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Analysis on the Development of an Android App for the Management of Blood and Organ Donations

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Abstract: Blood and organ donation are considered noble acts of helping mankind. Yet, one major challenge for the involved agencies is finding the exact blood group and needed specific organ at the required time and situation. This paper deals with the development of an Android app aiming to address this problem by tracking the donors and managing the donation process through Cloud computing. The app is designed in such a way that any person who is willing and eligible to donate blood or organs registers their information, which is preserved in the Cloud. It is capable of sending alerts to available donors whenever there's a patient that needs a particular organ or blood (*i.e.*, with specific details). The utilization of the Cloud for data storage enables the app to be more efficient as compared with the traditional blood and organ donor banks.

Keywords: Cloud Computing, Blood and organ donation, patient, donor, Android app

1. Introduction

Blood and organ donation are novel acts of humanity. There are a lot of people devoted to the cause of donating blood and organs to those in need, especially in the case of an emergency where human lives are at stake. Blood and organ donations have presented various opportunities and challenges where studies and innovations must be analyzed. One major challenge is that various organizations and individuals come forward to provide help by donating their blood or organs to those in need, yet there is a difficulty in finding the exact blood group or a matched organ at the required time (*i.e.*, especially in the case of emergencies such as during accidents, ongoing treatments, surgeries, *etc.*) [1].

Currently, the family of a patient who requires an urgent blood transfusion is always met with difficulties in finding the right blood donors that match the patient's blood group, as hospitals, blood banks, and medical centers do not have efficient information management regarding blood donors [2][3].

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During blood donation campaigns, blood donor information is provided that also includes their location and contact information. However, there is no centralized database that links all this information through hospitals, blood banks, and medical centers. Whenever there is a case of urgent information retrieval, the patient's family has to contact the ones on the list of blood donors, and the process can be tedious as the donor's availability is not indicated. That goes with organ donations too; in general, the patient's family is always burdened with finding the right, available, and willing donors of a particular body organ [4]. It becomes the responsibility of the patient's family to locate the organ donor, as hospitals and medical centers may not have an efficient information system that could track and manage the organ donation process effectively. Thus, a novel and efficient blood and organ donor information system must be implemented to address these issues and probably save human lives.

This paper deals with the design of an Android app for the management of blood and organ donations. It is a Cloud-based service that mainly aims to track, locate, and contact the right blood and organ donors in emergency situations.

The remainder of this paper is organized as follows: Section 2 outlines the related literature presenting related works and studies regarding blood and organ donation systems; Section 3 provides an overview of the Android app development platform; the design of the blood and organ donation app is outlined in Section 4; and Section 5 concludes the study.

2. Related Literature

This section outlines the various related works and studies pertaining to the challenges and opportunities incurred in the blood and organ donation systems. All literature indicates the same and related challenges of limited blood supply and the complex process of finding the right donors during emergency situations. Blood donors can be difficult to find, and the current system inefficiently manages the donors' details, especially their availability and location.

In the study of Snigdha *et al.* [5], the concept of the Android Blood Bank system was put forward to monitor and find the willing blood donors in case of emergencies (*i.e.*, at a particular time) using the global positioning system (GPS) technology to trace the nearby blood banks. This study aims to address the common problem of looking for willing donors during a particular period of time where human life can be at stake. In addition, it also aims to build a network of people and institutions that can help each other during an emergency. The two major challenges of this Android Blood Bank system application are the GPS service and the web browser.

Based on the study of Mostafa *et al.* [6], both blood donation and blood transfusion services (BTS) are crucial for saving human lives. As blood banks usually suffer from shortages, individuals turn to social media to find healthy and willing blood donors for their patients who urgently need blood transfusions. In addition, blood donation requires a long and complex process for both the donors and the medical staff, as there is no concrete system to manage the blood donation process and the communication between the donors and blood donation centers is inefficient. Thus, the study has aimed to develop a blood donation system (BDS) that is based on cloud and mobile computing that can facilitate the coordination between the blood donors and blood donation centers and integrate the system among different blood donation centers and health organizations.

Jenipha and Backiyalakshmi [7] proposed a cloud-based blood donation app to address the immediate and critical need for specific blood types during emergency situations (*e.g.*, accidents) and ongoing treatments and elective surgeries (*e.g.*, severe liver problems, blood disorders, leukemia, extreme bleeding, *etc.*) that require a blood transfusion. The blood and donation app requires the donor to enter details that include their name, address, contact number, and blood type. The app is capable of alerting

the donor (*i.e.*, through a phone call or Short Message Service (SMS)) in case there is a certain situation where a patient with the exact match of the donor's blood group is in need of an urgent blood transfusion. As a Cloud-based service, immediate access to a centralized list of blood donors with their locations and contacts can help address emergency situations requiring blood transfusions. The cloud-based service feature of the app enables emergency blood delivery since it has immediate access to the donor's information and location. It is also a location-based application; thus, it helps in finding donors in order to match blood groups with respect to location, and users can also access their mobile numbers for spontaneous help in case of emergency.

In the study of Naser *et al.* [8], a mobile app to track blood donors (*i.e.*, Mobile Blood Donor Tracker) has been proposed. The designed app directly connects the end-user with the donors in case of an emergency. It is capable of allowing donors to interact among themselves and also with the Hospital Blood center.

Bhowmik *et al.* [9] have indicated that blood banks in the least developed and developing countries are limited, and difficulties in finding blood donors in cases of emergencies essentially require immediate solutions. Blood transfusion required in emergency situations, such as extreme bleeding caused by accidents, ongoing treatments, and elective surgeries, require the immediate availability of blood donors with the right blood group. The study has proposed a mobile phone app that allows people to find a donor with the desired blood group in the nearest location. The app is to be developed using different platforms, including Android, Windows, and iOS.

In the study of Kate *et al.* [10], there is an immediate need for fast and proficient assistance (*i.e.*, a management app) from blood banks when human lives are at stake. The current systems that manage the blood transfusion requests in hospitals are inefficient and can be a factor in losing human lives. Thus, the study has proposed a framework that utilizes Cloud computing to store sector-based blood group data. The framework can eliminate ineffective processing steps in immediately acquiring blood for patients who urgently need a blood transfusion. The cloud-based structure summarizes the available blood groups per sector in every blood bank, hence, retrieval of data can be facilitated more efficiently.

Priya *et al.* [11] proposed an extended web application for a blood bank management system to timely update information about donors, acceptors, and patients. It maintains information regarding the available amount for every blood group, requiring replenishment every time it falls below the required minimum amount. In addition, it keeps track of available blood donors nearby during emergency cases. Moreover, it includes a Geographic Information System (GIS) capable of transmitting data wirelessly. Furthermore, the proposed work will utilize Push technology with security in order to protect the donors' privacy from third parties.

3. Android App Development Overview

The users of smartphones and mobile devices continue to increase rapidly, and mobile apps have been revolutionized. The Android platform on mobile devices is undergoing enormous growth as it offers great flexibility and freedom in mobile app development [12]. Android is considered the fastest growing mobile and open platform for developing mobile apps [13][14]. It offers fewer development restrictions on the features that are accessed and offers more freedom for what developers can do.

It was in 2003 that Android started out, and it got bought by Google in 2005 [15][16]. The first Android version as mobile software was released in 2008 on the HTC Dream (*i.e.*, also known as the T-Mobile G1) mobile phone. The Android software was built using Linux at its core and has become one of the most powerful mobile operating systems (OS) that is free and open source. Thus, mobile device manufacturers focus more on the development of their hardware as they just need to adopt Android as their OS.

Android as an application development platform utilizes a Software Development Kit (SDK) that provides the comprehensive development tools and Application Programming Interfaces (APIs) required for developing mobile apps using the Java programming language (*i.e.*, a Java Development Kit (JDK) must be installed before setting up the development environment in Android). In addition to Java, the application can also be written in Kotlin or C++.

The JDK is used for building applications, applets, and app components when using the Java programming language. It includes the various tools that are required for developing and testing programs written for the Java platform. It includes the development tools (*i.e.*, helps to develop, execute, debug, and document programs), the runtime environment (*i.e.*, it is a Java Runtime Environment (JRE) implementation that includes a Java Virtual Machine (JVM) and class libraries), additional libraries, the Java DB (*i.e.*, Apache Derby relational database), C header files (*i.e.*, supports native-code programming), source codes (*i.e.*, source files for all classes that make up the Java core API), and JavaFx tools.

3.1 Android Architecture

The android architecture is depicted in Figure 1, highlighting its major components (*i.e.*, layers) that include the Linux kernel, Libraries, Android Runtime, the Application Framework, and the Applications layer [17][18].

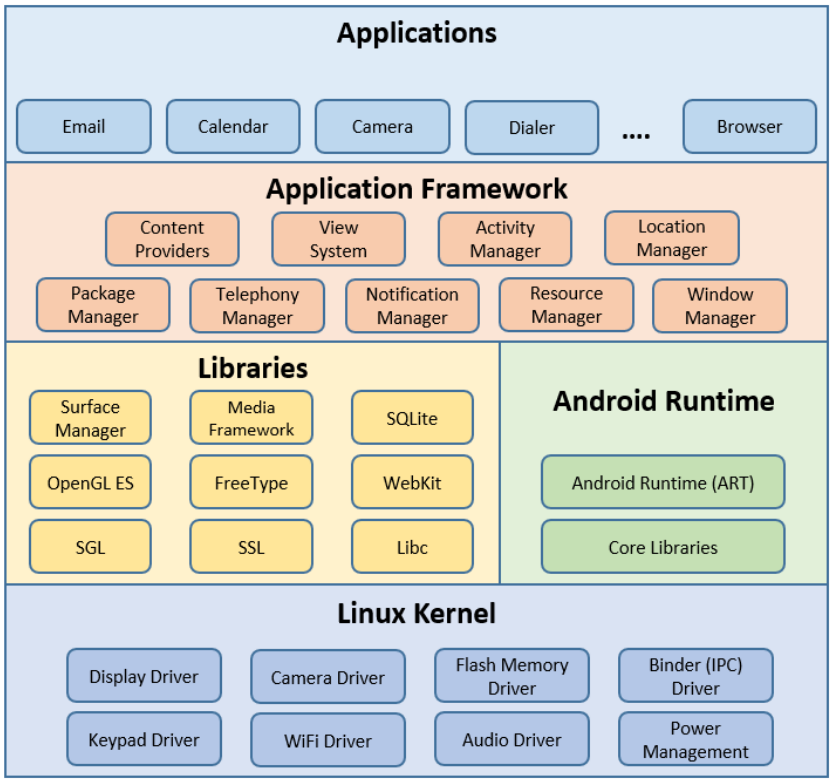

Figure 1. Android Platform Architecture [17][18]

Linux Kernel. Android relies on the Linux kernel for its core system services, which include device drivers such as display, keypad, camera, Wi-Fi, flash memory, audio, Binder IPC (Binder Inter Process Communication), and power management. It also provides services such as security, memory management, process management, and network stack. The Linux kernel also acts as an intermediary between the mobile device hardware and the rest of the software stack.

Native Libraries. The native libraries are comprised of a set of C/C++ libraries that are used by various components of the Android system, including the surface manager, media framework, SQLite, OpenGL ES, FreeType, WebKit, SGL, SSL, and libc. The developers can access these capabilities through the Android application framework layer.

- *System C library*. A Berkeley Software Distribution (BSD) - derived implementation of the standard C system library (libc) that is set for embedded Linux-based devices.
- *Media Libraries*. Supports playback and recording of many popular audio and video formats, as well as static image files, including MPEG4, H.264, MP3, AAC, AMR, JPG, and PNG.
- *Surface Manager*. It manages access to the display subsystem and aggregates both 2D and 3D graphic layers from different mobile applications.
- *LibWebCore*. A modern Android web browser engine.
- *SGL*. Scalable Graphics Library comprises the underlying 2D graphics engine.
- *SSL*. Secure Sockets Layer libraries are responsible for Internet security.
- *3D libraries*. These libraries are based on OpenGL ES 1.0 APIs and use either hardware 3D acceleration (where available) or the 3D software rasterizer.
- *FreeType*. A bitmap and a vector font rendering.
- *SQLite*. A powerful and lightweight relational database (RDB) engine is available to all Android applications.

Android Runtime. Android includes a set of core libraries and the Dalvik virtual machine (VM). The core libraries provide the functionalities of the Java programming language, while the Dalvik VM executes the developed applications written for Android. The Dalvik VM was later replaced by the Android Runtime (ART) to perform the translation of the written code into native instructions to be executed by the mobile device's runtime environment. The Just-in-Time (JIT) compilation of the Dalvik VM has been replaced by the Ahead-of-Time (AOT) compilation.

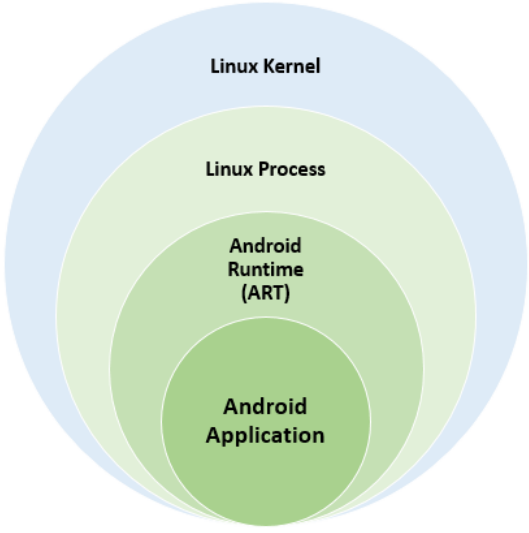

Figure 2. Android Application Architecture

Application Framework. This layer provides the developers with the application framework in order to build extremely rich and innovative Android applications. The Android application framework includes an activity manager, window manager, content providers, view system, package manager, telephony manager, resource manager, location manager, and notification manager.

Applications. This layer runs the core applications, consisting of an email client, a Short Message Service (SMS) program, a calendar, a camera, a clock, maps, a gallery, a browser, contacts, and others. The applications can be written in Kotlin, Java, and C++. Figure 2 depicts the Android application architecture.

3.2 Android Studio

Android Studio [19] has become the official integrated development environment (IDE) for Google's Android OS. It is built based on the IntelliJ IDEA software, which has been designed specifically for Android platform development [20]. It was announced in 2013, and its first version was released in June 2014 [21]. It has been adapted to replace the usually used Eclipse IDE and Android Development Tools (ADT) as the primary IDE for Android platform app development [22]. The Android Studio IDE user interface is depicted in Figure 3.

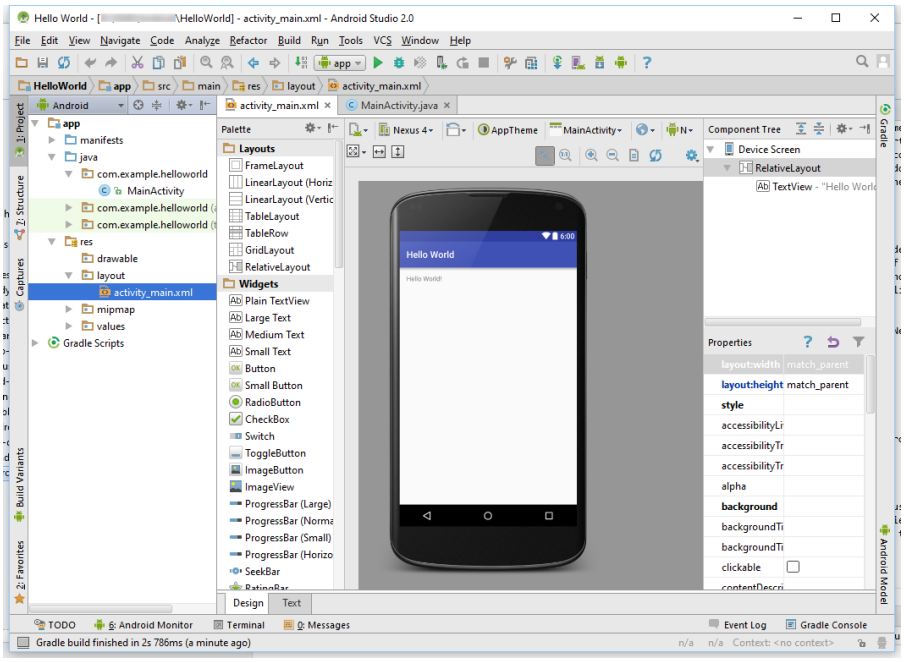

Figure 3. The Android Studio IDE

Android Studio features include the following [23][24]:

- The Autosave feature can’t be turned off [25].
- Flexible Gradle-based build system.
- It consists of a unified development environment for developing apps for all Android devices.
- It supports “*instant Run*” in order to push changes to your running app without building a new Android application package (APK).
- Extensive testing tools and frameworks.

- Template-based wizards and GitHub integration are available to build common app features and import sample code and components.
- C++ and Native Development Kit (NDK) support.
- Android-specific refactoring and quick fixes.
- Lint tools to catch performance, usability, version compatibility, and other app development problems.
- ProGuard integration and app-signing capabilities.
- The layout editor allows Android developers to drag-and-drop user interface (UI) components, and there is an option to preview layouts on multiple screen configurations [26].
- Building Android Wear apps is supported by Android Studio.
- Built-in support for Google Cloud Platform (GCP) that enables easy integration of Firebase Cloud Messaging (FCM) and Google App Engine.
- A fast and feature-rich emulator (*i.e.*, Android Virtual Device) to run and debug Android apps.

Android Studio supports the programming languages of IntelliJ, such as Kotlin [27], Java, C++, and Go. When the written app is compiled, it can then be packaged and published on the Google Play Store, considering the content policy standards.

4. Design of a Blood and Organ Donation App

The proposed blood and organ donation app can be used to maintain a database for the donor's information. The system as depicted in Figure 4 is comprised of three main modules: the User Interface (UI), the Admin Interface, and the Cloud Storage.

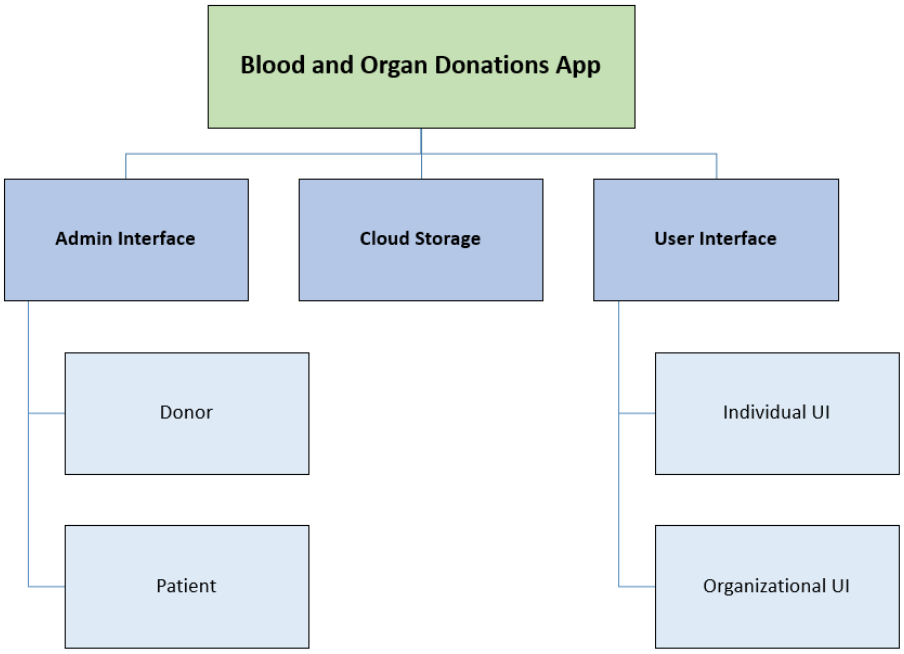

Figure 4. Structure of the Blood and Organ Donation App

4.1 Admin Interface

The Admin Interface module interacts with both donors and patients. Each member (*i.e.*, user of the proposed blood and organ donation app, which consists of donors, patients, medical staff, doctors, or family members of either patients or donors) will register their unique email id and password that will be used in identifying them. The Admin member is prompted with a login form where they can enter their email ID and password. The menu available to the Admin includes Change Password, Update Donor details, and Update Patient details.

4.1.1 Donor

Each donor had to fill out the donor registration form as depicted in Figure 5 providing their email ID, full name, date of birth, contact number, address, gender, blood group, location district, and other details. The menu available to the donor in the interface includes Change password, Update Profile, Search for Specific Blood Group, and Appointment for donating blood or body organ(s).

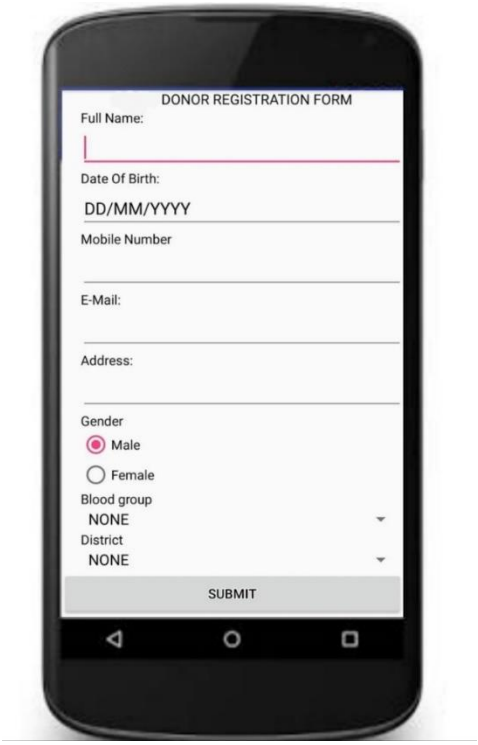

Figure 5. Donor Registration Form

4.1.2 Patient

The patient module requires the user to fill out the patient blood request registration form as depicted in Figure 6, requiring them to enter the patient's name, blood group, number of blood units required, and contact data. Other users (*e.g.*, medical staff, attending doctors, the patient's family) can also fill out the form in case a patient is unable to do so. In emergency situations where an uncommon blood group is required, the user can request predetermined blood directly from the benefactor. The blood group and unit required can be requested according to the medical state of the patient.

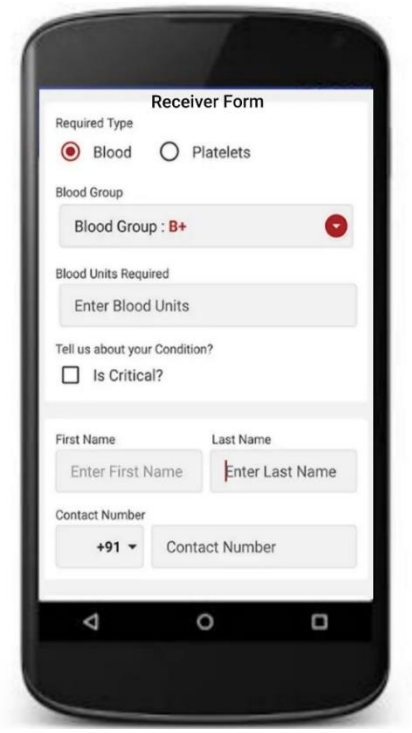

Figure 6. Patient Registration Form

4.2 Cloud Storage

All information, including the details about the blood donors and patients, will be stored in the Cloud database as depicted in Figure 7. The user can update their respective personal information, which will be reflected in the Cloud directly. This is essentially important and helpful in tracking and managing information.

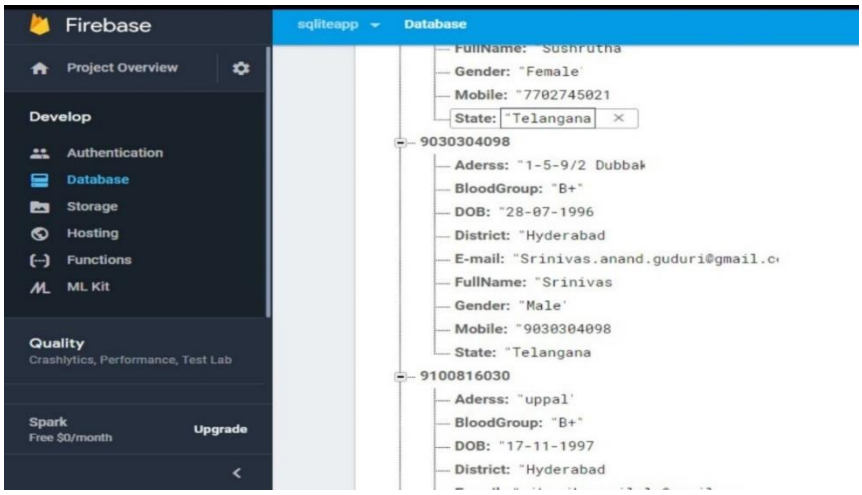

Figure 7. Cloud Database for Blood and Organ Donors

4.3 User Interface

The user interface module consists of two submodules:

- *Individual User Interface*: This module can be used by an individual member or user to register whenever he or she wants to donate blood or organs. The user registers through the link provided

in the application with the donor's name, government ID, gender, blood group, contact details, and other related information.

- *Organization Interface*: This module can be used by institutions or organizations to be connected with the blood and organ donation Cloud database. Thus, they can get access to the system whenever they decide to donate blood or organs, as well as request blood or organ donations.

4.4 Benefits of the Proposed Blood and Organ Donation App

This paper has proposed an effective blood and organ donation system based on the latest technology of Cloud computing. The app is characterized by ease of use and effective organization of organ and blood donations. The benefits of this blood and organ donation system include the following:

- Can attract new and more blood and organ donors.
- Tracking and locating the nearest donors with matched organs or blood groups.
- Efficient organization of both donor and patient information through Cloud database.
- Increased sharing and accessibility for blood and organ donations.
- Speed in knowing the shortage of blood and organ inventory through a knowledge-based Cloud database.
- Saving humanity and facilitating the process of finding blood and organ donors faster and with lower costs and losses.
- Faster data updates.

5. Conclusion

This paper has presented the issues related to blood and organ donation processing, which include an inefficient process for requesting blood or organ donations and difficulties in finding the nearest and most available donors, especially in cases of emergency, such as accidents where blood transfusion is urgently required. In this regard, a blood and organ donation app has been proposed based on Cloud computing and developed through the Android platform. The app is capable of tracking and locating the nearest and most available blood or organ donor, efficiently organizing the information of both donors and patients, making it more accessible, and facilitating the entire blood or organ donation process. Thus, through robust and efficient blood and organ donation management, human lives can be saved and prolonged.

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