British Journal of Mathematics & Computer Science
15(3): 1-9, 2016, Article no.BJMCS.24640
ISSN: 2231-0851

SCIENCEDOMAIN *international*
www.sciencedomain.org

Development of a Mobile Location-aware Campus Map Application

Akinwale O. Akinwunmi[1*], Halleluyah O. Aworinde[1] and Moses B. Adewale[1]

[1]Department of Computer Science and Information Technology, Bowen University, Iwo, Osun State, Nigeria.

Authors' contributions

This work was carried out in collaboration between all authors. Author AOA designed the study and supervised the work. Authors AOA, HOA and MBA carried out all laboratories and field work. Authors AOA and MBA wrote the first draft of the manuscript. Authors AOA and HOA managed the literature searches and edited the manuscript. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/BJMCS/2016/24640
Editor(s):
(1) Doina Bein, Applied Research Laboratory, The Pennsylvania State University, USA.
(2) Dariusz Jacek Jakobczak, Chair of Computer Science and Management in this Department, Technical University of Koszalin, Poland.
Reviewers:
(1) Vaishali D. Khairnar, Mumbai University, Mumbai, India.
(2) M. Bhanu Sridhar, GVP College of Engg for Women, Vizag, India.
(3) S. V. Saboji, Basaveshwar Engineering College, India.
Complete Peer review History: http://sciencedomain.org/review-history/13805

Short Research Article

Received: 28th January 2016
Accepted: 2nd March 2016
Published: 22nd March 2016

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Considering most of our Universities that have a stationary campus map at their main entrance which in most cases is outdated; with a campus that is expanding in size and in its number of buildings, locating those buildings can be very tedious especially for someone new to the campus.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.

**Corresponding author: E-mail: akinwale.akinwunmi@bowenuniversity-edu.org;*

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.

Fig. 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 border look at it. This system is not mobile and because it is not current and it is not being used.

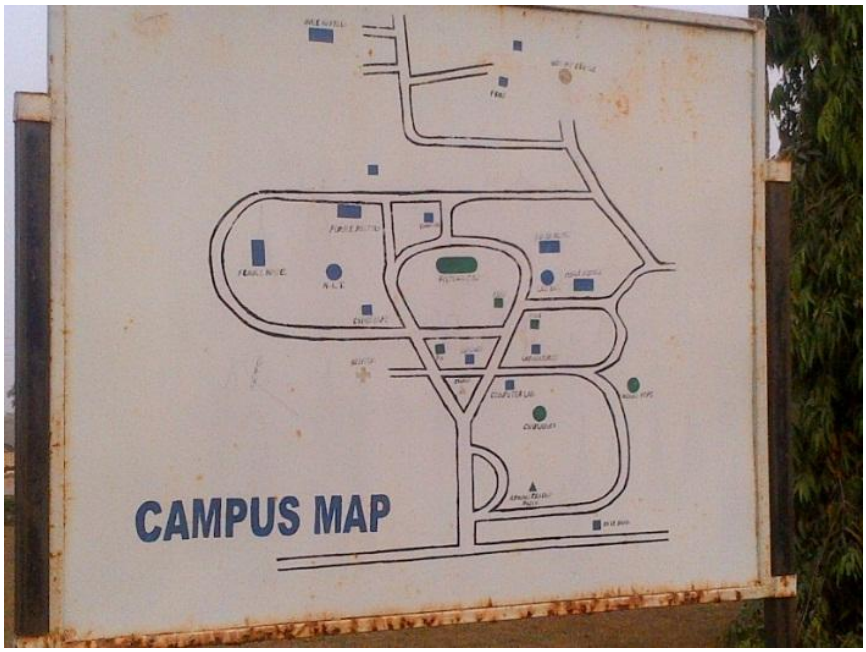

Fig. 1. Existing campus map

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

3 Methodology

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

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

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

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

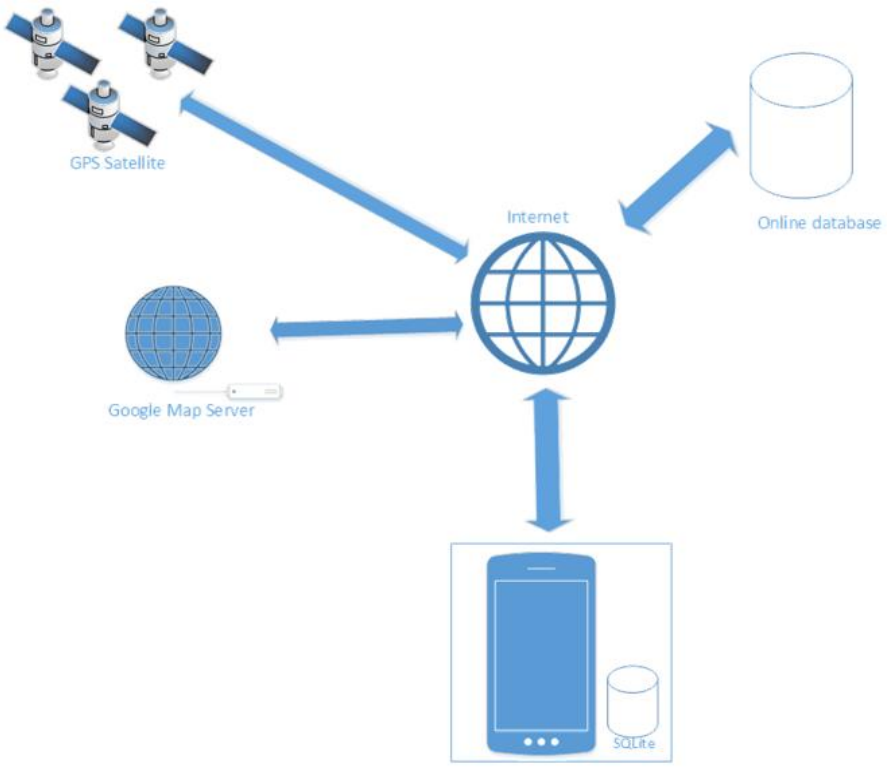

Fig. 2. Application architecture

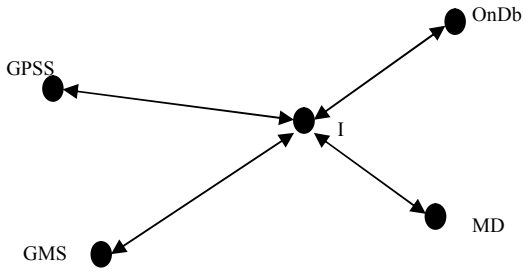

Fig. 3. Graph for the application

G is formally described as follows.

$$G = G(V, E) \tag{1}$$

$$V = \{GPSS, GMS, I, MD, OnDB\} \tag{2}$$

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

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

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

The specific components of the architecture are:

i. **Mobile Device:** Is an android based device on which the application resides, this platform provides functional libraries that enables the app to work properly, since it is a mobile application platform that makes it best suit for this project.
ii. **Internet:** The major component of this application requires the internet, the Google Maps API most especially requires the internet, and the internet is also required for pooling data from the server. Also for any GIS application/ system to work it needs the internet because a GPS dongle or device will not work if there is no internet for it to connect to the GPS satellite.
iii. **Database:** This is the database that will hold the location data. For this application, there are two databases; the online database on the web server and the local SQLite database on the mobile device. SQLite is an embedded Structured Query Language (SQL) database engine which does not have a separate server process; it reads and writes directly to ordinary disks. The reason for choice of SQLite is due to its ability to run in minimal stack space and very little heap. It's performance is quite good even in low-memory environments.
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 (4) [14], where *dBm* is the distance between the mobile terminal and access point *do, 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 (5) can better model the propagation in equation (4), where *AF* means the Attenuation factor, which is the loss of signal power as a result of distance.

$$P_r[dBm] = P_r(d_o)[dBm] - 10nlog\left(\frac{d}{do}\right) \tag{4}$$

$$P_r[dBm] = P_r(d_o)[dBm] - 10nlog\left(\frac{d}{do}\right) - \left\langle \sum_C AF \begin{matrix} i<k \\ i\geq k \end{matrix} \right. \tag{5}$$

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.

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

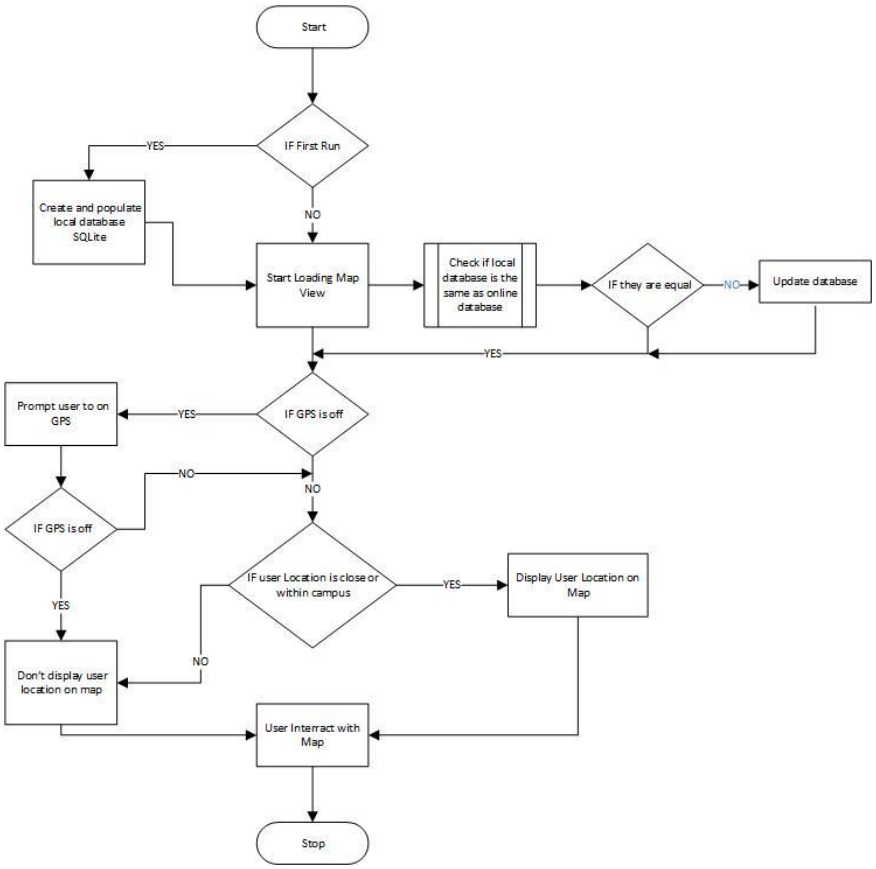

Fig. 4. Flow chart

4 Results 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.

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

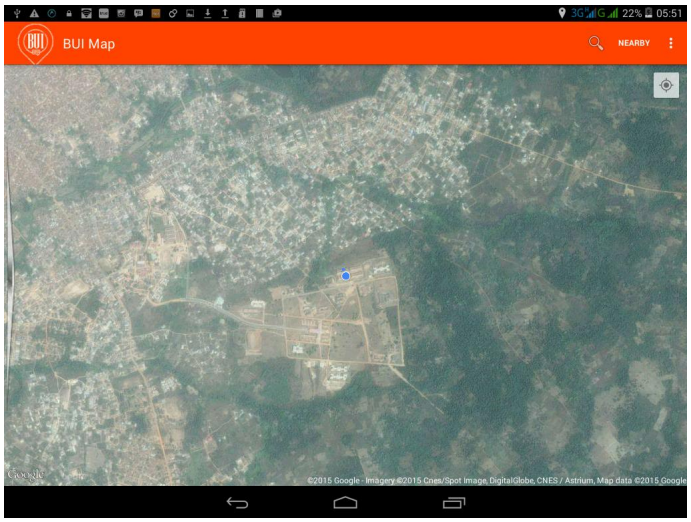

Fig. 5. Landscape orientation after the app is launched

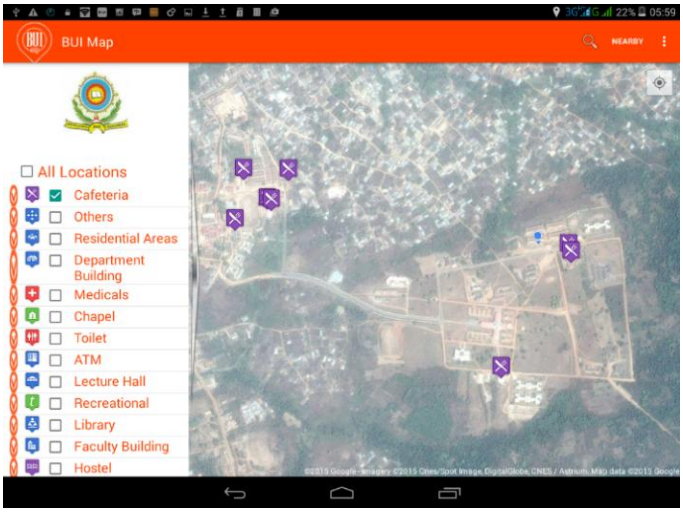

Fig. 6. Interface showing only cafeteria category selected

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.

In this work, a mobile location-aware campus map application was developed with a sense of simplicity and quality user experience with the aim of helping both visitors and members of the university community engage in a self-help location of places and landmarks within Bowen University Campus. This solution can be applied in any other environment desirous of having location aware mobile application for aiding new comers and members of such community in finding their ways within the environment without the use of a static location map. In the future, there will be consideration of making this application available on other mobile platforms other than android platform.

Competing Interests

Authors have declared that no competing interests exist.

References

[1] Rouse M. Location Awareness definition; 2015.
Available: http://searchmobilecomputing.techtarget.com/definition/location-awareness
(Accessed 25 January 2016)

[2] Chen G, Kotz D. 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 TR, Phanikrishna CV. A survey on location aware and context aware in mobile applications; 2012.

[4] Marmasse N, Schmandt C. Location-aware information delivery with commotion. In Handheld and Ubiquitous Computing. Springer Berlin Heidelberg. 2000;157-171.

[5] Hazas M, James Scott, John Krumm. Location-aware computing comes of age. Computer. 2004;37(2):95-97.

[6] Verma P, Bhatia JS. Design and development of GPS-GSM based tracking system with Google map based monitoring. International Journal of Computer Science, Engineering and Applications (IJCSEA). 2013;3(3):33-40.

[7] Misra P, Enge P. Special issue on global positioning system. Proceedings of the IEEE. 1999;87(1): 3-15.

[8] Wood TD. How to use a hand held GPS receiver; 2012.
Available: http://www/rei.com/learn/expert-advice/gps-receiver-howto.html
(Accessed 6 January 2016)

[9] Cardei M, Jones B, Raviv D. A pattern for context-aware navigation; 2013.
Available: www.cse.fau.edu/~mihaela/html/papers/fau_plop13.pdf
(Accessed 6 January 2016)

[10] Verma P, Bhatia JS. Design and development of GPS-GSM based tracking system with Google map based monitoring. International Journal of Computer Science, Engineering and Applications (IJCSEA). 2013;3(3):33-40.

[11] Kincaid J, Marissa Mayer. 40% of Google Maps Usage is Mobile (and there are 150 Million Mobile users); 2011.
Available: http://techerunch.com/2011/03/11/marissa-maer-40-of-google-maps-usages-is-mobile-and-there-are-150-million-mobile-users/
(Accessed 4 December 2015)

[12] Mihaela Cardei, Iana Zankina, Ionut Cardei and Daniel Raviv. Campus Assistant Application on an Android Platform; 2013.
Available: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.438.5970&rep=rep1&type=pdf
(Accessed 6 January 2016)

[13] Tesoriero R, Gallud JA, Lozano M, Penichet VMR. A location-aware system using RFID and mobile devices for art museums. In Autonomic and Autonomous Systems, 2008. ICAS. Fourth International Conference. IEEE. 2008;76-81.

[14] Hui Wang, Henning Lenz, Andrei Szabo, Joachim Bamberger, Uwe D. Hanebeck. Enhancing the Map Usage for Indoor Location-Aware Systems; 2007.
Available: https://isas.uka.de/Publikationen/HC107_Wang.pdf
(Accessed 26 November 2015)

Peer-review history:
The peer review history for this paper can be accessed here (Please copy paste the total link in your browser address bar)
http://sciencedomain.org/review-history/13805