Blood Donation Notification System Based on Donor’s Location Using Haversine Formula

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Abstract: Blood bank organisations are responsible for supplying, storing and delivering blood to private and government hospitals in their respective countries. These organisations need to educate and remind blood donors to donate blood at blood banks. Nevertheless, reminding blood donors using traditional methods such as advertisements and via phones is expensive, time-consuming and might not reach the desired donors. To find prospective donors in a critical situation would consume a lot of time, where any delay may cause loss of lives. The objectives of this research are to analyze the most effective method to organize and create awareness towards blood donations; to design and develop a mobile application that increase user awareness to donate the blood every three months; to encourage people to donate their blood; and to reduce the cost and time to reach desired donors. Haversine formula is used in the mobile application to calculate the distance between the blood bank and potential blood donor. The mobile application is developed using technologies such as Global Positioning System, Google Application Programming Interface and Android platform. The developed mobile application is expected to ease blood bank organisations in managing their blood stock and effectively reminding donors about blood donation campaigns.

Key words: Mobile Application • Blood Bank • Notification Service • GPS • Haversine Formula

INTRODUCTION

Blood donation is a voluntary procedure for donors to donate their blood to blood collecting agencies. Every year, millions of lives were saved with blood transfusion from donated blood. Donated blood can be used during surgery, trauma and severe illnesses such as dengue fever, cancer, or sickle cell anaemia where the composition of blood became unbalanced. Developed and developing countries usually have a blood donation organization that is responsible for supplying, storing and delivering blood donations [1]. These organizations need to monitor all of the donations in order to reduce wastage and avoid any shortage of donated blood.

There are several problems that need to be solved in blood bank organizations in order to make them more efficient in handling the donated blood. Among the problems are: donors do not remember when they are able to donate blood; lack of targeted notifications that lead to waste of time and money in advertising; and insufficient information regarding their blood donors. Blood donors can only donate their blood tri-monthly in order to avoid iron deficiency or anaemia. Therefore, blood donors might unintentionally elongate their future donation more than they are supposed to. This will ultimately reduce the frequency of donations and the amount of blood donations. Some method of notification is needed in order to solve this problem [1-2]. Apart from the lack of notifications, some blood bank organizations have an insufficient amount of information regarding possible donors [3-4], blood banks [5-6], and blood stock [1]. There are also donors who have difficulty finding blood banks that are near to them and vice versa.

Traffic accidents happen all the time, in fact, during long holidays or festive seasons, the number of traffic accidents increases tremendously because people are travelling more frequent than normal. Consequently, this requires the blood bank to store more donated blood than any other time of the year [7-8]. Hence, several weeks before festive seasons, blood bank organizations need to run several campaigns in order to encourage more blood donors to donate their blood. Blood banks usually rely on traditional campaigns such as banners; flyers; and mass media advertisements to spread the word. These methods are expensive and might not reach to the potential blood donors.
Blood Donation Information Systems

Existing Blood Bank Information Systems: In order to increase blood bank efficiency, some blood bank organisations rely on computer applications to track and manage all of the information regarding blood banks, their donors and blood donations. The most important information in a blood bank information systems are the stored blood donations. This information is needed in case there are requirements for transferring blood donations from the blood bank to hospitals or other blood banks. The blood donor information is also crucial for blood banks; the information is used when there is a need for the blood bank to request new blood donations due to insufficient blood stock.

Walekar et al. [1] developed Blood Locator System to help blood bank organisations. The system uses Haversine formula to calculate the distance between blood banks and their donors. The result of the calculation is stored in a matrix table to find the donor or blood bank location. It will guide the donor to search for the nearest blood bank to donate their blood [1]. Pawar et al. [2] developed Optimal Facility for Location Tracking of Blood Bank and Donor. The system uses the combination of Haversine formula and Dijkstra algorithm [9-10]. The former is used to calculate the closest blood bank based on user’s location. The latter is utilised to determine the shortest path for the donor to go to the blood banks. The system is used to calculate nearest blood banks in case the previous blood bank is not available to accept blood donations. Nevertheless, the system can only calculate one destination at a time [2].

Developed Blood Donation Notification Application:

In this research, a mobile application has been developed in order to assist blood bank organisations in managing information that they have. The application, Blood Donation Notification Application (BDNA) uses Haversine formula to calculate the nearest blood bank from the blood donor’s current location. As shown in Figure 1, the BDNA system is divided into two parts depending on the type of users, namely: donors and blood bank administrators, where the former is using a mobile application interface and the latter uses a web based application. The donors can be anybody that download the mobile app, whether or not they have donated their blood to any blood bank. The administrators are officers in the blood bank organisations that manage all of the information in the blood bank.

Campaigns usually are information and advertisement to rally more donors to donate their blood. Campaigns are usually done before festive seasons where there will be high demand for blood stocks. Alerts are urgent notifications from blood banks requesting for certain type of blood that is needed by hospitals in the area. By using BDNA, the blood request alert will arrive to blood donors who is nearby and have the correct type of blood that is needed by the hospital. Apart from campaigns and alerts, the mobile app also presents additional information and frequently asked questions regarding blood donations to educate and encourage the app users to donate blood.

Fig. 1: Framework of Blood Donation Notification Application.
Determining Nearest Blood Bank: BDNA utilises the Haversine formula in order to determine the closest blood bank from the donor’s current location. This calculation was done to avoid donors receiving alerts and notifications from blood banks that are far away from the donors. BDNA will only notify mobile app users campaigns and alerts that are nationwide or localised to the donor. Donors’ current locations are obtained from their mobile phones by using the Global Positioning System (GPS) technology [11]. The donors can key in the date of their previous donation and they will obtain the earliest date for their next donation. Haversine formula is as shown in Equation 1.

\[ d = 2R \cdot \sin \left( \frac{\Delta \text{lat}}{2} \right) \cdot \cos(\text{lat}_1) \cdot \cos(\text{lat}_2) \cdot \sin^2 \left( \frac{\Delta \text{long}}{2} \right) \]  

(1)

where \( \Delta \text{lat} \) is the difference between donor’s and blood bank’s latitude (\( \text{lat}_1 - \text{lat}_2 \)), \( \Delta \text{long} \) is the difference between donor’s and blood bank’s longitude (\( \text{long}_1 - \text{long}_2 \)), \( R \) is the radius of the earth (6371 km) and \( d \) is the distance in km between the donor and the blood bank.

Both Walekar et al. [1] and Pawar et al. [2] use Haversine formula to calculate the distance between the donor’s current location and nearby blood banks. Pawar et al. [2] added Dijkstra algorithm to find the shortest path to the blood bank, however, is restricted to only one blood bank at a time. Locations of all blood banks registered to the blood bank organisation will be stored in the BDNA database. When donors turn on the mobile app, the app will automatically retrieve all blood bank latitude and longitude, compare it with the GPS information of the mobile device and calculate the distances to all blood banks registered in BDNA. Therefore, there is no leak of donor’s current location information because all of the calculation tasks is done by the mobile device.

RESULTS AND DISCUSSIONS

As shown in Figure 1, BDNA system consists of a mobile application and web-based application. Donor and the blood bank administrator can interact with the blood bank information using the mobile application and web-based application respectively. Blood donors can download the mobile application and fill some information regarding their blood donation to the system. Once information is filled, the mobile application will automatically calculate the next donation date and show any blood donation alert by the blood banks. Figure 2 shows some of the mobile application screenshots. Figure 2 (a) shows all the blood bank campaign list where donors could go and donate blood. Figure 2 (b) shows the donor the earliest date for the blood donor is able to donate blood.

![Fig. 2: Blood Bank Mobile Application Screenshots](image-url)
Blood bank administrators need to register and sign into the web-based application in order to manage the blood bank information. They are required to check the blood type and add the blood stock into the system. Blood bank administrators can add, update and change the status of a blood donation campaign. The status of the campaign range from upcoming, ongoing and ended. Among the statuses, only the ongoing campaign will be visible to the mobile application users. Campaigns that have ended are stored in BDNA archives for future references.

When a new donor comes to the blood bank to donate blood, the blood bank administrator will check using the system to avoid multiple registrations. Once the donor is clear for registration, information such as name, age, gender, blood type and date of donation is recorded in the system. This information will be used later for directing blood donation campaign and notification to the potential donor via the mobile app. The mobile app of the donor will go through all the notifications from the blood bank and filter out all notifications that are not suitable for the donor. For example, if a blood bank has a shortage of blood type A, the system will broadcast the notification. Nevertheless, only donors that have a blood type A, able to donate (passed the three months cooling period) and currently nearby the blood bank will receive the blood shortage notification (Figure 2 (c)).

CONCLUSION AND FUTURE WORKS

The Blood Donation Notification Application is expected to satisfy both the blood donors and the blood banks. It will make it easier for blood donors to keep track their next blood donation date and notify them if there is a blood donation shortage at the nearby blood bank. The system can also reduce the cost of advertising and educating in regards to blood donations. Donors will only get nationwide notifications or localised notifications where the donations are practical to both the donors and the blood banks. Therefore, the notification will be more targeted and hopefully, can increase the collection of blood donations.

Additional features such as information regarding the blood donation are also included to increase awareness about the movement. Information such as nearby blood banks and campaigns also expected to increase the amount of blood donation collection. The distance between the donors and blood banks are done in the donors’ mobile devices. Therefore there is no information sent via online to the system, maintaining the privacy of the mobile app users.

REFERENCES