A Web-based blood donation and Medical Monitoring System Integrating Cloud services and Mobile Application

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Abstract. Medical monitoring requires instant visibility across data sources and access to dynamic analyses. However medical monitoring among patients, perform in-stream medical advice, remains a challenging problem. Blood banks suffer frequent shortage of blood due to lack of blood donations, hence blood donation requests are frequently seen on social media for patients who urgently require blood transfusion with specific blood group. Recently, worldwide efforts have been undertaken to utilize social media and smart phone applications to make the blood donation process more convenient and provide a concrete information system that allows donors and blood donation centers to communicate efficiently and coordinate with each other to minimize time and effort required for blood donation process. This paper aims at developing a Cloud medical monitoring and Web-Based Blood Donation System which will allow blood donors and patients to offer/request blood donation from blood banks. Additionally, a new method is proposed for continuous observation and communication among doctors and patients. Using IOT cloud platform, simple medical devices equipped with medical sensors can monitor health status of patients and update the electronic medical records of patients’ information. Medical experts can remotely monitor patients dynamic status and give prompt medical advice. The developed Web-Based application utilizes a cloud based hosting platform to enhance system performance and ensure high availability. A mobile application has been developed where users will be able to use as an application installed on their smart phones to help them complete blood donation process with minimum effort and time. This application helps people receive remotely medical advices and helps establish a blood donation community through social networks. This paper also presents various tools that were used to measure system performance.

1. Introduction
Medical monitoring and blood donation are one of the most important applications needed on daily basis in medical sector. Blood donation involves collecting blood from a donor so it can be used to treat someone else. Blood donations are an essential part of our healthcare system. If we did not have volunteers giving blood, many medical procedures we take for granted could not take place. Recently, worldwide efforts have been undertaken to utilize social media and smartphone applications to make the blood donation process more convenient, offer additional services, and create communities around
blood donation centers [1]. In addition, remotely medical monitoring provide computer-aided support for elderly homes, orphanages and with athletes, who need continuous observation to prevent any critical emergent failure situations. Healthcare systems suffers high cost, especially for those who live far from medical centers and need long-travel to follow-up with doctors, especially in developing countries. Additionally, blood banks suffer frequent shortage of blood. The blood donation process usually consumes a lot of time and effort from both donors and medical staff since there is no concrete information system that allows donors and blood donation centers communicate efficiently and coordinate with each other to minimize time and effort required for blood donation process. Moreover, most blood banks work in isolation and are not integrated with other blood donation centers. Yet the quantity and quality of blood pool available for transfusion is still a major concern across the globe, especially in the developing countries [2, 3, 4]. The proposed system is used by donors, patients and medical centers. It provides a way for remotely medical care and blood donors to show their desire to offer blood donation on system, there donation offers are viewed by medical centers. The main contribution of this research is to provide a way for donors, patients and blood banks to interconnect, manage information of registered donors, patients. This proposed system includes medical sensing, mobile application, a website which is hosted on a cloud hosting provider which acts as an interface for the users of the system and it also uses cloud for storing and processing user’s data.

2. The Proposed Web-based Blood Donation and Medical Monitoring System using Cloud

Current Blood banks and medical care centres suffer frequent shortage of blood. The blood donation process usually consumes a lot of time and effort from both donors and medical staff since there is no concrete information system that allows donors and blood donation centers communicate efficiently and coordinate with each other to minimize time and effort required for blood donation process. Accordingly, the proposed Web-Based blood donation system (W-BDSC) utilizes new technologies by providing a Web-Based application and mobile application integrated with cloud services. All patients with medical equipment are connected to the cloud through the developed mobile Application (MobiHealthcare). Continuous medical readings are recorded and stored on cloud platform. On the doctor side, the doctor can observe all his patients medical situations and has the option to give medical advice and recommend medicines. On the patient side, medical advices can be received where actions are taken on proper way (As shown in Figure 1-a).

The proposed web based application is hosted on the cloud using a cloud hosting provider called Miles Web, this allows system to utilize cloud hosting features such as easy to deploy, high availability, scalability and easy to manage. The proposed system serves 4 types of users which are: blood donors, patients, medical centres (Blood banks) and admin as shown in figure (1-b).
In the proposed W-BDSC users must first register either as a donor, patient or medical centre, based on user type different functionality are provided. Blood donors have the ability of offering donations specifying blood group and quantity. Donors can also follow-up their previous donation offers. Patients have the ability of requesting blood donations specifying needed blood group and quantity, patients can also follow-up their previous donation requests. Also W-BDSC system provides medical centers with additional functionality such as the ability to enter, update their current blood stock and ability to create events which can be seen by donors and patients. Figure (2) illustrates the proposed system architecture of Blood Donation Web-Based application which is hosted using cloud hosting provider called Miles Web. The proposed system utilizes Miles Web architecture, users can access system either through various types of web browsers installed on laptops and personal computers or using android application. The web browsers and android application communicates with cloud hosted Web-Based application to retrieve data from database hosted on the cloud. Web-Based application performs query on database and send results to end user devices.

Integrating Miles Web cloud hosting services with the proposed model provides various features [4] such as Cost effective, Easy to Deploy, Easy to Scale, Easy to Manage and Data Security

3. The proposed System Implementation

3.1. Medical Sensing. Medical sensors are connected to IoT platform to obtain stream of data from patients. Software codes are implemented to manage readings among sensors. Each sensor has a hardware interface to be connected to the Arduino. For the connections and network layer, the a Wi-Fi module (ESP8266) that sends patients measurements using the protocol of "Message Queuing..."
Telemetry Transport (MQTT) protocol”. This server collects all the patients’ readings with each patients’ unique ID and sends them to the database to be saved on the cloud. For data receivers: The cloud has the data of each patient saved, these data are accessible by the doctors for medical observation.

In our proposed model, two types of sensors are used per each patient: the temperature sensor and the ECG/EMG sensor (as shown in figure 4). The temperature sensor allows to measure body temperature. The electrocardiogram sensor (ECG or EKG) is a diagnostic tool that is routinely used to assess the electrical and muscular functions of the heart. Its utility in the diagnosis of a myriad of cardiac pathologies ranging from myocardial ischemia and infarction to syncope and palpitations has been invaluable to clinicians for decades. The Electromyography Sensor (EMG) measures muscle response or electrical activity in response to a nerve’s stimulation of the muscle. EMG measures the electrical activity of muscle during rest, slight contraction and forceful contraction.

![Figure 4: The proposed Hardware connection platform](image)

The proposed Web-Based application database is used to stores all information related to different system user types which donors, patients and blood banks, all donation offers and requests created by donors and patients and blood bank’s events. The system uses MySQL is an open-source relational database management system. System database used will be hosted on the cloud same as with Web-Based application on Miles Web. The system database includes 8 tables which holds different users data, donation offers, requests and events.

### 3.2. Implementation

Web-Based Blood Donation application was written in java programming language using spring tool suite (STS) IDE utilizing Spring framework. Spring Framework is a Java platform that provides comprehensive infrastructure support for developing Java applications. Web-Based Blood Donation application user interface is built using Sencha Ext JS java script framework. Web-Based Blood Donation application store application data on MySQL database which is hosted on Miles Web. Figure (5) illustrates the web based application home page.

![Figure 5 Web-Based Application Home Page](image)
3.2.1. Blood Donor. Once Blood Donor user have logged in Web-Based application and completed his information, Web-Based application view changes according to user type. The functionalities provided for user are displayed in left side navigation panel. Blood Donor can choose to offer blood donation which will open a form asking blood donors to specify the blood group that will be donated and quantity of blood donation, once donation offer have been submitted it is saved in the system and Blood donor can view his/her previous blood donation offers to follow up donation offers status if it have been accepted. Blood Donor can also view events such as blood donation campaigns posted by registered blood banks.

3.2.2 Patient. Web-Based application shows different functionalities for patients. Patient can choose to request blood donation which will open a form asking patients to specify the blood group requested and requested quantity, once donation request have been submitted it is saved in the system and Blood donor can view his/her previous blood donation requests to follow up donation requests status if it have been accepted as shown below. Patients can also view events such as blood donation campaigns posted by registered blood banks.

3.2.3 Authorized Blood Bank Authority. Authorized Blood bank Authority must register using system registration form and login using created account, Blood bank authority cannot use social login. Once Blood Bank account have logged in to the system, system will display blood bank’s available functionalities as shown below. The system provides blood banks with ability to view pending donation offers and pending donation requests submitted by donors and patients, any of registered blood banks can accept these offers or request. Blood banks are also provided with additional functionalities such ability enter and update their current blood stock, also blood banks can view some system statistics in the form of charts such as: (1) System Users Chart: This chart shows current count of registered users according to their type. (2) Blood Bank Blood Stock Pie Chart This chart shows quantity owned by blood bank related to each blood group, (3) Pending Offers Vs Request Chart: This chart shows blood banks number of donation offers offered by donors versus number of donation requests requested by patients that are currently pending.

3.3 Web-Based Application Hosting

Web-Based blood donation application is hosted on Miles Web which is India's #1 trusted web hosting company. Miles Web offers various types of hosting plans such as shared hosting, reseller hosting, VPS hosting, dedicated hosting and cloud hosting. Web-Based application is hosted using cloud hosting plan. Cloud hosting is the most advanced type of web hosting service. It is one of the most secure form of web hosting as well. Nowadays medium and large businesses are turning towards cloud hosting services for a better performance of the website.

3.3.1 Miles Web Cloud Hosting Environment and Deployment. Miles Web provide its clients with a cPanel control panel which can be used to create new cloud environment, manage hosted domains, sub-domains, email accounts, databases, etc. Miles Web provides developers with a full-fledged wizard which can be used to create desired environment on the cloud. This allows developers to select type of technology used to develop Web-Based application and according to that technology different environment options are available. Blood Donation Web-Based application is built using java technology, according to this Miles Web wizard provides developers with the ability to select type of used application server. Blood Donation Web-Based application is deployed on an Apache Tomcat server based as shown in figure (6), Apache Tomcat was used because it is light weight, open-source and highly flexible.
Developers can also select database type which will be used to store data, Blood Donation Web-Based application user MySQL database store all system data. This database is available for access through a public IP address.

### 3.4 Android-based Mobile Application for The proposed System

The design and implementation of mobile application for the proposed system provides users with the ability to instantly access all Web-Based application features through their smart phones. Android is an open source framework designed for smart devices that packages an operating system, middleware, and key applications. The user opens android application installed on his device, then selects to login as one of system user types as shown below in figure 7 and figure 8. The android application authenticates user credentials with Cloud hosted Web-Based application through Restful Services.

### 4. Performance Measures

There are many performance measures available which can be used to measure proposed system performance, however since proposed system is still under development and have not been published there was a need to obtain data set which can be used to measure system performance. The Proposed system performance was measured based on dummy data set which was generated by a java library called Mock Neat. Mock Neat library was used to generate system donors, patients and blood banks’ data. Mock Neat was also used to generate various system operations such as donation offers, donation requests, blood bank’s events and their blood stocks. Mock Neat was used to generate 1000 donors,
500 patients and 50 blood bank authority. It was also used generate more than 4000 donation offers and 1500 donation requests. This data was used in measuring Web-Based application performance using various performance measurement tools.

**Java Melody**

JavaMelody is an open source (LGPL) application used to monitor Java or Java EE application servers in QA and production environment. JavaMelody is mainly based on statistics of requests and on evolution charts. JavaMelody was used to help improve application performance by viewing application request average response time, system database calls and response time. JavaMelody also provides number of summary charts which are used to show various performance metrics such as number of executions, mean execution times, percentage of errors of http requests, SQL requests, Java memory, Java CPU, number of user sessions, number of database connections (as shown in figure 9).

![JavaMelody Performance Measures](image)

**Dotcom monitor**

Dotcom monitor is a Web-Based tools which was used to perform stress load testing on our proposed model. Stress testing is testing that checks the upper limits of system by testing it under extreme loads. The testing examines how the system behaves under intense loads such as large number of users accessing Web-Based application at the same time. The test performed by dotcom monitor tool simulated multiple users accessing Web-Based application simultaneously to measure Web-Based application average response time, number of sessions started and server load as shown in figures (10,11).

![Number of Sessions Started](image)
5. Conclusion
In this paper, a Web-Based Blood Donation and medical monitoring system was proposed based on cloud and mobile platforms. The proposed mobile platform utilizes a smart phone android application to allow users to access system functionality easily. The proposed system facilitates communication between patients, blood donors, medical experts and blood banks to ease process of medical observation and blood donation. The proposed system also has a database which saves blood donors, patients and blood banks information. The system developed was hosted on cloud utilizing various cloud hosting features such as high reliability, availability, scalability and data security. It integrates the electronic medical records and blood information scattered among different blood banks to improve blood donation service quality. This paper was also concerned with system performance measures and ability of developed system to serve multiple users at the same time using various performance measurement tools. The developed system builds on current existing system by utilizing cloud hosting features, system performance improvements and providing users with various statistics. The proposed system solved many of challenges faced by previous models, providing fast and good utilization of donation quality of service. The developed system can be improved by using user’s current location to show patients nearest medical center or blood banks in case of emergency.

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