

Towards Healing

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Abstract: *Communication between patients and doctors are invaluable especially in life threatening diseases such as cancer. After Chemo therapy, patients will have plenty of questions and concerns to which they would like to direct to their doctor immediately. The aim of this project is to establish an application for communication, called Towards Healing, for patients with cancer and their corresponding doctors. Towards Healing is a mobile application which sets up online communication between a doctor and the patients. This app is helpful to patients to ask questions and state their concerns to doctors regarding their health condition. Also they can find references that provide educational information about the side effect of the chemo or radiation therapy. This app will allow the patients to interact with doctors without making any physical appointments.*

Introduction

Patients who have head and neck cancer suffer from two types of symptoms: psychological symptoms and physical suffering. So they need to communicate with their doctors to asking questions about many issues (treatment, side effects, concerns, food restrictions, hair loss, weight loss and so on). They will ask these questions either by visiting the doctor or calling him by phone. Physical communication requires time scheduling, cost and is subject to limited availability.

After the digital revolution, communication between physicians and patients have changed and become more virtual. The information technology and communication are changing rapidly worldwide. Over the coming years, face-to-face doctor and patient contacts will become less frequent and communication between patient and providers will increasingly by through electronic devices.

Towards Healing provides electronic healthcare communication with an easy to use application that is as simple as sending text messages (SMS). Towards Healing is a healthcare application solution. It is a free mobile text messaging solution that is available to all doctors and patients. Towards Healing is designed to improve care collaboration by allowing providers to securely send and receive patient inquiries, and other rich media of educational information about the side effect of the chemo or radiation therapy.

These days most email services, text messaging, and other communication methods are not compliant with HIPAA (Health Insurance Portability and Accountability Act), which sets standards for protecting sensitive patient data.

Towards Healing enables healthcare providers to have instant access to their patient's messages, and supports sending and receiving sensitive patient information securely by adopting HIPAA standards.

Towards Healing is a mobile application that will be available for Android smart phone through Google play.

Related Work

Healthcare is "the maintenance or improvement of health via the diagnosis, treatment, and prevention of disease, illness, injury, and other physical and mental impairments in human beings [1]".

"In 1984, Peter Reichertz gave a lecture on the past, present, and future of hospital information systems. In the meantime, there has been tremendous progress in medicine as well as in informatics [2]". Twenty years later, the health information systems (HIS) has been considered as one of the most challenging science in education, medicine, and medical fields.

The improvement of healthcare processes provides rapid and comprehensive access to information with regard to care field. The evolution of HIS from the past to present can be noticed as follows:

- It increases settings of data in health care. Since it replaces the paper-based processing and storage with computer-based processing and storage.
- It improves users' involvement such as patients with doctors or administrators.
- It improves access to patient's information and records. It also reduces medical errors.

- It provides complete access to patients' records from the past to present.
- It reduces costs, and provides the best quality of care.
- It improves the process of sharing records and test results with other doctors.

After the huge development in HIS and communication technology, users' demand for accessing a wide range of information has increased overtime; including patient's health information. However, these users still need social support.

“Consumer demand for health information and the availability of new media technologies have spurred substantial interest in interactive health communication (IHC) [3]”. These days, users have to use electronic devices or communication technology to access or transmit health information; or any health-related issue. The process does not require direct communication such as face-to-face counseling.

There is a growing demand for Interactive Health Communication Applications (IHCAs) used in the healthcare environment. According to the study results of Murray et al. [4], IHCAs have a significant positive effect on knowledge, perceived social support, health behaviors, and clinical outcomes. These results propose that self-efficacy has significant effects on IHCAs. However, it is not possible to determine the effects of IHCAs on emotional or economic outcomes.

The government of Kingdom of Saudi Arabia gives high priority to healthcare services. Recently, health services have improved significantly compared with previous years.

Gallagher [5] said: “Although many nations have seen sizable growth in their health care systems, probably no other nation (other than Saudi Arabia) of large geographic expanse and population has, in comparable time, achieved so much on a broad national scale, with a relatively high level of care made available to virtually all segments of the population.”

According to the World Health Organization (WHO) [6], the Saudi Arabia was ranked 26th among 190 in health care system.

Before 1925, many people depended on traditional medicine in the Kingdom of Saudi Arabia. Therefore, epidemic diseases increased, especially in Hajj season. At that time, the first public health department was established in Mecca. It provided health care services for free to all people. In 1950, The Kingdom of Saudi Arabia established the Ministry of Health. Since 1950, the Kingdom implemented many strategic development plans to improve all its sectors. They have been considered as significant achievements for the Kingdom.

Based on the growth in Saudi's hospitals and IHCA, it is recommended to create an application that facilitates the communication interaction between patients and doctors anywhere. Patients and doctors can securely use IHCAs in their homes, cafes, libraries or anywhere.

HIPAA Protocol

There are many bodies such as government sectors and health facilities lack precise mechanisms for policy enforcement. Therefore, they suffer from information leakage. This issue costs hospitals, clinical offices, and health insurance companies because they do not follow proper regulations and policy enforcement.

Communication in a medical environment is usually concluded through the hospital network that uses a firewall to protect the network from strangers. On the other hand, the communication between patients and doctors outside the hospital is usually conducted through emails, text messages, or applications. It is often not protected. Therefore, strangers may get and disclose the patients' information.

First of all, the policy and privacy terms must be defined clearly. WHO defines the health policy as follows: "decisions, plans, and actions that are undertaken to achieve specific health care goals within a society [7]". However, the clear health policy can achieve the following: it can define a clear vision for the future. It can determine the priorities and roles. It can build consensus and notifies people. Whereas, privacy is defined as follows: “an individual's interest in limiting who has access to personal health care information [8]”.

Health Insurance Portability and Accountability Act (HIPAA) is a US law. I was started on 21 August 1996. It sets requirements for the use of health information in order to identify, expose, and secure the identity of the information owners. It applies to hospitals, doctors' offices, and health insurance companies.

HIPAA Privacy Rule

- Protect the patient's health information (PHI) from unauthorized used or in any form.
- Combat against fraud, waste of any patient's information, and wrong use of health insurance.
- Enable federal protections for the PHI.

HIPAA Transactions

- Claims encounters and coordination of benefits.
- Payment advice and remittance.
- Claims status.
- Eligibility inquiry.
- Referral certification.
- Authorization.
- Premium payments.
- Enrollment in a health plan.
- Retail drug claims, coordination of drug benefits.

HIPAA in Kingdom of Saudi Arabia hospitals

Al-Rajeh [9] studied two Saudi health institutions; King Khalid University Hospital (KKUH), including King Abdulaziz University Hospital (KAUH) and King Fahd Medical City (KFMC), which were using HIPAA based qualitative assessment approach to secure healthcare information. These institutions presented some recommendations as an attempt to fill their gaps.

King Khalid University Hospital (KKUH) was established in Riyadh city in 1982 as the teaching hospital of King Saud University (KSU). It has 850 beds with all medical services provided. KKUH is considered the largest medical teaching hospital in the Kingdom. King Abdul-Aziz University Hospital (KAUH) was established in 1975. Collectively, the system of the King Saud University Hospitals (KSUH) consists of these two educational hospitals.

“King Fahd Medical City (KFMC) consists of four hospitals making up a total of 1200 beds. Main hospitals, maternity hospital, pediatric hospital, rehabilitation center. In addition to the hospitals, there are primary care clinics, Faculty of Medicine, Medical Centers which is King Salman Heart Center, Neuroscience Center, Prince Sultan Hematology & Oncology Center and Specialized Diabetes & Endocrine Center [10]”.

A survey was performed to check security safeguards in five categories: 25 administrative requirements, 12 physical requirements, 10 technical requirements, 4 organizational requirements, and 5 policies requirements.

KSUH achieved only 11 requirements out of 25 administrative security requirements, while KFMC achieved only 19 requirements. Physical security requirements indicated that KFMC was much better than KSUH as it scored 10 points, while KSUH reached 4 points. However, KSUH was better than KFMC in the technical requirements. Furthermore, the policies in both KSUH and KFMC were approximately identical, and their organizational securities were almost the same.

Al-Rajeh proposed some recommendations at the end of his report, as follows: “Ministry of Health should have a national policy for health information security based on HIPAA model. Such a policy targets not only the setting up of healthcare information security programs in all Saudi hospitals but also the implementation of appropriate HIPAA based feedback mechanisms enabling each hospital to assess its compliance with security safeguards requirements [9]”.

As more healthcare providers begin to use email and text messaging SMS to communicate with patients, traditional Internet security methods are not sufficient to guarantee that medical information will not be compromised during data transmission. Based on that in Toward Healing application will use HIPAA protocol to protect patient information and the communication between the doctors and patients.

Similar Applications

In this section, some related work to our application presented. We have searched and analyzed some similar online applications that have similar goals and objectives. The purpose of this review is to have an insight on the right features for inspiration and to avoid some mistakes committed.

There are a lot of applications that provide communication between doctors and patients in the USA, but no one is offering online communication in Riyadh's hospitals. Here are some of the best application that offers communication service and their features:

DocbookMD

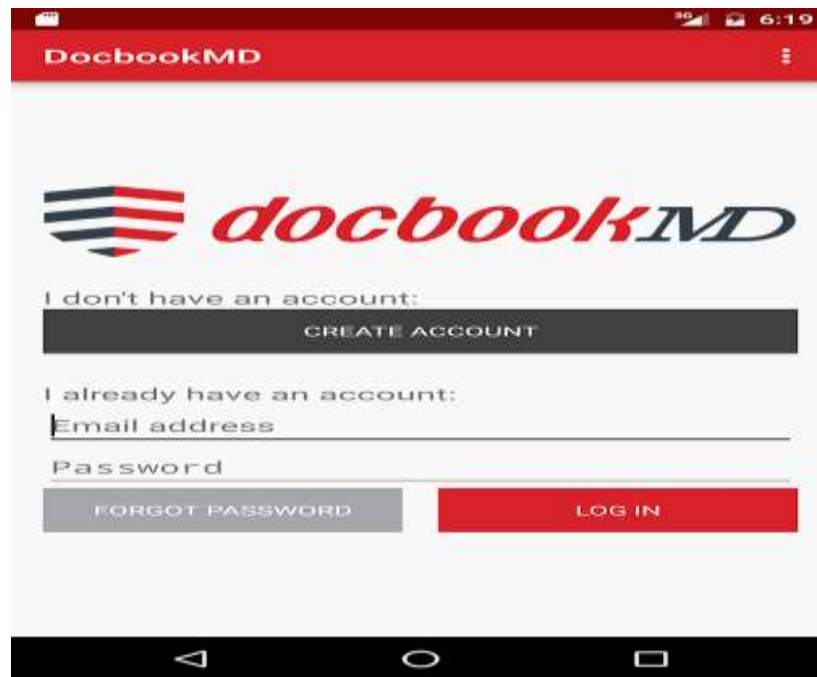


Figure 1 : DocbookMD application

DocbookMD is an application for healthcare providers also it's using HIPAA-secure messaging. Thousands of customers across the United States rely on this application every day to streamline and improve patient care.

Features:

- Send and receive HIPAA-secure messages and images.
- Message priority settings alert users when a communicate.
- PIN lock with optional Touch ID secures the application.
- notify the sender when their message has not been read.
- Invite nurses and other office staff to join you.

- Integrate with laboratories EHRs and call centers for delivering the patient results and information.
- All message data are protected by strong encryption.

PingMD

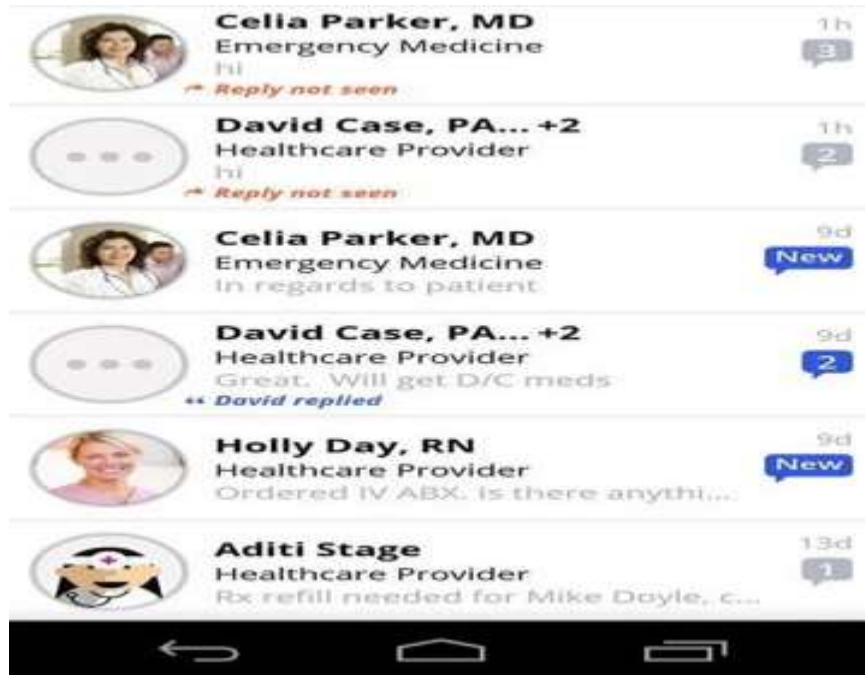


Figure 2 : PingMD application

PingMD is an HIPAA-messaging application for doctors to connect with other physicians, as well as their patients.

Features:

- Available on Android, iOS, Web
- Doctors can get advice from other physicians.
- Doctor recommend the application for his patients to download it.
- The doctor can follow patient symptom progression, ask follow-up questions after the last visit.
- Communicate via text messaging, asynchronous messaging, image-sharing.

Practice Unite



Figure 3 : Practice Unite application

Practice Unite is an HIPAA-messaging mobile application, that customized to the needs of your healthcare system.

Features:

- Reduce communications delays.
- Collaborate with care providers more easily.
- Communicate by secure text or by phone.
- Receive data anywhere and anytime.
- Provide feedback through surveys.
- The patient can search for physicians based on name, specialty, areas of practice, insurance participation, location.
- Submit news, images, and videos from your organization.
- Deliver consults directly from the patient's EHR to physicians' mobile devices.
- Receive abnormal lab results and valuable information from your EMR.
- Securely share patient notes among physicians and nurses.

Architectural Design:

Client server is an architectural design as defined in [14]"the functionality of the system is organized into services each service delivered from a separate server clients are users of these services and access servers to make use of them a system that follows the client server pattern is organized as a set of services and associated servers, and clients that access and use the services"

Client server pattern was used when the system contains data accessed from large range of locations and deal with variable load.

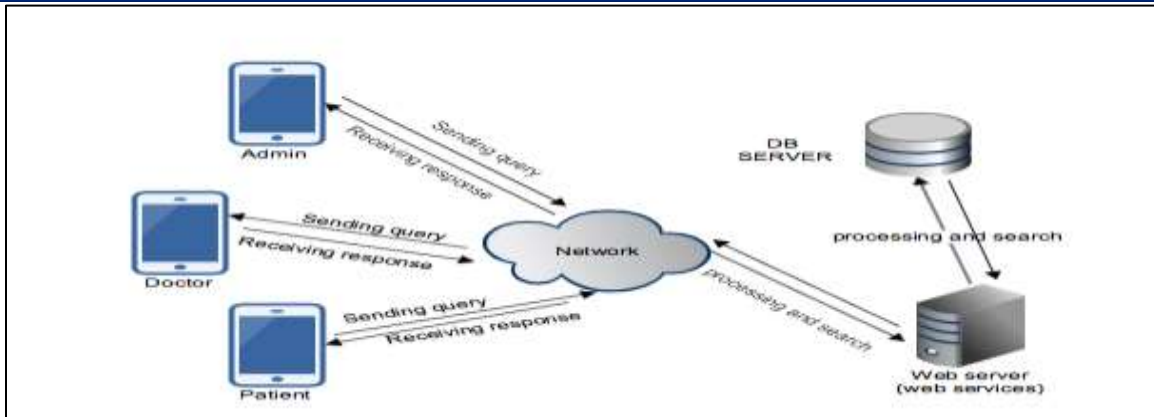


Figure 4: CLIENT-SERVER ARCHITECTURAL DESIGN

Figure 37 describes how the communication between the user's admin, doctors and patients. The users need to download the application in their Android phone, all users are differentiated based on their logins. All the interactions such as messaging, sending health tips announcements, and uploading references are initially sent to the web server, these interactions are service requests made by the user stored on the web server. Similarly, the data is fetched from the DB server and then through the web server to the user. The users should always be connected to the internet in order to interact with the web server. Hence this way the communication takes place in the Toward Healing application.

Proposed Solution

Depending on DSR methodology we designed the user screens to specify the functional and nonfunctional requirements then take the agreement from the customer. After receiving the agreement, we analyzed the functions, now we start to build the solution and implement the application.

Toward healing is a mobile application that helping the doctor and his patients to communicate anywhere and anytime. Because it may not be possible for a patient to meet his doctor in the hospital due to some busy schedule, also for the doctor it may not be possible to give an appointment for the patient to clear minor issues. In such cases it will be helpful to have a medium of online interaction where the patient can quickly ask the doctor some questions. Toward healing has many beneficial features such as uploading health tips to patients, interacting with the doctor through messages, and getting announcement from the doctor. To develop the Toward Healing app Android framework, Android Studio and web server are used. The Android system designed for devices with touch screen such as smart phones and tablets. It's also have many features like: it's compatible with multiple hardware and supports various features like Web browser, Email, Java, Video calling, Media streaming, Bluetooth, Wi-Fi, Multitasking, External storage, Screen capturing, and etc. It is an open source technology. Large number of users use Android. And comparing with the other popular operating systems it's has low cost.

Android Operating System

Android Studio 2.3.3

Android Studio is the official Integrated Development Environment (IDE) for Android app development, based on IntelliJ IDEA. On top of IntelliJ's powerful code editor and developer tools, Android Studio offers even more features that enhance your productivity when building Android apps, such as: [15]

- A flexible Gradle-based build system.
- A fast and feature-rich emulator.
- A unified environment where you can develop for all Android devices.
- Instant Run to push changes to your running app without building a new APK.
- Code templates and GitHub integration to help you build common app features and import sample code.
- Extensive testing tools and frameworks.
- Lint tools to catch performance, usability, version compatibility, and other problems.
- C++ and NDK support.
- Built-in support for Google Cloud Platform, making it easy to integrate Google Cloud Messaging and App Engine.

Android Studio is a platform for creating apps and games, as well as an open marketplace for distributing them instantly through Google's play store.

This app is developed for smart phone users, there are many operating systems available for smart phones but we opted the Android operating system for developing this product because it has a very good user bank worldwide. Users can only avail the services of the application when they are connected to internet, because the communication between doctors and patients, and data exchange from cloud server needs the internet connection.

Toward Healing is compatible on different versions of Android, such as starting from the minimum SDK version 15 and maximum SDK version 25 of Android 6.0 "Marshmallow" using JAVA language.

Android 6.0 "Marshmallow" was unveiled under the codename "Android M" during Google I/O on May 28, 2015, for the Nexus 5 and Nexus 6 phones, Nexus 9 tablet, and Nexus Player set-top box, under the build number MPZ44Q. The third developer preview (MPA44G) was released on August 17, 2015 for the Nexus 5, Nexus 6, Nexus 9 and Nexus Player devices, and was updated to MPA44I that brought fixes related to Android for Work profiles. [16]

Depending on the sensitive information in our application we need security protocols to encrypt the patient information and password. In cryptography, we used MD5 (Message-Digest algorithm 5) is a widely-used cryptographic hash function with a 128-bit hash value. MD5 was designed by Ronald Rivest in 1991 to replace an earlier hash function, MD4. As an Internet standard, MD5 has been employed in a wide variety of security applications, and is also commonly used to check the integrity of files [17]. This algorithm is not reversible; it is normally impossible to find the original word from the md5 hash.

Data Design:



Figure 5: phpMyAdmin

phpMyAdmin is a free software tool written in PHP, intended to handle the administration of MySQL over the Web. phpMyAdmin supports a wide range of operations on MySQL and MariaDB. Frequently used operations (managing databases, tables, columns, relations, indexes, users, permissions, etc) can be performed via the user interface, while you still have the ability to directly execute any SQL statement. [18]

In this project we use phpMyAdmin to create the application database to store user information. It's uses MySQL because it minimizes the allocation and perform. We create 6 tables shows in Figure 39.

The image is a screenshot of the phpMyAdmin interface showing the 'Structure' view of a database. It displays a table with columns for 'Table', 'Action', 'Rows', 'Type', 'Collation', 'Size', and 'Overhead'. The table lists six tables: 'admin', 'conversation', 'doctor', 'message', 'reference', and 'user'. Each table has a 'Rows' count and a 'Size' in KB. A summary row at the bottom indicates '6 tables' with a total of '176 Kib' and '8' overhead.

Table	Action	Rows	Type	Collation	Size	Overhead
admin	Browse Structure Search Insert Empty Drop	1	InnoDB	utf8_general_ci	16 Kib	-
conversation	Browse Structure Search Insert Empty Drop	2	InnoDB	utf8_general_ci	48 Kib	-
doctor	Browse Structure Search Insert Empty Drop	1	InnoDB	utf8_general_ci	16 Kib	-
message	Browse Structure Search Insert Empty Drop	4	InnoDB	utf8_general_ci	32 Kib	-
reference	Browse Structure Search Insert Empty Drop	8	InnoDB	utf8_general_ci	32 Kib	-
user	Browse Structure Search Insert Empty Drop	7	InnoDB	utf8_general_ci	32 Kib	-
6 tables	Sum	13	InnoDB	utf8_general_ci	176 Kib	8

Figure 6 : DB Tables using phpMyAdmin

Entity Relationship Diagram

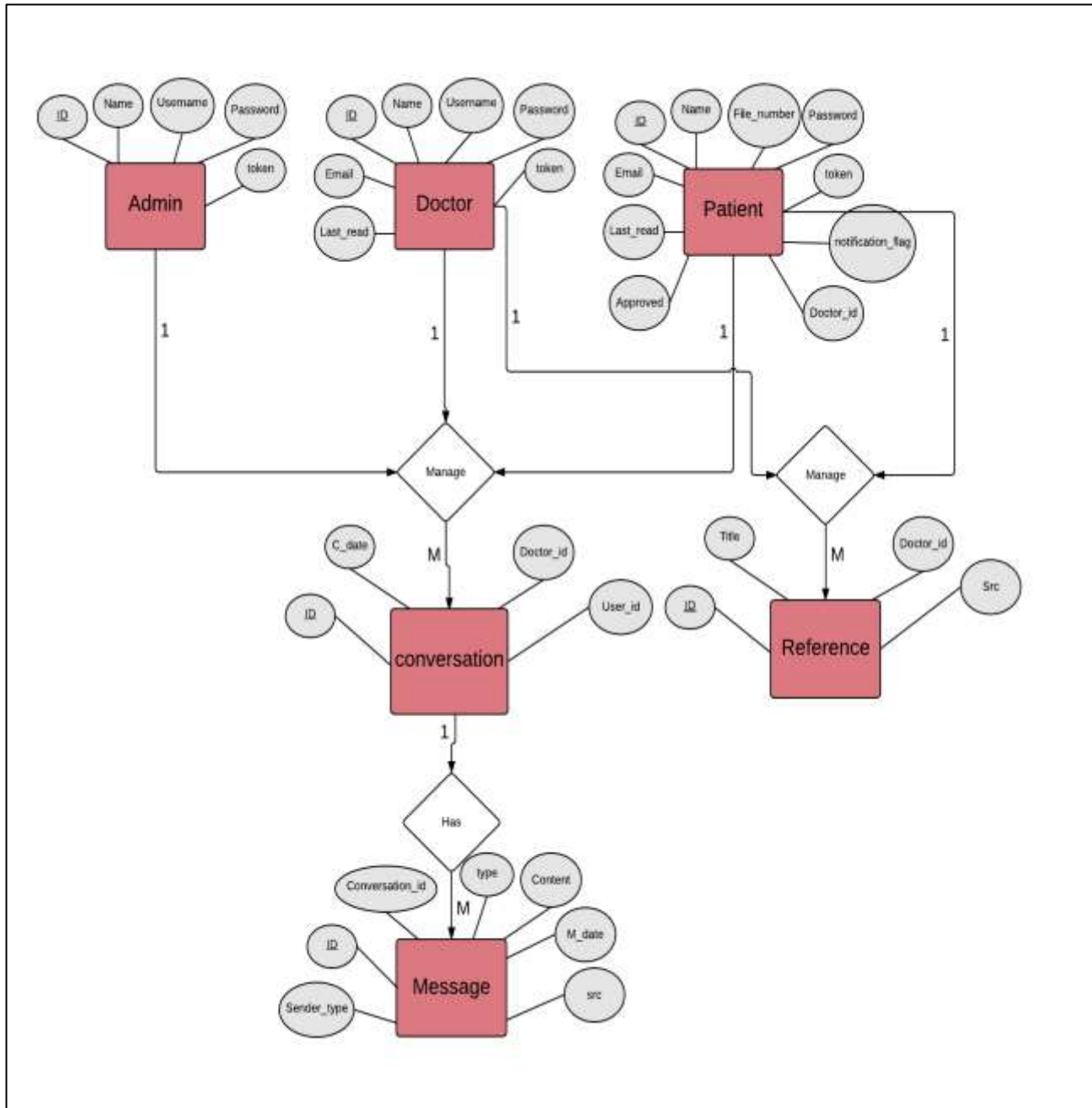


Figure 7 : Entity Relationship Diagram

System Testing

In this phase the functionality is tested on 2 Android device v7.0 (Nougat). After uploaded the APK release on google play [19] we install the application in 2 devices which has Android version 4.1 or up. To use this application, the device should be connected to the internet by 4G or WIFI with good connection.

Registration

- A. **Negative Test Case:** If the patients clicking on Sign up button without entering the main values in any of the fields and trying to register with the application will generate a dialog by showing warning message as in Figure 41.
- B. **Positive Test Case:** Figure 42 shows the successful registration; by which we ensure the patients is registered successfully with the application. Before registering the user, we make sure all the fields are validated. These kind of requests are requiring further approval like from the doctor.

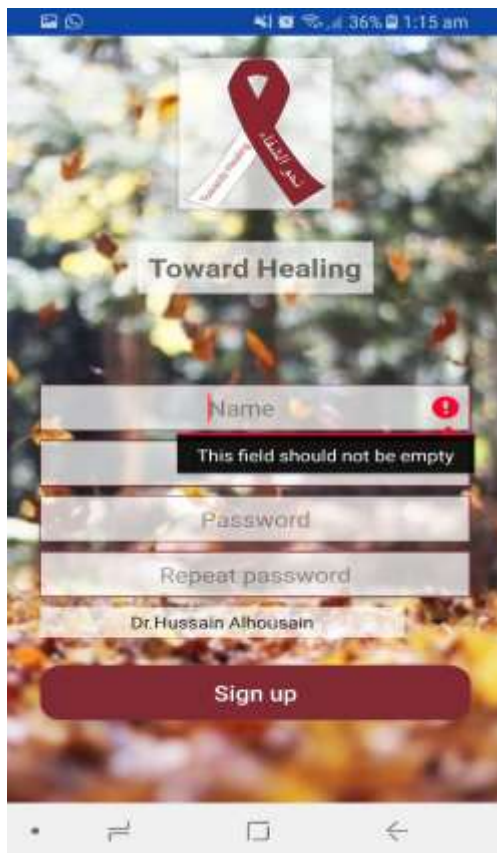


Figure 8: Registration negative

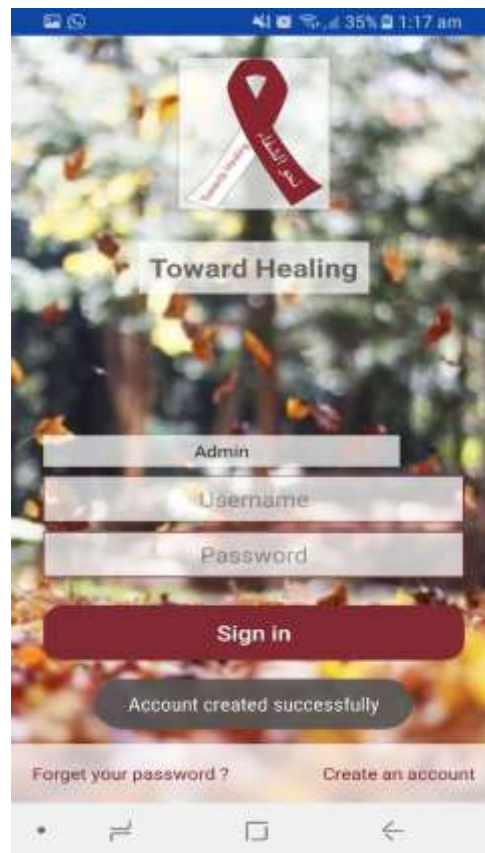


Figure 9: Registration positive

Approve/Reject patient

- A. **Negative Test Case:** When doctor clicking on Approve/Reject the patient button and there are no patients the application will generate a dialog by showing warning message as in Figure 45.

A. Positive Test Case: Figure 43/44 shows the successful message after the doctor select the patient then clicking on Approve/Reject the patient button.

Send messages/ Announcement

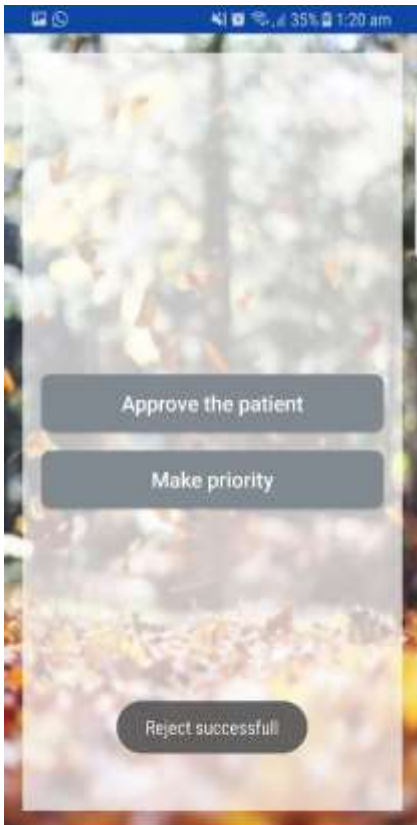


Figure 11:Reject patient positive

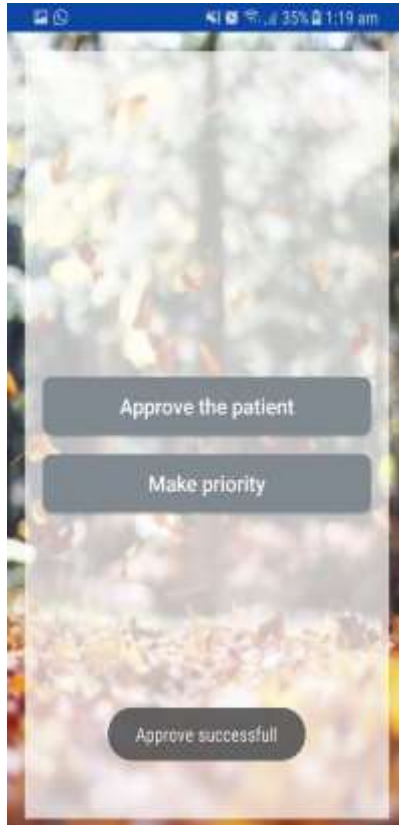


Figure 10:Approve patient positive



Figure 12:Approve/Reject patient negative

- A. **Negative Test Case:** When
- B. the doctor/patient tries to send a message without typing the message, or when the doctor tries to send an announcement without selecting the recipient, then an alert dialog will be displayed as shown in Figure 46/47/48.
- C. **Positive Test Case:** For sending a message the user can select a recipient, type a message and click on the send button.

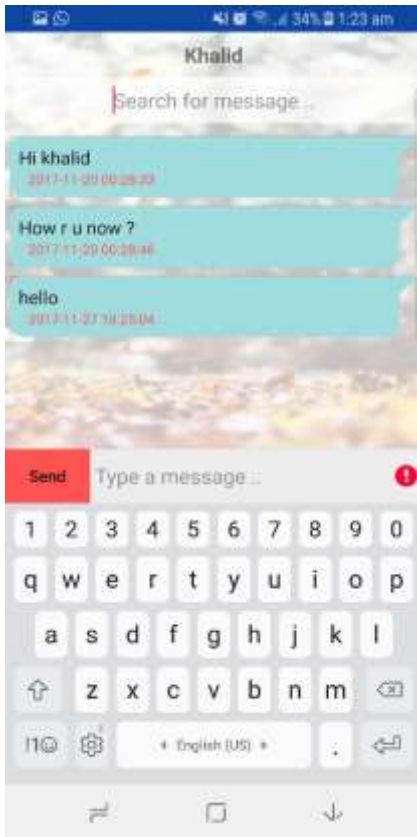


Figure 15: Send messages negative



Figure 14: Send an announcement negative



Figure 13: Send an announcement negative

Add doctor

- A. Negative Test Case:** If the admin tries to add a doctor without entering all the values then a validation error dialog is displayed as shown in Figure 49.
- B. Positive Test Case:** After entering all the fields and clicking on create an account as shown in Figure 50, the doctor will be registered. These kind of requests are automatically approved and does not require further approval like patient account.



Figure 16: Add doctor negative



Figure 17: Add doctor positive

Dr. Hussain's comment

The main note:

Extending to Apple iOS because King Fahad Medical City's doctors carry iPad devices with them to deal with their daily tasks.

For the current version the notes are as follows:

- The Logout button should be an icon and in the right corner of the screen.
- The phrase "we hope you have a wonderful day :)" must be removed.
- Add to the doctor's profile more options such as the specialization and the position of the doctor.
- Add the sender's name to each message.
- Statement on the status of the message (Readed or not).
- Enable file uploads (PDF, images, WordPress, Hyperlink)
- Ability to add attachments to Send Announcement function.
- Button to return in the application instead of using the back button of the android.
- In Approve the patient display the patient's name with patient's file number.
- Library of educational materials selected by the doctor and sent to the patient directly according to the diagnosis of his condition.

Conclusion

Through this report, we tried to meet all of the objectives mentioned in the first chapter. The first objective we met was to create online interaction between doctors and patients to fulfil the basic needs/problems of the patients. Patients can raise their problem to doctors by messaging and get advice from the doctor. Through the messaging services, patients can seek 24/7 help from doctors.

Impact report

Local impact:

Toward Healing helps patient and doctors to communicate in an efficient matter. Toward Healing is designed to be an application which can be accessed at home easily without external help. It enables the administrators to manage commutations, add doctors, delete doctors, delete the patient and delete messages. It allows patient to register and send a message to the doctor and view important announcements and references published by the doctors.

Global Impact:

Similar to the case in the King Fahad Medical City, other hospitals in Saudi Arabia, don't have this kind of application. Therefore, developing Toward Healing would be of great help to patients and doctors in Saudi Arabia because of their treatment plans similarities.

Future work

In this report, we delivered a complete document of analysis and design. In the next stage we will actually implement our system in application environment and test it to make sure it is meet the doctors and patients' requirements.

Also, this app can be improved in the future by adding the following functionalities:

- Extending to Apple iOS.
- Create two separate apps for doctor & patient.
- Sharing the medical test reports of patients to doctors through this app.
- Supporting sending voice note and images.
- Supporting video calls to discuss the problems with doctors.
- Allowing patients to book appointments.

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