data Repositories and to the current position of assets; it provides a spatial query interface, providing processes data to the caller.

---

2 http://www.i-locate.eu/

- ○ OGC Spatial: this module provides access to the geographical information in a standardised way, enabling third party software to ingest the (spatial) information without any conversion.
  - ○ Routing: is the component capable to generate a route plan and corresponding turn-by-turn directions for a trip with given origin and destination location.
  - ○ Geofencing: this module is responsible to ingest the location information of an asset (person) and on that verify spatial roles (entry/exit from a room) defined case by case.
  - ○ Location analytics: this module computes a number of statistics related to the occupancy of indoor spaces. Indicators computed include total dwell time, frequency of visits to a given area, time spent within a given area, transitions among indoor areas etc.
  - ○ Upload/Download: allows upload of arbitrary files attached to a site in the portal,and download through a web service. IndoorGML navigation data can also be downloaded.
  - ○ Crowdsourcing: this module provides i-locate users with the opportunity to enter and validate geo-localised information.
- ● Specific LBS Enablers:
  - ○ Asset management: the module provides the ability to accurately represents assets and the definition of maintenance processes.
  - ○ Mobile app: this refers to the GuideMe app subject of this paper.
- ● Cross-cutting modules:
  - ○ Security & Privacy: based on OpenAM[3] is the component allowing a relying party to identify the principal and determine if service is to be offered.
  - ○ Monitoring: monitors the functioning of the toolkit runtime providing diagnostics and statistics.
  - ○ Mqtt broker: a pub/sub communication system used to let enablers access location updates from the proxy.

More details can be found in Anestis et al. (2014) and Piffer et al. (2014).

2.1 Relevant Components

The following i-locate toolkit components are used to support the app backend operations.

2.1.1 Proxy

The goal of the proxy component is to provide location information relative to i-locate entity(ies), specified by a given unique ID. The key functionality provided by this module is to return the position of a given object; this is offered in both push and pull mode. At the moment it supports the following positioning technologies: WiFi (through Combain APIs[4]), Quuppa Intelligent Locating System[5], ZigPos eeRTLS[6], cameras, QR codes, GPS, EGNOS, iBeacons, UWB. See Miorandi et al. (2015) for more details.

---

3 https://www.forgerock.com/en-us/products/access-management/
4 https://combain.com/
5 http://quuppa.com/
6 http://www.zigpos.net/zigpos/index.php?c=2&a=36

2.2.2 Outdoor Localization

The outdoor localization component currently supports localization through GPS and WiFi (through the Combain APIs). It is shipped in the form of an Android native library, which is integrated in the app for ease of usage.

2.2.3 Routing

The routing service works for both indoor and outdoor routing, with a specific definition of the indoor data structure. Given the start and end locations specified by longitude and latitude coordinates, the service gives the optimal route. The routing service supports multimodal routing from door-to-door in a seamless way across outdoor and indoor environments. In this first release implementation, the routing service currently allows only a single level/floor for indoors. It will allow the navigation among multiple floors by incorporating stairs, elevators, open spaces, etc. Furthermore, in this first release turn-by-turn navigation guidance adopts the same structure as for outdoor routing.

The routing service of integrated indoor and outdoor navigation is built upon the OpenTripPlanner (OTP)[7], an open source software specifically designed for multimodal routing.

The data used for outdoor routing are based on OpenStreetMap[8] and GTFS data[9]. The i-Locate routing system extends the OTP by incorporating indoor routing using the indoorGML standard for the representation of indoor spaces.

2.2.4 OGC Spatial

The spatial services are supported by the use of Geoserver API. In the first version of the toolkit, following OGC standards are provided:
- WMS, Web Map Service;
- WFS, Web Feature Service.

3 The GuideMe app

The GuideMe app comes in the form of a flexible prototype which supports:
- Display of a map with current location;
- Ability to search the route to a given location (across indoor/outdoor);
- Display the computed route on a map;
- Navigate the user to the intended destination;
- Notify the user that it is entering the destination building;
- Display an indoor map with the current location;
- Signal the user of the arrival at the intended destination.

The mobile client has been developed using the Titanium Appcelerator SDK v.3.4.1[10] for ensuring cross-platform support. In the initial phase of development, and given operating system-level restriction in terms of access to raw GPS and WiFi data (see Outdoor Localization component description above), we have decided to focus on Android as target operating system.

The mobile client interoperates with the following other toolkit components running in the backend:

---

7 http://www.opentripplanner.org/
8 http://www.openstreetmap.org/
9 https://developers.google.com/transit/gtfs/
10 http://www.appcelerator.com/titanium/

• Proxy: for retrieving indoor/outdoor position based on the provided client-measured parameters (e.g., WiFi access points BSSID and RSSI);
• Outdoor localization: for retrieving GPS and WiFi data;
• OGC Spatial: for accessing reverse geocoding functionality;
• Routing: for computing route to a destination (outdoor/indoor);
• Upload/Download: to dynamically download indoor map of the reference building.

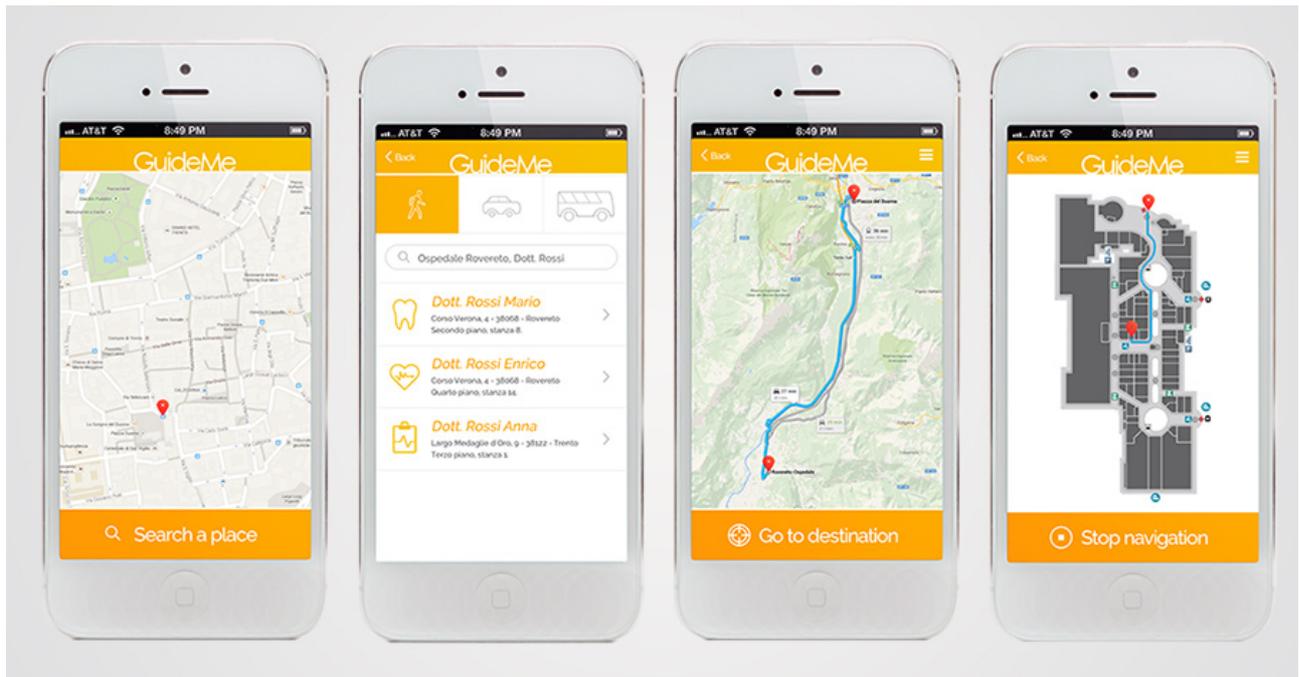The GuideMe app is released under Apache v.2 license at https://gitlab.com/ilocate/ilocate-app

Figure 2: GuideMe app screenshots.

4 Conclusions

GuideMe is meant to act as a template for the community to quickly and easily develop navigation apps able to seamlessly work in both outdoor and indoor environments. The app builds upon the open source i-locate toolkit. While the app already supports a number of different positioning technologies and presents basic functionalities, we strongly encourage the community to contribute to its further development and to use it, properly tailored, to support additional use cases.

References

✔ Trypitsidis, A. et al. (2014). System Architecture. i-locate project deliverable D.1.4. Retrieved from htttp://www.i-locate.eu/public-deliverables/
✔ Piffer, S. et al. (2014), i-locate toolkit v.1.0. i-locate project deliverable D.3.1. Retrieved from http://www.i-locate.eu/public-deliverables/

✔ Miorandi, D. et al. (2015). Localisation and tracking systems. i-locate project deliverable D.3.2. Retrieved from http://www.i-locate.eu/public-deliverables/