

Development of a Mobile Location-Aware Campus Map Application**ABSTRACT**

Considering most of our Universities that have a stationary campus map at their main entrance which in most cases is outdated; with a campus that is expanding in size and in its number of buildings, locating those buildings can be very tedious especially for someone new to the campus. Hence, this work addressed the issue of designing and implementing a mobile location-aware campus map application that aids navigation and location of landmarks within the campus. The work brought up a location-aware application which enables its user to locate himself or herself and landmarks within Bowen University Campus. The system was designed with the view of providing maximum simplicity, quality user experience, great user interface and most importantly accurate data

Keywords: *Location-aware map, GPS, Google map, Mobile Computing*

1. INTRODUCTION

The Yoruba has a proverb which says “*Abere ona ki I sina*” meaning he who asks for direction will not miss his way. That proverb is half true and half false as the determinant of that is the person that is being asked. With the ubiquity of today’s sophisticated mobile devices, and mobile phones having capacities that beats that of some desktops, that right person might just be lying in your hands. Location guides have to exploit the advantage of mobile smartphone to make navigation easier for users.

Location-awareness is a component of presence technology that delivers information about a device physical location [1]. The purpose of a location-aware campus map is to make navigation and finding locations for freshmen and visitors easy. The use of static campus maps would be another useful option for the person but the use of static maps (unintelligent maps) can also be frustrating when the knowledge of map reading is unavailable.

Figure 1 shows the image of the campus map in use. The existing system is a flat stationary board at the entrance of the campus that tries to describe the campus environment, this map is outdated and is not comprehensive enough, this makes people not to bother look at it. This system is not mobile and because it is not current it is not being used.



Fig. 1: Existing campus map

This previous campus guide approach motivated the need for intelligent location-aware maps, this type of maps not only guide the user but it also informs the user of their current location and how close or far they are from their destination. This work is aimed at developing a location-aware campus tour guide using Bowen University as a case study and which will as well expose us to old and new methods of navigation.

2. RELATED WORKS

During the last few years, mobile phone has gained significant progress in its development with respect to memory capacities, processing capacities and improved hardware features. Nowadays the use of mobile phones has become a basic necessity for people, with mobile phones having advanced features and being able to perform sophisticated things, we can refer to this era as the era of smart phones [2].

Two important and major technologies has empowered users with computing power and network resource at hand as they move from one place to another, they are portable computers (mobile computers) and wireless communication. With the trend of computers shrinking in size and increasing wireless network bandwidth, more than ever this has enabled people to access files and data anytime and anywhere. "Mobile computing refers to the use of any kind of computer in a moving environment"[3].

Context-aware computing however is a mobile computing paradigm in which application can discover and take advantage of contextual information such as user location, time of day, nearby places and activities and user's activity [2]. One of the most used contexts in context aware computing is location; this is due to the fact that people and mobile devices change position frequently. Location-awareness is a component of presence technology that delivers information about a device's physical location to another

user or application [3][4]. The research team at Olivetti Research Limited(ORL) Xerox PARC laboratory pioneered the context aware computing area under the vision of ubiquitous computing which is also called pervasive computing, with a goal of making computers available throughout the environment and yet making them invisible to the users. Since then, researchers has gained interest in this area and contributed to it [2].

Chen and Kotz in [2] defined context awareness as being complementary to location awareness. They stated that whereas location may serve as a determinant for resident processes, context may be applied more flexibly with mobile computing with any moving entities, especially with bearers of smart communicators; however, Chen and Kotz [2] defined context awareness in terms of active context awareness (a situation whereby an application automatically adapts to discovered context, by changing the application's behavior) and Passive Context awareness (a whereby an application presents the new or updated context to an interested user or makes the context persistent for the user to retrieve later).

Authors in [5] described location awareness as the concept of sensing and reacting to dynamic environment. Location being a crucial component of context has undergone series of research in the past decades; these researches have focused on location-sensing technologies, location-aware application support and location based applications. Many companies have employed the concept of location-awareness and hence developing navigation systems and context-aware map applications.

According to [6][7], Global Positioning System (GPS) was described as one of the technologies that are used in a huge number of applications today. One of the applications is tracking your vehicle and keeps regular monitoring on them. This tracking system can inform you the location and route travelled by vehicle, and that information can be observed from any other remote location. It also includes the web application that provides you exact location of target.

A campus map application is a dynamic electronic map that guides individuals around a campus environment. It should have the ability to perform navigational functions, show the users current location should be able to identify the user's point of interest (POI) and should be able to give a little description of those POI and most importantly, it must be user friendly. Campus map application includes mapping location of objects and the map giving the location and or direction to such objects. GPS applications allow users to enter a destination and based on their current coordinates displays the fastest way to the destination [8]

Google Maps and Google Navigation display navigation information. As technology evolves, it has begun to incorporate various types of navigation, such as bus routes, driving directions, walking directions and biking directions [9][10]. Kincaid and Marissa in [11] equally revealed that Google maps and GPS systems have become indispensable in recent years, with vast amounts of users relying on them for directions but according to [12] their capabilities have not yet been fully applied to university campuses. Directions within campuses are not available using Google map application and as such this work is geared towards making provision for such on mobile devices due to the fact that emerging location-aware mobile technologies are being applied successfully and different technologies such as Radio-Frequency

89 Identification (RFID), Wireless Fidelity (Wi-Fi) and so on are being applied to allow mobile devices interact
90 with the environment [13].

91 **3. METHODOLOGY**

92 In order to achieve the aim of this work, find below the methods, procedures, tools and technology used
93 for the work.

94 The major data collection instrument for this project was a GPS device. This project being a Global
95 Information System (GIS) application requires a location aware or a location detection device. The Global
96 Positioning System (GPS) device alone is enough to gather data required for the application, but it is
97 liable to some errors- inaccurate readings, to boost the accuracy of the GPS device we combine it with
98 services offered by mobile telecommunication companies. So for accurate data, this system is getting its
99 data from a GPS device and data from mobile telecommunication companies.

100 The data being collected is location data, and these data are collected a number of times and the average
101 reading is chosen. For this project the data collection instrument was an Android device with GPS
102 hardware and an internet enabled SIM card because the use of Wi-Fi network can generate undesired
103 data.

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105 Considering the application architecture as shown in figure 2, this was modeled as a graph G . The graph
106 G consist of the following vertices namely Mobile Device (MD), Internet(I), Google Map Server (GMS),
107 GPS Satellite (GPSS), and Online Database (OnDb). Figure 3 shows the graph

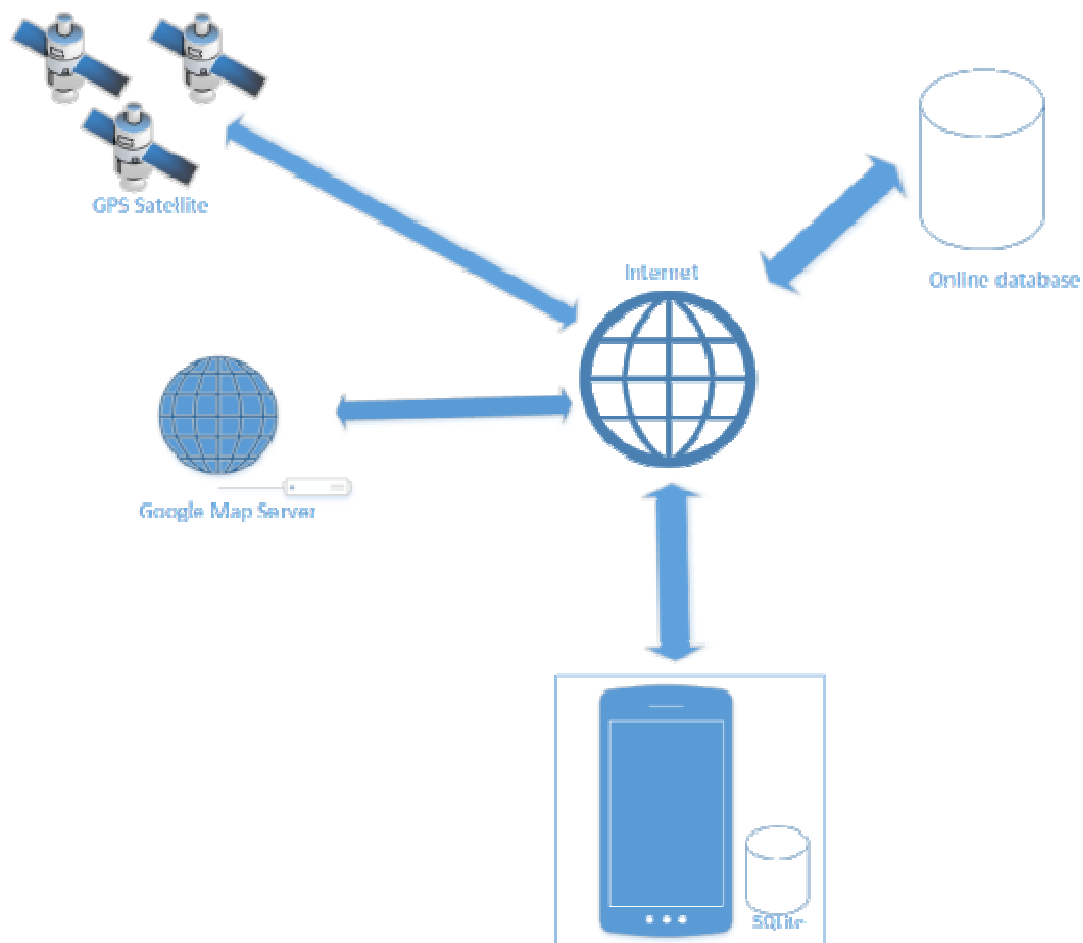


Fig. 2: Application architecture

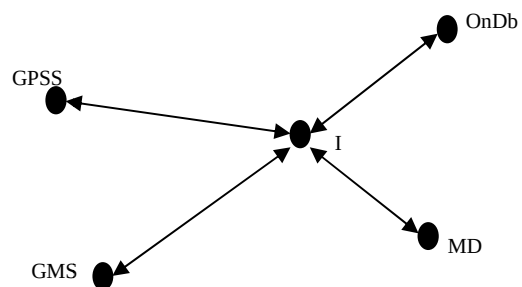


Fig. 3: Graph for the application

120 G is formally described as follows.

$$G = G(V, E) \quad (1)$$

$$V = \{GPSS, GMS, I, MD, OnDB\} \quad (2)$$

$$E = (\{GPSS, I\}, \{GMS, I\}, \{MD, I\}, \{OnDB, I\}) \quad (3)$$

121 There is a bidirectional (extraverted) edge between the vertex I (Internet) and every other vertex of the
 122 application. This implied that the vertex I is the gateway vertex in order to establish point-to-point wireless
 123 link among the application components for realizing the application workability. This also implies that
 124 every other vertex is adjacent to vertex I. Table 1 shows the adjacency matrix for the modeled application

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126 **Table 1. Adjacency matrix**

	GPSS	GMS	I	MD	OnDb
GPSS	0	0	1	0	0
GMS	0	0	1	0	0
I	0	0	0	0	0
MD	0	0	1	0	0
OnDb	0	0	1	0	0

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128 The specific components of the architecture are:

- 129 i. Mobile Device: is an android based device on which the application resides, this platform
 130 provides functional libraries that enables the app to work properly, since it is a mobile
 131 application platform that makes it best suit for this project.
- 132 ii. Internet: the major component of this application requires the internet, the Google Maps API
 133 most especially requires the internet, and the internet is also required for pooling data from
 134 the server. Also for any GIS application/ system to work it needs the internet because a GPS
 135 dongle or device will not work if there is no internet for it to connect to the GPS satellite.
- 136 iii. Database: this is the database that will hold the location data. For this application, there are
 137 two databases; the online database on the web server and the local SQLite database on the
 138 mobile device.

iv. GPS satellites: they make it possible for the application to get the current location of the mobile device.

v. Google Map Server: It is the server from which Google map related data is pooled from through the aid of the internet.

Theoretically, the mobile device received signal power P_r which follows the radial propagation model, as described in Equation (3) [14], where dBm is the distance between the mobile terminal and access point d_o , which is the reference distance, normally equal to 1 meter. n is the attenuation parameter, which is equal to $n=2$ in free space and $n=1.5$ in indoor scenarios [14].

Since distance can contribute to attenuation which is reduction in signal strength, a model as described in equation (4) can better model the propagation in equation (3), where AF means the Attenuation factor, which is the loss of signal power as a result of distance.

$$P_r[dBm] = P_r(d_o)[dBm] - 10n \log \left(\frac{d}{d_o} \right) \quad (3)$$

$$P_r[dBm] = P_r(d_o)[dBm] - 10n \log \left(\frac{d}{d_o} \right) - \left\langle \sum_c AF_{i \geq k}^{i < k} \right\rangle \quad (4)$$

With the above equations, the implication is that signal strength is obtained from the various available mobile operators for campus aware application to work properly since the technology of both google map and GPS were employed to pick locations on campus either outdoor or indoor spots on campus. Equally, provision was made to handle any eventuality of attenuation (which is a situation whereby there is signal loss or reduction in signal strength due to distance and infiltration of noise) in the cause of signal transmission and reception.

Figure 4 displays the flowchart depicting the flow of operation of the application.

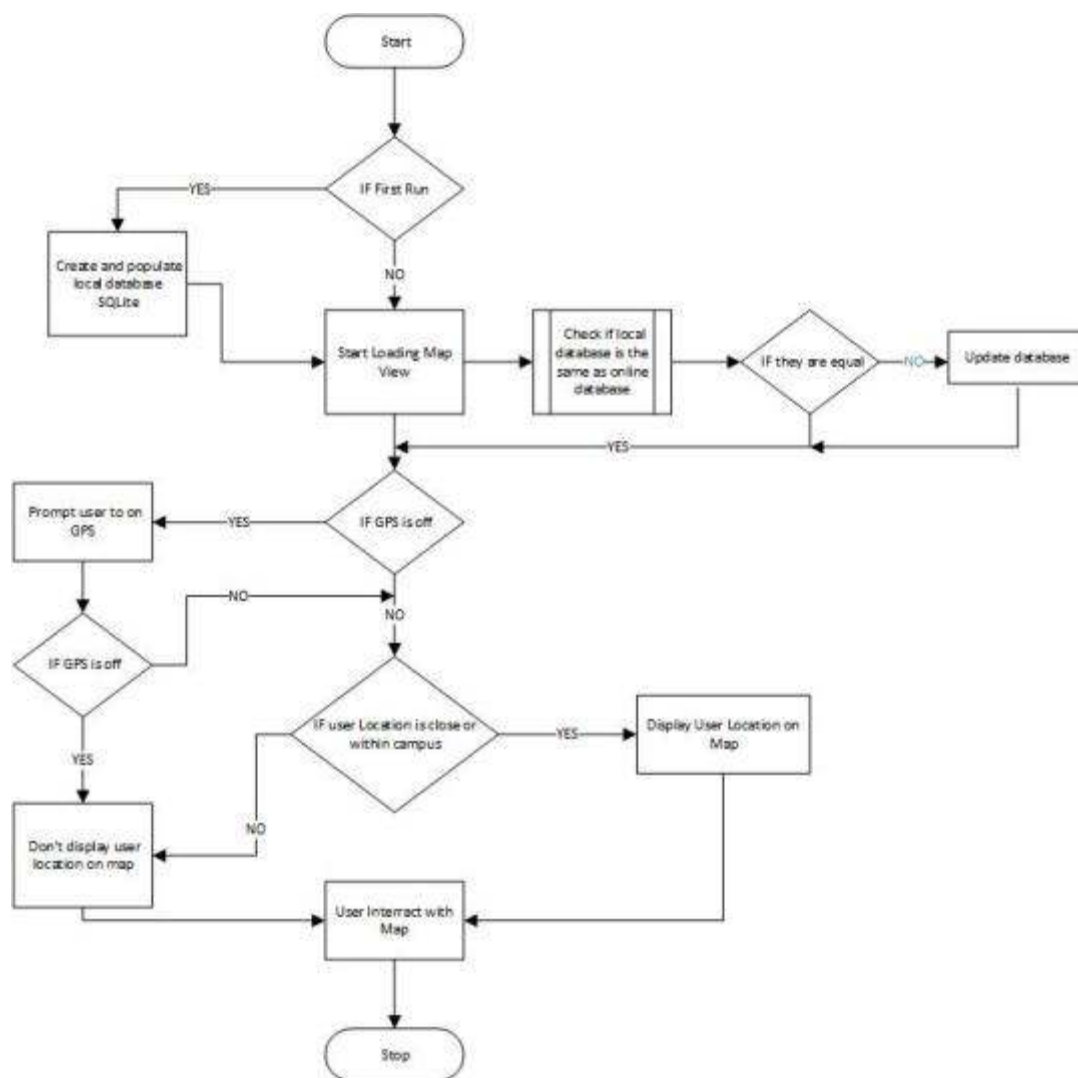


Fig. 4: Flow chart

4. RESULT AND DISCUSSION

Agile software approach was employed for the application development due to the fact that it is an iterative, incremental development where requirements for a system can evolve during the lifetime of the software. The approach is flexible and supports map application requirements which are liable to surface and evolve.

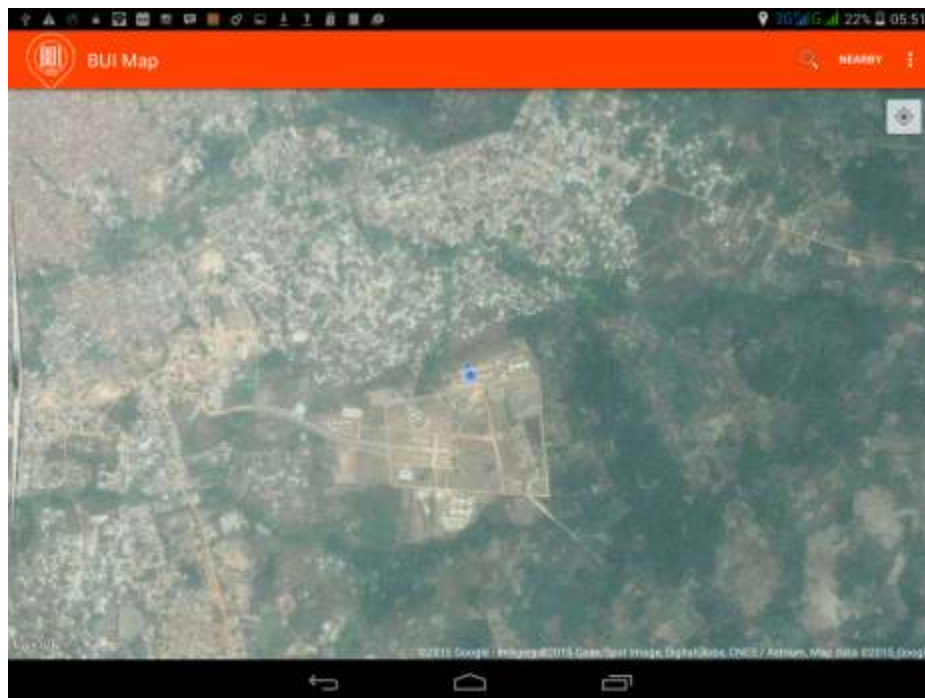
The essence of the mobile location campus map application is to provide users location and landmarks around them. Other features of the application include searching for places, checking nearby landmarks and getting brief description of landmarks.

169 The user interface is designed to conform to android design pattern which is aimed at providing users
170 with friendly interfaces. Some of the screenshot of the application are shown below

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Fig. 5: Landscape orientation after the app is launched

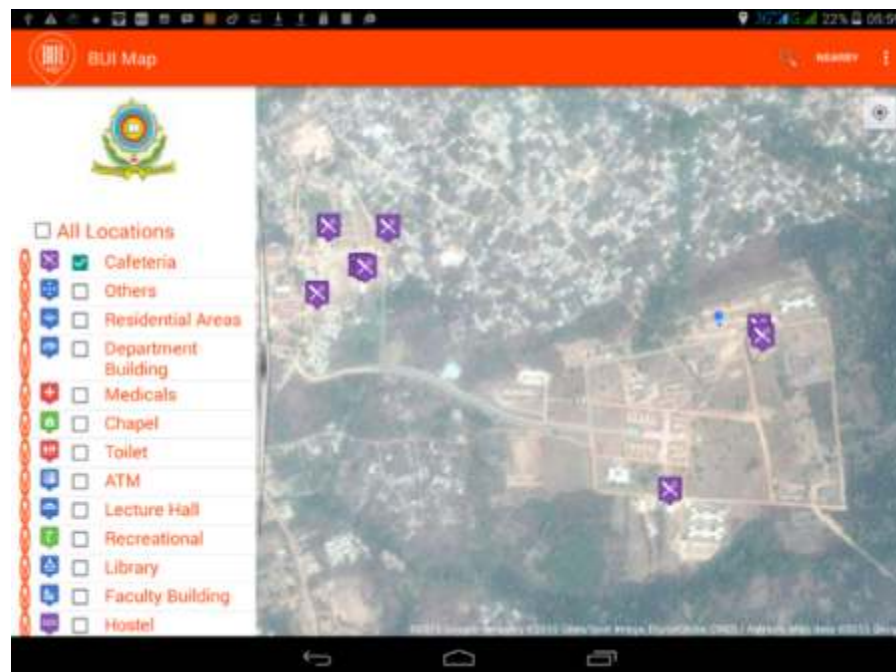


Fig. 6: Interface showing only cafeteria category selected

5. CONCLUSION

With great advancement in mobile computing and drift to mobile devices, people are taking advantage of being connected to data, and are enjoying the benefit of information being close to them. The advancement of mobile technology has aided industries like social media, location services, object tracing etc.

Location-awareness has been making use of mobile platforms for decades now; it is time for universities to use mobile platforms to solve their needs. Decades ago desktops and laptops used to be powerful tools compared to mobile phones, but now mobile platforms are more powerful than some desktop and laptops, universities need to apply the power of mobile computing platforms (smartphone technology) to meet their needs, ranging from administrative, learning and research needs.

REFERENCES

- [1]. Rouse, M. (2015). Location Awareness definition Accessed 25 January 2016 Available: <http://searchmobilecomputing.techtarget.com/definition/location-awareness>
- [2]. Chen, G., and Kotz, D. (2000). *A survey of context-aware mobile computing research* Technical Report TR2000-381, Dept. of Computer Science, Dartmouth College. 2000;1(2.1):2-1.
- [3]. Phanikanth, C., Krishna, T. R., and Phanikrishna, C. V. *A Survey on Location Aware and Context Aware In Mobile Applications*. 2012

- 198 [4]. Marmasse, N., and Schmandt, C. Location-aware information delivery with commotion. 2000 In
199 *Handheld and Ubiquitous Computing* (pp. 157-171). Springer Berlin Heidelberg.
- 200
- 201 [5]. Hazas, M., Scott, and J. *Location-aware computing comes of age*. Computer. 2004;37(2):95-97
- 202
- 203 [6]. Verma, P., and Bhatia, J. S. Design and development of GPS-GSM based tracking system with
204 Google map based monitoring. *International Journal of Computer Science, Engineering and*
205 *Applications (IJCSEA)*, 2013;3(3):33-40.
- 206
- 207 [7]. Misra, P., and Enge, P. Special issue on global positioning system. *Proceedings of the*
208 *IEEE*.1999;87(1):3-15.
- 209
- 210 [8]. Wood T.D. How to Use a Hand Held GPS Receiver. 2012 Accessed 6 January 2016 Available:
211 <http://www.rei.com/learn/expert-advice/gps-receiver-howto.html>
- 212
- 213 [9]. Cardei, M., Jones, B. and Raviv, D. A Pattern for Context-Aware Navigation. 2013 Accessed 6
214 January 2016 Available: www.cse.fau.edu/~mihaela/html/papers/fau_plop13.pdf
- 215
- 216 [10]. Verma, P., and Bhatia, J. S. Design and development of GPS-GSM based tracking system with
217 Google map based monitoring. *International Journal of Computer Science, Engineering and*
218 *Applications (IJCSEA)*, 2013;3(3):33-40.
- 219
- 220 [11]. Kincaid J., Marissa Mayer (2011). 40% of Google Maps Usage is Mobile (and there are 150
221 Million Mobile users). 2011 Accessed 4 December 2015 Available:
222 [http://techerunch.com/2011/03/11/marissa-maer-40-of-google-maps-usages-is-mobile-and-there-](http://techerunch.com/2011/03/11/marissa-maer-40-of-google-maps-usages-is-mobile-and-there-are-150-million-mobile-users/)
223 [are-150-million-mobile-users/](http://techerunch.com/2011/03/11/marissa-maer-40-of-google-maps-usages-is-mobile-and-there-are-150-million-mobile-users/)
- 224
- 225 [12]. Mihaela Cardei, Iana Zankina, Ionut Cardei and Daniel Raviv. Campus Assistant Application on
226 an Android Platform. 2013 Accessed 6 January 2016 Available:
227 <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.438.5970&rep=rep1&type=pdf>
- 228
- 229 [13]. Tesoriero, R., Gallud, J. A., Lozano, M., and Penichet, V. M. R. A location-aware system using
230 RFID and mobile devices for art museums. 2008 In *Autonomic and Autonomous Systems, 2008.*
231 *ICAS 2008. Fourth International Conference on* (pp. 76-81). IEEE.
- 232
- 233 [14]. Hui Wang, Henning Lenz, Andrei Szabo, Joachim Bamberger and Uwe D. Hanebeck (2007).
234 Enhancing the Map Usage for Indoor Location-Aware Systems. 2007 Accessed 26 November
235 2015 Available: https://isas.uka.de/Publikationen/HC107_Wang.pdf
- 236
- 237