Donor Tracker: An Innovative Real-Time Tracking System for Blood Donors in Mauritius

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Abstract

In Mauritius, caravans are sent around the island to collect blood from volunteers. This ensures that storage of pints of blood does not get depleted. However, in cases of urgent requirement of fresh blood, for instance an open heart surgery, it is very hard to quickly find a blood donor. The problem is even worse if the blood group is rare. In this paper, we explore the possibility of using location-aware computing to track blood donors in Mauritius and locate the nearest donor in cases of emergencies and whenever fresh blood is required. A number of blood donor management systems exist but none of them tracks the real-time location of blood donors. DonorTracker, the proposed innovative system, provides an easy and fast way to find a blood donor, thus saving time and saving lives.

Keywords: Context-awareness, location-awareness, mobile and ubiquitous computing, location sensing technique, real-time.

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1. INTRODUCTION

The infiltration of mobile devices and mobile communication to support a mobile lifestyle makes computing increasingly mobile and ubiquitous today. The eventual aim of ubiquitous computing, as envisioned by Mark Weiser (Weiser, 1999), is to provide various services by making multiple computers available throughout the physical space while in effect making them invisible to the user. At the core of ubiquitous computing (Hazas et al., 2004) is context-awareness, the concept of sensing and reacting to dynamic environments and activities.

Location is a key component of context. "As the quality of positioning technology in handsets improves and the cost of including it declines, GPS location technology will approach the status of a standard device feature" (Ionut, 2009). "We are approaching the point where location-awareness will be synonymous with smart devices, a point where personal navigation, social spatial knowledge, and location-specific contextual information will be assumed handset capabilities." (Ionut, 2009). According to a research report (Ionut, 2009), smart phones with GPS will increase in number by 19 percent through the year 2014. With numerous factors driving deployment of sensing technologies, location-aware computing is paving its way to become an integral part of everyday life.

In a hectic society, where people are very busy with their work, it is becoming more and more difficult to find a person willing to donate blood. This has an adverse effect in cases of emergencies when fresh blood is required, e.g. for open heart surgery. In such cases, the blood bank is unreliable. It is even worse if the blood group is rare. In this paper, we explore the possibility of using location-aware computing to track blood donors in Mauritius and locate the nearest donor in cases of emergencies and whenever fresh blood is required. A number of blood donor management systems have been studied but none of them tracks the location of blood donors in real-time.

Section two gives an overview of concepts related to context-awareness and location-awareness. Section three describes some related works and the motivation for this paper. Section four presents DonorTracker, the proposed innovative real-time tracking system for blood donors in Mauritius. Section five discusses the

implementation of DonorTracker. Section six gives an evaluation of the system and finally section seven concludes the paper.

2. CONTEXT-AWARENESS AND LOCATION-AWARENESS

2.1. Context-Awareness

"Context is any information that can be used to characterize the situation of an entity. An entity is a person, place or object that is considered relevant to the interaction between a user and an application, including the user and application themselves." (Dey, 2000; Dey and Abowd, 2000) "A system is context-aware if it uses context to provide relevant information and/or services to the user, where relevancy depends on the user's task." (Dey and Abowd, 2000) E.g. a context aware mobile phone may know that it is currently in the meeting room, and that the user has sat down. The phone may conclude that the user is currently in a meeting and reject any unimportant calls. Context awareness is regarded as an enabling technology for ubiquitous computing systems (Wikipedia). Context-aware applications offer entirely new opportunities (Baldauf et al., 2006) for application developers and end users by gathering context data and adapting system behavior accordingly.

2.2. Location-Awareness

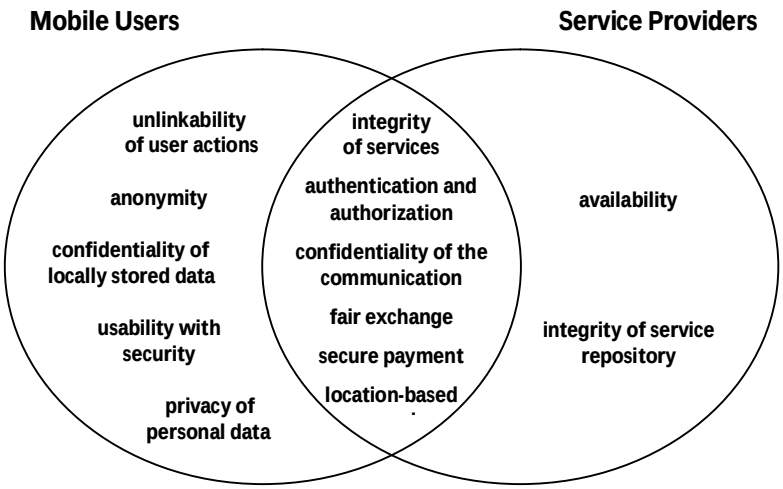
Location-aware computing (National Research Council, 2003) responds to user's location spontaneously. Such a system may also use location information without the user being aware of it, e.g. to take advantage of a nearby compute server to carry out a demanding task. Examples of location-aware applications (Educause, 2009) include navigation systems, a system that triggers a nap alarm by the user's specific stop on a commuter train, and an application that locates and communicates nearby bottlenecks in traffic. A large number of established location sensing techniques exist, such as the Global Positioning System (GPS), Bluetooth, Cell-Identity, Ultra-Wide-Band (UWB) and pressure sensors, to name but a few. Yet, there is no single reliable and accurate one in all environments. They differ in (Roussos, 2002) characteristics, infrastructure, device requirements, cost and

limitations where each is particularly suited for a different situation. Furthermore, more accurate and reliable location can be found by using location sensing fusion. It (Fox et al., 2003) is a method for conveniently integrating information provided by various location sensors to obtain the best estimate for an entity's location.

2.3. Challenges of Location-Aware Applications

The primary challenges (EminIslam Tath, Dirk stegemann, Stefan Lucks, 2005) of location-aware applications are privacy and security. The security challenges, as illustrated in figure 2.3.1, include (1) anonymity that allows a user to use a resource or service without disclosing his/her identity, (2) privacy of personal data, i.e. the ability and/or right to protect a user's personal data, (3) confidentiality of communication, and (4) confidentiality of stored data, such as the user's password.

Figure 2.3.1: Security challenges of location-aware applications



3. RELATED WORKS

3.1. Network of Community Blood Bank (NCB) Management System

Due to the serious shortcomings faced by the India's blood bank system (Premasudha et al., 2009), NCB management system was developed. The aim of the system was to eliminate blood shortage through location-based services and

ensure that every patient has access to adequate quantity of safe blood whenever required. The NCB is a web based blood bank management system with Geographic Information System (GIS). It is a complete blood bank management solution that covers all the activities of a blood bank. A GIS application was created that covers some of the blood bank management issues related to Tumkur city of India. The application was designed to achieve the analysis of the spatial distribution of donors, which shows how GIS can be used quickly to locate the blood donors of the required blood group near to a given blood bank location on a GIS based map of Tumkur city. It creates a GIS based database to determine and visualize catchments of donors to a particular blood bank. These features are available on a Web application including finding nearest blood bank with the availability of the required group of blood at the right time and right place. It develops a computerized supply chain management and distribution system to collect and distribute blood from the community blood bank to the hospitals. This web based blood bank service portal also provides awareness generation to facilitate the coordination between the need of blood during emergency, arrangement of blood donors and blood banks.

Figure 3.1.1 below is a screenshot of the web application (Premasudha et al., 2009):

Figure 3.1.1: Screenshot of Web application develop for NCB

However, the limitation of the system is that it does not cater for the current location of blood donors. It stores the address of the donor in a database and to find the nearest donor to a blood bank, it uses GIS functions together with a table containing x- and y-coordinates of the address. As a result, it locates the address of the donor but problem arises if the person is not at that particular address at that moment.

3.2. "Save-A-Life"

"Save-a-life" (Simon, 2009), created by Romin Irani, is a blood donor management and communication application which incorporates SeeMyWhere (SeeMyWhere), an application that shares your mobile phone location on a map and on Facebook in real-time. "Save-a-life" application allows users to search a database of blood donors and match them with patients in need of blood. The possibility to link to SeeMyWhere.com enables users to find the donor closest to the patient, a crucial element when time is of essence. Once the donor has been located via a search, they can be contacted through a phone call, SMS, email or by sending Twitter alerts.

Figure 3.2.1 shows a map of the SeeMyWhere (SeeMyWhere) application:

Figure 3.2.1: A map of SeeMyWhere Application

The limitation of this application is that it becomes unreliable in conditions like bad weather or obstacles which hinder the application from finding the location of a person. In such cases, the user is required to sign in to his account and send his location.

4. DONORTRACKER: AN INNOVATIVE REAL-TIME TRACKING SYSTEM FOR BLOOD DONORS

Donor Tracker is a location-aware application used to track blood donors in Mauritius using the Cell-Identity location sensing technique. The aim is to be able to quickly identify an appropriate blood donor in cases of emergency where fresh blood is required. The system consists mainly of a mobile phone application and a web application for the server. The mobile phone application allows a donor to (1) register when he/she launches the application for the first time, and (2) login to the application whenever he wishes to do so using the login interface provided. The tracking feature in the application enables the server to get the current location of the donor, without requiring the blood donor to send his/her cell identity. A feature to search blood donation details is also provided, thus allowing a donor to get details on his/her blood donation history directly on his mobile phone. A database containing personal details pertaining to eligible blood donors, blood stock details and Cell-Identity details is stored at the server. The latter also responds to requests from the mobile phone application. To cater for privacy, the application allows the user to disable tracking at any time via the mobile phone application. As a measure of security, data sent from the mobile phone to the server are encrypted before transmission.

5. IMPLEMENTATION OF DONORTRACKER

5.1 Overview of DonorTracker

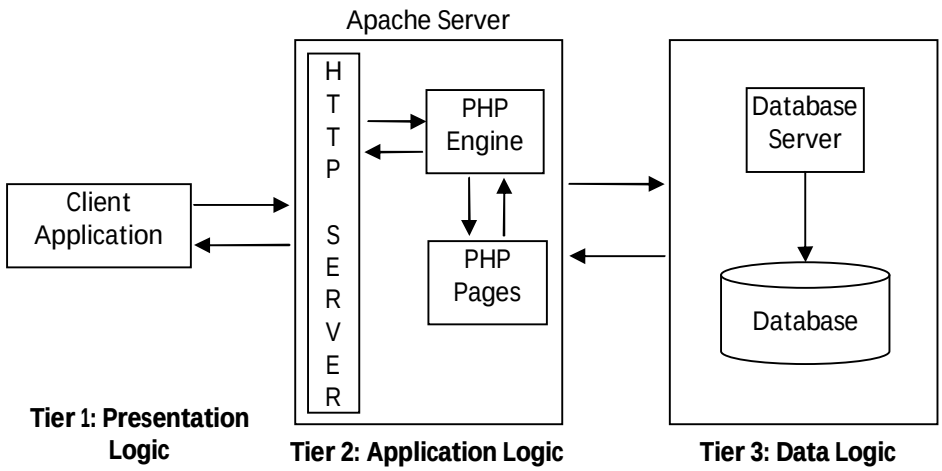
A person willing to become a blood donor has to perform all the compulsory blood tests required before donating blood. If the person is found to be an eligible donor, his/her personal details will be fed into the system database of eligible donors by

healthcare personnel. An email will then automatically be sent to the user with the link to download a mobile phone application. After successfully downloading and installing the application, the system will be able to track and locate the user whenever required.

Whenever, a blood donor is required, healthcare personnel can use the system to quickly and easily locate and contact the nearest blood donor. Healthcare personnel send a query using the web application to find donors of the required blood group. The query gives a list of all donors with the required blood group together with a notification for those donors who have their tracking option on. A query is then sent to the mobile phone application of those donors who have their tracking option on requesting his/her cell identity. The mobile phone application then responds accordingly. Communication between the mobile phone application and the web application is through HTTP connection. Using the information obtained, the nearest donor can be retrieved by performing a query which will sort out the donors according to the smallest distance from the hospital. As a result, the nearest donor will be located and can be contacted.

Figure 5.1.1 below illustrates the architecture of the tracking system:

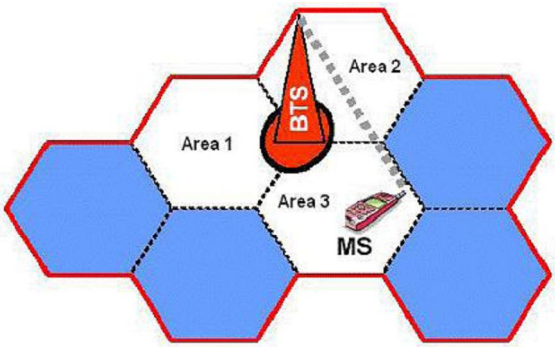
Figure 5.1.1: DonorTracker Blood Donor Tracking System



5.2 Location Sensing Technique

The Cell Identity technique has been selected as the most appropriate location sensing technique for DonorTracker since (1) it is easily to deploy, (2) it is available both indoors and outdoors, and (3) it involves low cost. Figure 5.2.1 below shows the cell identity location sensing technique:

Figure 5.2.1: Cell Identity Location Sensing Technique



5.3 Mobile Phone Application

J2ME was used to create midlets for the mobile phone application. The main components available in the mobile phone application are (1) a WAP page that can be used by WAP-enabled mobile phones to download the mobile phone application, (2) an interface to login or register to the application, (3) an option to enable/disable tracking, (4) an interface to perform search, e.g. of the last date the user donated blood, (5) a function to retrieve the IMEI of the mobile phone which is unique. This is for security purposes to ensure that each donor login to the application on his own mobile phone and (6) a function to retrieve the current Cell Identity of the donor. This will give an indication of the current location of the donor thus locating the closest donor is much easier and faster.

When using the application for the first time, the eligible blood donor has to register to the system. The mobile application will retrieve the IMEI number of the phone which will be used as a primary key in the database of eligible donors. As a measure of security, data transmitted between the server and the mobile application

is encrypted and sent using HTTP. Once the user has registered to the application, he/she can login to the system using his/her appropriate username and password. The application also caters for privacy of the user by providing an interface that allows the user to enable or disable tracking at anytime. The application also provides an interface that enables the user to make a search about the last time he/she donated blood without having to go to the hospital for enquiry.

When the hospital needs a donor, the database is checked and a request a request for cell identity is sent to the mobile application of all those who have their tracking option on as previously explained. Thus, the closest donor will be tracked much easier and faster.

Figure 5.3.1 shows the main interface of the mobile phone application and figure 5.3.2 shows the WAP page for downloading the application

Figure 5.3.1: Main interface of the mobile phone application

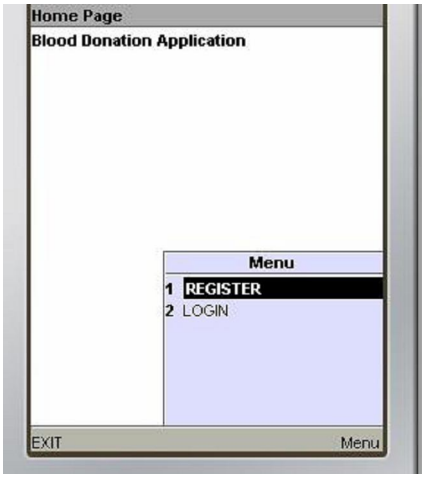


Figure 5.3.2: WAP page for downloading the application

5.4 Server-Side Application

The server-side application has been developed using PHP and MySQL. The main components of the server are (1) a database containing all the required details of donors, (3) data about cell identity to be used to locate the nearest donor, (3) web

pages, e.g. to locate donors of blood group A, and (4) an interface to handle communication with the mobile application.

Whenever data is received at the server, it is first decrypted and then processing is done accordingly. For security reasons, database access is strictly restricted to administrators and their passwords are also encrypted using AES engine (Rags, 2003). PHP built-in functions handle for SQL injection attack. Figure 5.4.1 below shows the home page of the server-side application:

Figure 5.4.1: Home page of the server-side application

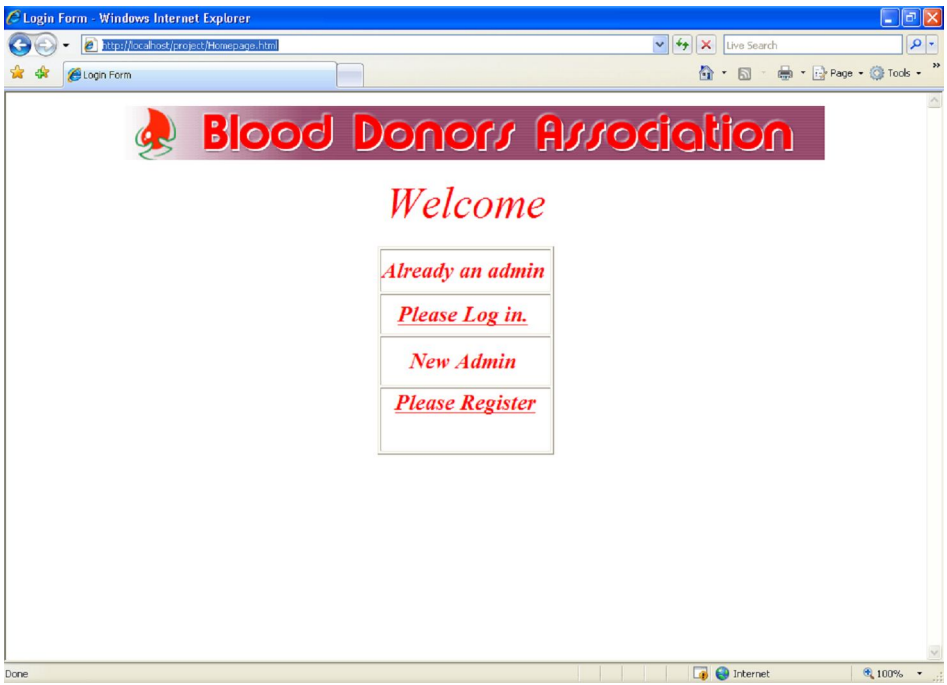


Figure 5.4.2 illustrates the list of available blood donors sorted according to shortest distance:

Figure 5.4.2: Donor sorted according to shortest distance

6. EVALUATION OF DONORTRACKER

The primary aim of the application, i.e. to locate and contact the closest donor to the hospital especially in cases of emergency, has been successfully achieved. The application has been able to retrieve the cell identity from the user's mobile phone, and hence identify the location of the user. A communication channel between the server and the mobile phone application has also been successfully set up using HTTP connection. Encryption of data also was correctly implemented to ensure security. The system was developed and fully tested and it works correctly. However, the limitation is that not all mobile phones are WAP-enabled and J2ME compatible for the application to run. Also, since the cell identity is kept confidential by the mobile phone service provider, an application was developed to retrieve the cell identity at different locations. This information was then used to build a database storing cell identities and its corresponding location. The mobile phone service provider was also contacted to ensure that the cell identities retrieving were accurate.

The application was tested and the screenshots below show the results of some sample tests. The cell-identity location sensing technique was successfully tested on a Sony Ericsson W580i mobile phone.

Figures 6.1 (a), 6.1 (b) and 6.1 (c) illustrates the steps for downloading the mobile phone application:

Figure 6.1 (a): Download page

Figure 6.1 (b): Confirmation for download

Figure 6.1 (c): Application successfully downloaded

Figure 6.2 illustrates the event when a donor wrongly enters the required data for login:

Figure 6.2(a): Login page

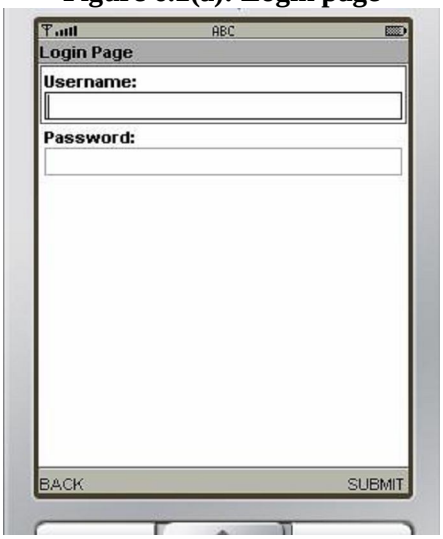


Figure 6.2 (b): Error message

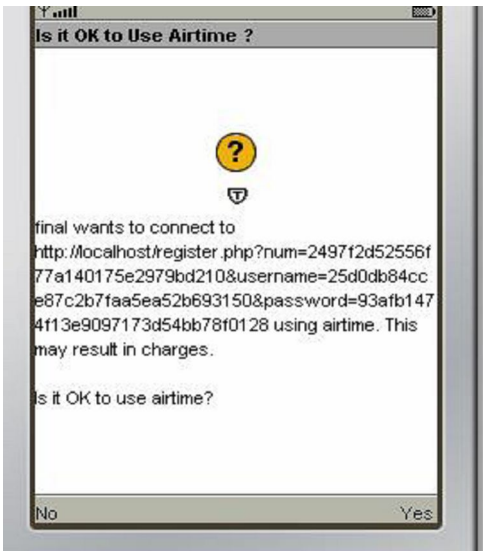
Figure 6.3 illustrates the tracking option available in the mobile phone application:

Figure 6.3 (a): Tracking page

Figure 6.3(b): Acknowledgment message

Figure 6.4 illustrates a sample encrypted message sent through HTTP connection:

Figure 6.4: Sample encrypted message sent through HTTP connection



7. CONCLUSION

The main aim of the project is to locate the nearest blood donor in case of emergency. The application has been successfully developed and consists of a mobile phone application and a web application for the server. A function has been implemented that retrieves the current cell-identity of a blood donor and sends the identity to the server. The server uses the data to locate the donor closest to the hospital. The application provides a much reliable, easy and fast way to locate the closest donor. Hence, saving time and saving lives.

Although the application was fully developed, there is still room for improvements. Some possible future works that can be considered are to (1) use GPS to acquire a more accurate location of blood donors, (2) dynamically obtaining the location of an eligible donor and keep track of its movement to identify donors who are moving nearer to the healthcare center, and (3) developing an application that will automatically dial and contact the nearest blood donor.

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