

DESIGN AND DEVELOPMENT OF ANDROID BASED MOBILE APPLICATION FOR HEALTHCARE MANAGEMENT AND SOLUTION

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Abstract—Healthcare is one of the most important needs of any human being. For any nation to prosper, it must first ensure that its citizens get the appropriate health care facilities. It is often observed that due to expensive routine check-ups, people usually procrastinate going to the hospitals until it becomes absolutely necessary and sometimes, that is too late. Moreover, time and resources get wasted when patients have to go from one hospital to another for the required services. The project aims to reduce these shortcomings in the healthcare system by recommending doctors along with the laboratory names to the patients, based on their requirements. For the disease prediction, the symptoms inputted by the users are processed using machine learning algorithm (Random Forest Classifier), based on which the users can then choose appropriate lab packages. Besides the aforementioned facilities, the application also allows the users to view nearby hospitals in case of an emergency, check their blood pressure and levels whenever they want to. Furthermore, our app provides users with a pedometer to keep track of their steps and health and also provides them with an option to register themselves as blood donors or view the list of blood donors.

Index Terms—healthcare, android application, symptoms, disease prediction, appointment scheduling, pedometer, blood bank, SpO₂, blood pressure, nearby hospitals locator, Random forest classifier

I. INTRODUCTION

In today's world, mobile phone has become an essential part of everyone's life. Laptops may not be owned by everyone but nowadays, everybody has a mobile phone equipped with an internet connection. A mobile phone can be used to solve many problems related to healthcare. People have now become more aware regarding proper health and fitness. This project is an online diagnostic lab manager application equipped with an emergency, pedometer, SpO₂, blood pressure and blood bank option.

The app can be used by people to view variety of tests along with their prices, conducted by various labs. It also allows the users to input their symptoms and then accordingly, our application predicts the disease. Based on the output, the users can then choose the appropriate lab package. The application also allows the registered doctors to keep a track of their appointments. The dataset used for the prediction of diseases has been taken from a study conducted at Columbia University.

Along with these facilities, the users can track their steps using the pedometer option and monitor their levels and blood pressure by placing their finger on the camera lens. In case of an emergency, the application allows the users to view the list of nearby hospitals and medical care facilities. The application also allows the users to register themselves as potential blood donors or view the list of blood donors. The doctor and user credentials along with their appointment details as well as the list of donors based on the blood group are stored in the Firebase database. The admin has access to all the information stored in the database while the user can view only his/her details.

II. PROBLEM DEFINITION

The mobile healthcare web services by using android can provide benefits to the users, allowing them to enter their symptoms and get the correct response from the system in the form of disease identification and providing appropriate lab packages for the illness. Using the new technologies, users can be equipped with powerful and efficient tools, support systems that can help them in their everyday management of health and thus, they can be more involved in decision making when it comes to their health; for instance, the patients can timely plan their routine body check-up's and further consult a doctor if a serious situation arises. They can also locate nearby hospitals in case of an emergency by making use of the built-in feature of GPS and find routes through Google Map API.

Due to the technology advances in healthcare, a user can now locate the nearest available blood donor and communicate with him/her in case of an emergency situation. People can also keep track of their fitness, calories burnt and cholesterol levels by using the pedometer applications that are available on playstore. Instead of going to the hospitals or buying instruments to calculate blood pressure and levels, a person can now use his/her mobile phone to do the same. For healthcare applications, user-friendliness of the system is very important as there is a big spectrum of users with different needs and expectations that should be met by the application.

Furthermore, we have tried to integrate all the above facilities into a single application, thus reducing the hassle of juggling between multiple apps.

Our project consists of three main modules namely, doctor, admin, patient and provides the user with five other options on the home page namely, emergency, blood bank, SpO₂ monitor, BP monitor and pedometer. Once the application is installed, the user can click on any one of the aforementioned options. On clicking the admin button and giving the correct admin username and password, the user is allowed to view the details of the patients (along with the appointment details) or that of the doctors'.

When the user clicks on the patient button present on the home page, he/she is given an option to make a new account or log into an existing one by entering the registered phone number and view his/her details. The project allows the patient to fix an appointment or delete an existing one. The appointment details include, name of the doctor and the hospital, name and price of the test and appointment date and time. Also, the patient can choose from a pool of packages, that suit his/her needs. The basic packages included are: Lipid Panel, Liver Panel, Full Body Check-up, Urinalysis, Complete Blood Count and Haemoglobin A1C. To view more packages, the patient is given an option to select the symptoms, on the basis of which an illness is predicted. The algorithm used to predict the disease is Random Forest Classifier and some of the diseases predicted are: fungal infection, common cold, migraine, acne, allergy, diabetes and so on. Once an appointment is fixed, the user receives an SMS notifying his/her of the same. The details get updated in the Firebase, allowing the admin to view the modified data. On clicking the doctor button present on the home page and giving the correct username and password, the doctor is allowed to view the name of his/her patients and when the name of the patient is clicked, the user is taken to a new page displaying if the patient had made any appointments.

When the emergency option is clicked, a list of all the nearby hospitals and health care facilities is displayed to the user based on his/her location. The pedometer option present on the home page allows the user to keep track of his/her steps. Furthermore, the options to monitor blood pressure and SpO₂ levels work only when the user places his/her finger on the camera lens. The blood bank button present on the home page and displays two options, either to be a donor or view the list of blood donors. When the user chooses to be a donor, he/she is asked to fill in certain details including his/her name, blood group and mobile number. When the user chooses the latter option, he/she is asked to select a blood group type in order to view the list of donors of the particular blood group (along with their locations).

Our main focus was on the convenience of the user, thus making sure that the project had the following characteristics:

availing health service facilities such as scheduling an appointment, low cost and time saving system, and disease prediction.

III. RELATED WORK IN THE AREA

Health care is changing with a new focus on the patient. In relation to this transformation, the new focus on the patient includes recognition of the role of patients in health care design and delivery. By using the Internet as a medium, users now have more freedom in decision making regarding their preferences and have improved access. Many positive changes in some areas have been observed after adopting mobiles for healthcare such as decreased no-show rate, less staff labour, reduction in waiting time, and better satisfaction, and so on. Major reasons that discourage providers from switching to mobile-based scheduling include cost, flexibility, safety, and integrity. Patients' unwillingness to use such applications is mainly characterised by their past experiences regarding usage of computers and the Internet as well as their communication preferences.

The mobile based healthcare systems are faster than the web applications and have greater functionality due to access to the system resources. Also, mobile health [m-Health] applications are safer and more secure as they must first be approved by the play store. Out of 120 applications that we surveyed on the play store, most of them either focus on online lab bookings or disease prediction, and few of them are either pedometer, blood bank or pulse oximeter applications. On the contrary, we have tried to incorporate all the aforementioned facilities into one.

IV. LITERATURE SURVEY

For the project, we surveyed various research papers, out of which we zeroed in on the following ones. To comprehend the significance of data mining in healthcare, we referred to [1]. It states that data mining techniques are necessary for better decision and prediction in the healthcare field. This paper also shows how data mining of medical data contributes to business intelligence which is very useful for the diagnosis of diseases. [2] states that for fast classification of big data and accurate prediction of the disease, KNN and CNN are used. Since medical data is increasing daily, the need for correct prediction is crucial. On the contrary, [3] claims C4.5 algorithms to be an efficient one when compared to the other algorithms and since, the number of attributes is less, the complexity of decision tree is reduced. After going through [4], we decided to use Random Forest Classifier for disease prediction in our project, as when compared to Naive Bayes and KNN, Random Forest was better in terms of f degree and accuracy over distinctive datasets. Also, [5] states that in situations where the number of variables is larger than the number of observations, Random Forest has shown good performance. This has helped us with regard to the project as our dataset has large number of

symptoms for the prediction. [6] author have been used machine learning model using genetic algorithm and support vector machine.

[7] provided us with a framework for implementing our idea. In this paper, an android based application has been designed which provides many features to the user. This application helps the user to keep a track of his/her fitness regime and also manages appointments with the doctors easily. Similarly, in [8], a healthcare-based app has been proposed which is user friendly and efficient. Also, this application can be deployed on the cloud when integrated with different hospitals and linked with their servers to the cloud. For the use of Firebase in our project, we studied [9] and found out that android apps run faster and efficiently when Firebase is used as PHP is not required to communicate with the database. Also, it provides a safe and secure channel to interact with the database directly from Java.

As the main objective of our project is to reduce the time and energy spent by users in travelling and standing in long queues in hospitals, we decided to provide them with an option to fix appointments online. For this, [10], [11] and [12] were consulted. [10] states that the benefits of implementing such system are easy registration by the customer from anywhere, at any time and on any device. [12] suggests that for a system to achieve integrity, mutual authentication, data confidentiality and secure search, the following four entities must be used: Cloud Server, Trusted Authority, User and Medical Service Providers.

In order to incorporate SpO₂ and blood pressure monitor in our application, we consulted [13]. The paper talks about how mobile phones with numerous in-built sensors can be used to develop and design applications to collect different biomedical signals. It proposes the use of mobile phone's camera to predict heart-rate and pulse oximeter level. This is achieved by making use of the ability of the smart phone to record and detect variations in colour signals in a fingertip when placed in contact with the phone's camera. [14] was studied to get an idea of how a blood bank option should be added to our project. The paper proposes an android application that searches for the nearest donor available by tracking their present location via GPS by making use of the Haversine Mathematical Algorithm. It then consults the Department of Health and Welfare regarding the benefactor's medical case history. We are living in a world where perilous situations can happen to anybody therefore emergency rescue assistance and relief operations become very important. In order to make sure that our application includes an emergency option, [15] was consulted. The paper proposes an application that locates the nearest hospital (within five km radius) with the desired medical specialist. The location of the hospital is found out by making use of the GPS in smartphones and finds the route from the user's current location through Google Map API.

To make sure that the user takes out time for fitness during his/her daily routine, we have included a pedometer option. For this, we referred to [16] which is a study on how accurate pedometer mobile applications are. The aim of the paper was to evaluate the accuracy of six different free pedometer applications for three different cell phones, worn at three different cell phone positions. Since many pedometer applications are available for download, it is necessary that their accuracy is evaluated before use.

V. IMPLEMENTATION

The application is written in Kotlin on Android Studio. For storing the details of the users, doctors and donors, Firebase Real-time Database has been used. It stores the data in JSON format which has a nested structure and can be represented using a tree. The dataset used for the prediction of diseases has been taken from a study conducted at Columbia University [17]. It has then been cleaned and pre-processed. The dataset contains the name of the diseases along with their symptoms as shown in Fig. 1. We have used random forest classifier to classify the disease because random forest has shown better performance in situations where the number of variables is larger than the number of observations and in our project, the dataset has large number of symptoms for each disease. The confusion matrix for the random forest classifier is shown in Fig. 2 and Fig. 3 displays the precision, recall and F-1 Score of the classifier.

silver_like	small	denin	flammat	blister	red_sore	yellow	crs	prognosis
0	0	0	0	0	0	0	0	Fungal infect
0	0	0	0	0	0	0	0	Fungal infect
0	0	0	0	0	0	0	0	Fungal infect
0	0	0	0	0	0	0	0	Fungal infect
0	0	0	0	0	0	0	0	Fungal infect
0	0	0	0	0	0	0	0	Fungal infect
0	0	0	0	0	0	0	0	Fungal infect
0	0	0	0	0	0	0	0	Fungal infect
0	0	0	0	0	0	0	0	Fungal infect
0	0	0	0	0	0	0	0	Fungal infect
0	0	0	0	0	0	0	0	Fungal infect
0	0	0	0	0	0	0	0	Fungal infect
0	0	0	0	0	0	0	0	Fungal infect
0	0	0	0	0	0	0	0	Allergy
0	0	0	0	0	0	0	0	Allergy
0	0	0	0	0	0	0	0	Allergy
0	0	0	0	0	0	0	0	Allergy
0	0	0	0	0	0	0	0	Allergy

Fig. 1. Dataset

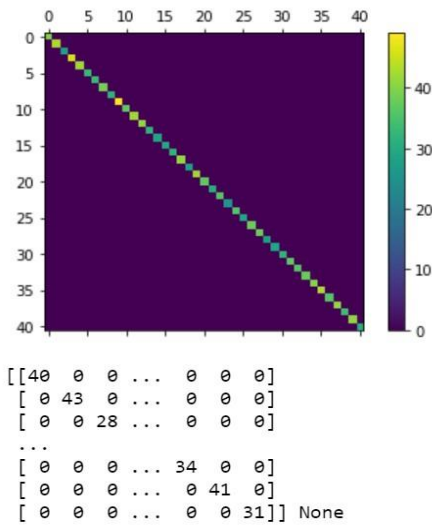


Fig. 2. Confusion Matrix

Precision score: 1.0
 Recall score: 1.0
 F1 Score: 1.0

Fig. 3. Precision, Recall, F-1 Score

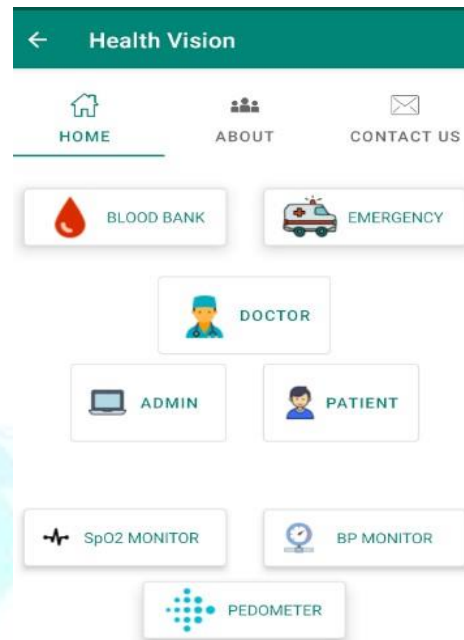


Fig. 4. Home Page

When the app is launched, it displays the home page as shown in Fig. 4. The user can click on any of the buttons present on this page namely: Home, About, Contact, Blood Bank, Emergency, Doctor, Admin, Patient, SpO₂ monitor, BP monitor and Pedometer. When the contact button is clicked, the users are taken to another page where they are prompted to click on the mail id. When this mail id is clicked, the users can then compose a mail from their mail ids to the id displayed on the contact page. On clicking the about button, a new page is displayed which describes the basic functions of the application.

When the blood bank button is clicked, the application asks for the location permission to be enabled if not. The user is then presented with three buttons namely: need blood, be a donor, why should you donate blood as shown in Fig. 5. The latter, when clicked, displays a page telling the user why it is important to donate blood. When the need blood button is clicked, the user is asked to enter a blood group they require and then hit continue. If there are no donors of the specific blood group, a toast message, regarding the same, is displayed. If there are donors

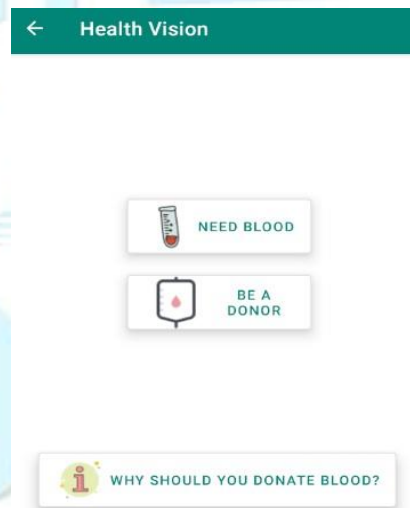


Fig. 5. Blood Bank Option

available, a list of every donor with his/her name, location and phone number is displayed. On clicking on any one of the list items, a google map is displayed which shows the donor's location in red marker and the user's location in blue marker. When the be a donor button is clicked, the user is asked to

enter the following details: name, blood group and mobile number. On hitting continue, the details get stored in the Firebase Database along with the user's location.

When the emergency button is clicked, the application asks for the location permission to be enabled if not. A new page is displayed which has search nearby hospitals button. When the button is clicked, a google map is displayed with nearby hospitals and medical care facilities shown with red markers and the user's location shown in blue marker. This page also has a button which when clicked, displays the list of the nearby hospitals with their names and addresses as shown in Fig. 6. The pedometer button allows the user to count his/her steps as shown in Fig. 7. Once started, the application simultaneously displays the number of steps travelled on the top. When stopped, a toast message is displayed with the total number of steps travelled as shown in.

In order to estimate oxygen saturation level and blood



Fig. 6. List of Nearby Hospitals

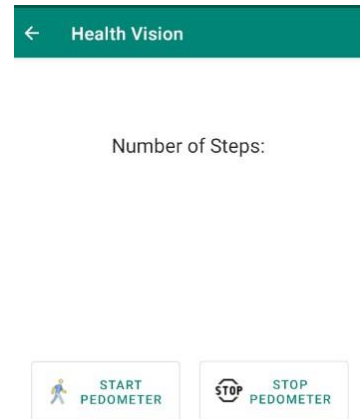


Fig. 7. Pedometer

pressure, SpO₂ monitor and BP monitor buttons are included respectively. On clicking on any one of these buttons, the user is taken to a new page wherein he/she is asked to place a finger on the camera lens. For this, IIR filter library and Fast Fourier transform code were used. The application makes use of the Photoplethysmography (PPG) signal to measure the oxygen saturation level and blood pressure. When the user places his/her finger on the camera lens, image processing method is applied to obtain the RGB intensity. This contains the PPG signal which is then used to estimate the two vital signs.

For oxygen saturation level, it is important that AC and DC signals are calculated first. Here, DC signal is defined as the mean value of red and blue intensities for the whole period of time while AC signal is defined as the standard deviation. To calculate the SpO₂ of a user, the following formula is used:

$$SpO_2 = 100 - 5 \frac{AC_{RED}/DC_{RED}}{AC_{BLUE}/DC_{BLUE}}$$

The signal at the receiver is divided into two parts: the AC component is due to the pulsatile arterial blood and the DC component is due to the venous blood, tissue background and constant part of the arterial blood flow. The AC component is amplified while the DC component is subtracted.

For blood pressure, the red and green intensities are stored in an array, on which Fast Fourier Transform code is applied. The following formulas are used to calculate the blood pressure:

$$P_s = P_m + \frac{2}{3}P_p$$

$$P_d = P_m - \frac{P_p}{3}$$

Here, P_s stands for systolic pressure which is the blood pressure when the heart is contracting. P_d stands for diastolic pressure which is the blood pressure when the heart is relaxing. P_m stands for mean arterial pressure, it is a medical term to describe the average blood pressure of an individual and P_p stands for pulse pressure which is the difference between the systolic and diastolic pressure.

The home page consists of three main modules: admin, doctor and patient. When the user clicks on the admin button, a new page is displayed that allows the user to enter the admin username and password. If the admin username or password is incorrect, an error message is displayed. On giving the correct username and password, the user is allowed to view the details of the patients (along with the appointment details) or that of the doctors'. On clicking the patients' details, a list of all the users registered with the application is displayed. When a particular list item is clicked, the appointment details of that particular user are displayed. If the user has not made any appointments, "No appointments made so far is displayed". On clicking the doctors' details, a list of all the doctors registered with the application is displayed. When the user clicks on the doctor button, a new page is displayed that allows the user to enter the doctor username and password. If the doctor username or password is incorrect, an error message is displayed. On giving the correct username and password, the doctor is allowed to view the names of his/her patients. If there are no such patients, a toast message, "Patient details are unavailable", is displayed. Otherwise, a list of the names of the patients is displayed. The doctor can click on any one of the list items to view the appointment details. When the user clicks on the patient button, he/she has two options to choose from: to either create a new account or log into the existing account. If the user decides to create a new account, he/she has to enter the following credentials: username, password, date of birth, mobile number and email address. If these inputs are valid, the user is notified of the successful registration otherwise, appropriate error messages are displayed on the screen. The user can log into the existing account by entering his/her registered phone number. If the number is incorrect, an error message is displayed otherwise the user is taken to a new page which displays his/her details as shown in Fig. 8.

From here, the user can either opt for viewing the packages or deleting appointments. If the user clicks on the button to delete appointments, a toast message is displayed if he/she has not made any appointments till now otherwise the user is taken to a new page that displays the appointment details made by the user. To delete any one appointment, the user needs to click on that appointment detail. Doing so, a dialog

Fig. 8. User Details

Fig. 9. Test Details

box appears confirming whether the user wants to delete it. If the user clicks on yes, the appointment gets deleted and the corresponding changes are made in the database. If the user clicks on no, a toast message is displayed. If he/she chooses to view packages, a new page is displayed that contains the name of the basic common lab packages namely, lipid panel, haemoglobin a1c, complete blood count, urine analysis, full body check-up, liver panel along with a button to perform disease prediction. Clicking on any one of these lab packages takes the user to a new page which displays two tests related to that package. After selecting any one of the two tests, the user can then fix an appointment by choosing a date and time slot as shown in Fig. 9. If the date and time slot are valid, the appointment details are again displayed on the screen before getting stored in the database. If the user wishes to receive the

detail, he/she can click on the button “receive appointment details”. If the user wants to view more packages, he/she can choose the option to predict disease. This takes the user to the next page that displays a list of symptoms as shown in Fig. 10. Before clicking on the button “predict”, the user needs to select at least one symptom.

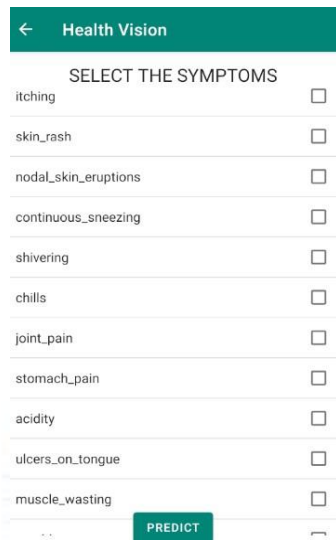


Fig. 10. Symptoms List

The symptoms are then sent in the form of an http (for the symptoms, puffy_face_and_eyes and pus_filled_pimples, http://localhost:5000/?symptoms=puffy_face_and_eyes,pus_filled_pimples is used) to the flask app that is running in the background. The result is then transferred from the flask app to the android application which is then displayed to the user as shown in Fig. 11. The user can then choose a test related to the predicted disease and fix an appointment in the aforementioned manner. The details then get updated in the database.

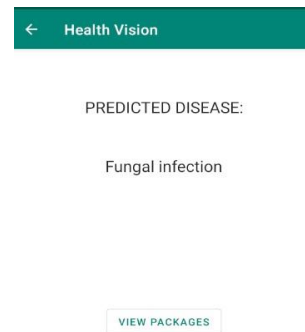


Fig. 11. Predicted Disease

VI. CONCLUSION & FUTURE WORK

Our project provides a paperless, electronic application that is designed with high flexibility and has ease of usage implemented for the comfort of our users. The system serves in managing appointments for different labs and also helps in predicting diseases according to the symptoms selected. It allows the users to keep track of their fitness by providing them with a pedometer option as well as an option to monitor oxygen saturation levels and blood pressure. In case of an emergency, the users can avail of the blood bank option or the emergency option to view the list of nearby healthcare facilities. Overall, it provides a user friendly, easy appointment booking and fitness tracking facility to the patients. Currently, the app does not give doctors the permission to cancel their appointments or reschedule it. They can just view their appointments. Since the application makes use of the Firebase Real-time database, the app can work only when the user is connected to the internet. Also, the disease prediction system works best when the user has selected at least 4-5 symptoms. Currently, the blood bank facility only allows the users to register themselves as donors or view the list of donors. To make use of the emergency and the blood bank option, the user must make sure that the location permission is enabled otherwise the application doesn't proceed further.

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