Development of Monitoring and Health Service Information System to Support Smart Health on Android Platform

A'isya Nur Aulia Yusuf
Department of Electrical Engineering
Universitas Indonesia
Depok, Indonesia
aisya.nur@ui.ac.id

Fitri Yuli Zulkifli
Department of Electrical Engineering
Universitas Indonesia
Depok, Indonesia
yuli@eng.ui.ac.id

I Wayan Mustika
Department of Electrical Engineering
and Information Technology
Universitas Gadjah Mada
Yogyakarta, Indonesia
wmustika@ugm.ac.id

Abstract—**Indonesia has relatively low health index compared to other countries, which is caused by increasingly complex disease pattern. One way to solve this problem is using the Smart Health concept, which enables monitoring of health condition by patient and healthcare institutions, to prevent diseases. Researches related to health monitoring have been conducted. Most of them focus only on the reading and visualization of sensor data while the data management aspects including data storage, processing and synchronization between system, patients and healthcare institutions are not developed yet. This research proposes a design of health monitoring system named Mooble (Monitoring for Better Life Experience), a system to monitor patient health condition and to prevent diseases as early as possible. Mooble consists of three subsystems: web application, database and API design, and mobile application on android platform. But this research will only focus on the design and development of the mobile application subsystem. This research consists of three main aspects: application design, development and testing. The system is developed using Rational Unified Process (RUP) framework. In the end, this research will result a mobile application to be used by patients.**

Keywords—smart health, e-Health, m-Health, health monitoring system, mobile application, android

I. INTRODUCTION

Health is a global priority because it becomes one of the key factors that influence the economic development and the welfare of a country, both for developing and developed countries. Indonesia as one of the developing countries still has a low health level compared to the other countries [1], [2]. The low level of health in Indonesia is caused by several factors, one of them is the disease pattern that becomes more complex [3].

Along with the development of technology, efforts to support health improvement had been done, one of them is to implement the concept of smart health. Smart health is a new approach to health monitoring process using advanced technology consist of smart devices, or usually called intelligent approach, to overcome health problems [4]. In reality, the concept of smart health, e-Health, and m-Health cannot be separated.

This research focuses on the design and development of mobile application as part of health information system named as MOOBLE (Monitoring for Better Life Experience). MOOBLE is designed to help doctor in monitoring patient's health condition and prevention of disease as early as possible. The application that will be developed has an android operation system and will be used by patients.

In using this system, patients can report their health condition based on the level of pain felt at that time. In addition, patients also can see the health condition progress in graphical form. The health conditions that can be seen include the input value of the level of pain based on body parts, body temperature and heart rate. If these health conditions pass a certain value, system will give notification to the doctor for further communication and advise the patient to check his/her health condition to a health clinic. System also facilitate patient to request medical checkup by online and see medical treatments provided by the doctor for the illness.

II. LITERATURE REVIEW

The concept of smart health is adapted from the development of information technology and communication in health sector that trigger the concept of electronic health (e-Health). E-health is defined as the field that appears in the intersection of medical information, business and public health, referring to health service and delivered or improved information through internet and other related technologies. In a broader aspect, e-health terminology does not only have characteristics in technical development, but also thinking, way of thinking, behavior and commitment to global thinking and connected to improve health services.

Following e-health development, next concept arises due to the general use of mobile device is mobile health (m-Health). It is a concept that arises from the use of mobile device in health sector, or more specifically, delivering health services through mobile communication devices. Another understanding also defines m-health as network and communication technology on mobile devices that arises because of health service system.

While smart health is a provision of health service by using context-aware network and sensing infrastructure from smart city. Smart health is part of e-health but based on the information and communication technology in smart city. In its implementation, the concept of smart health, e-health and m-health cannot be separated [5].

The implementation of smart health concept in Indonesia began with the implementation of e-Health and m-Health concept in several studies, including Triantafyllidis [6] who designed and developed a health system that used to facilitate health monitoring of chronically ill patient independently. Patients can monitor their health condition through sensors

installed in patient's body, record the status of health condition in the form of additional information entered by the patients in addition to sensor data, and share it to social media from the community of each patient. This system has not been connected with health care facilities.

Hendrata [7] designed and developed an android-based electrocardiograph monitoring system to monitor the heart condition based on heart rate. The system is made in the form of designing an integrated portable electrocardiogram device with smartphone device. The device works with capturing the heart signal through electrodes, then amplified and filtered, and processed in microcontroller to obtain the heart rate parameter as the sign of heart fatigue. However, the implementation is still limited to the process of reading and visualizing data from sensor, not yet covering the data management process, starting from storing, processing until synchronization between system, patients and health workers.

III. METHODOLOGY

A. Research Flowchart

This research focuses on the development of MOOBLE system information. The flow of this research starts from literature review and ends with report writing. The flowchart of this research can be seen in Fig. 1.
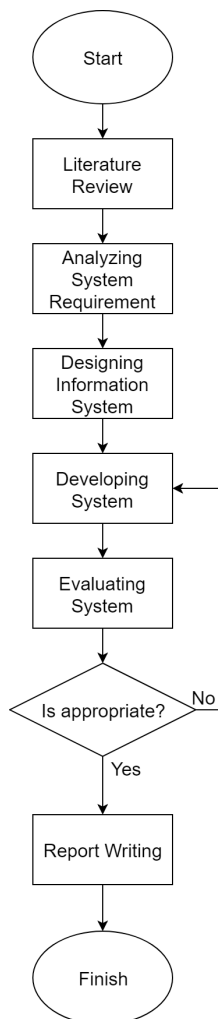

Fig. 1. Research flowchart

B. System Concept

Users of this system are divided into 3 groups, they are patients, doctors and health staffs. Doctors and health staffs can access the system through a website using web browser, as well as health staffs. Patients access the system through a mobile application. To access the system, users must be connected to internet network. In this system, database is not accessed directly but through an API. API is used to receive data from sensor and put it in the database, and also to connect the database with patient application. System architecture can be seen in Fig. 2.
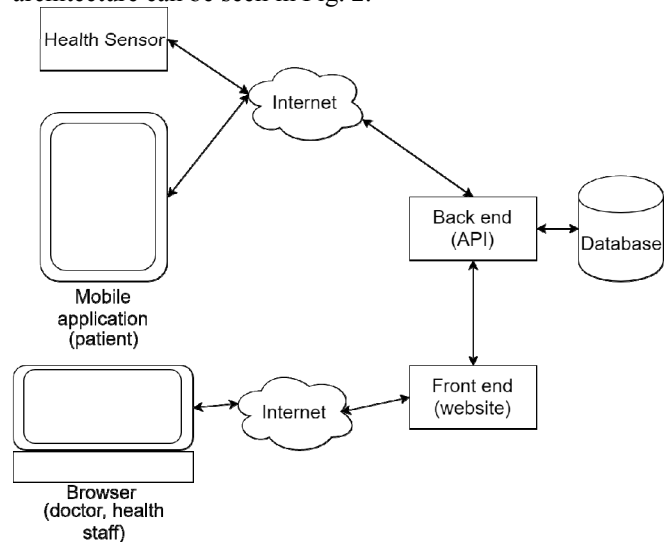

Fig. 2. System architecture

C. Use Case Diagram

Use case diagram is used to determine which users can use the system and what the users can do to the developed system. For mobile application subsystem, there will be patient as actor that can access several features such as register, a feature to create an account for patients who have never accessed the system before; login, a feature to enter the system after an account has been created; insert health report, a feature to input patient's health condition; view health report graph, a feature to view the progress of patient's health condition in a graph; view medical treatment history, a feature to view what treatments have been carried out by the patient; change profile, a feature to change patient's identity information; send message, a feature to send message to doctor; call emergency number, a feature to call emergency number in the state of emergency; view health article, a feature that provides information in the health sector; request appointment with doctor, a feature to make an appointment with doctor without having to come to the medical clinic or hospital. Use case diagram designed as the basis for developing the information system can be seen in Fig. 3.
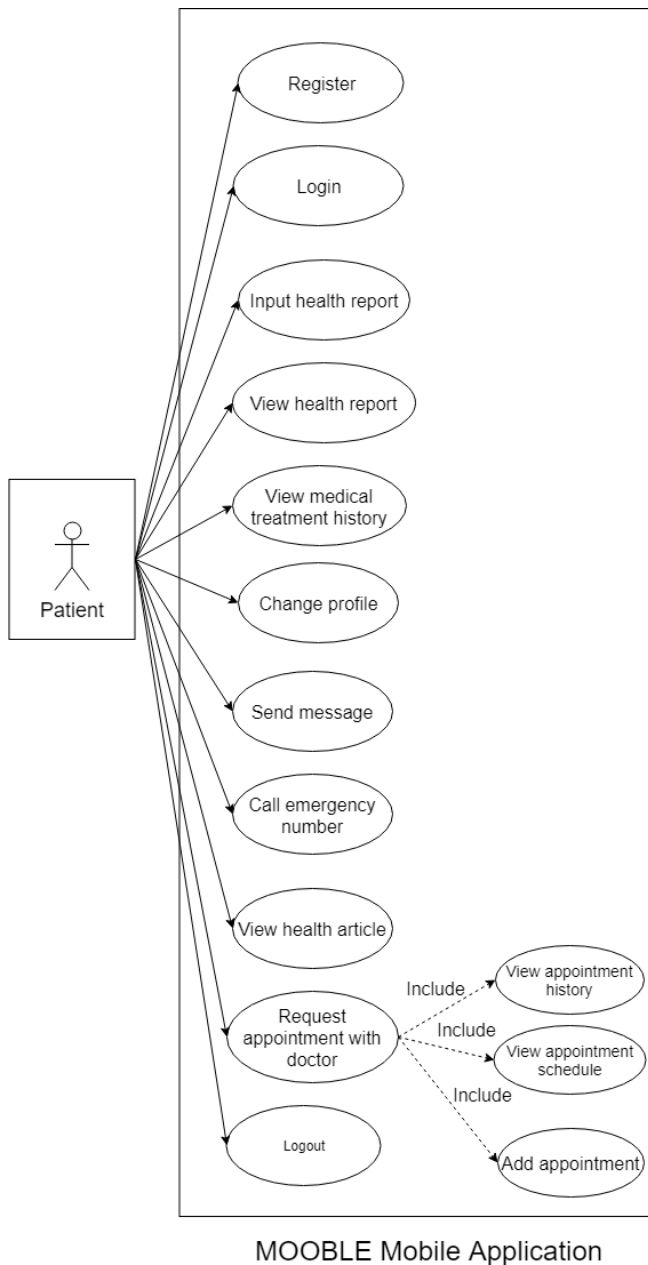
Fig. 3. Use case diagram

Fig. 4. Activity diagram of login and register

D. Activity Diagram

Activity diagram is used to describe flow of function in the information system that have been described previously in the use case diagram.

To use the application, the patient must do the login process or register first. For patients who do not have an account, the registration process is required before logging in. The login and registration process is done by filling out the form with patient data for further data to be entered into the system and authenticated. Register and login activity diagram can be seen in Fig. 4.
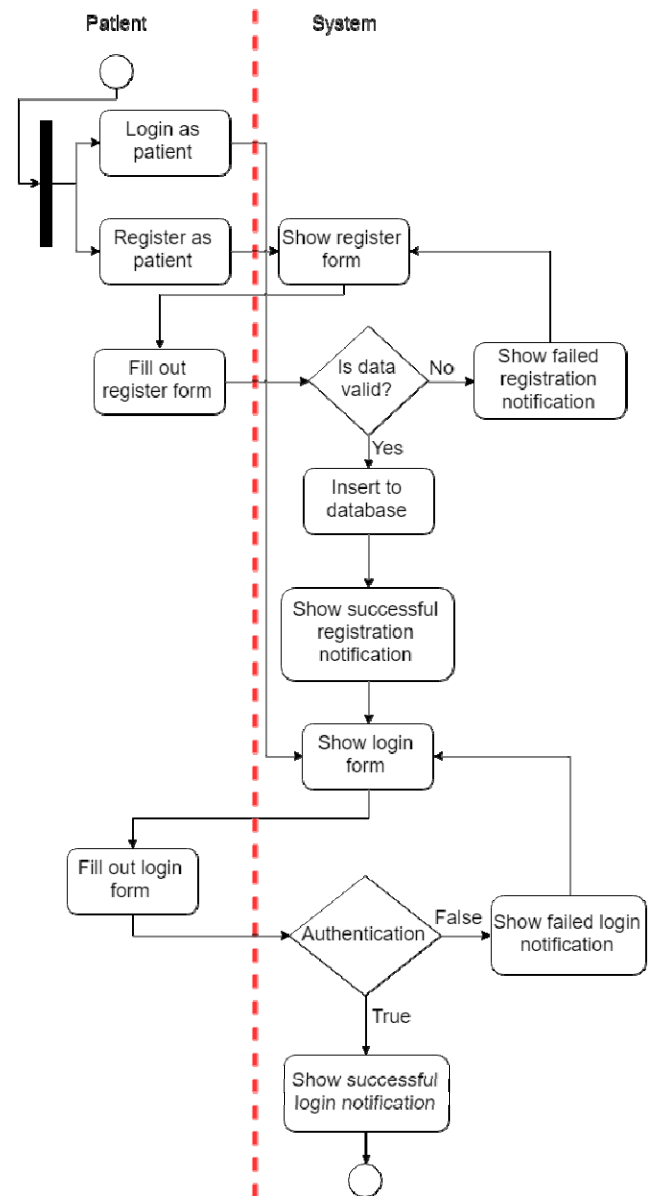
A successful login process will direct the patient to the display to choose a health condition. Then the patient needs to choose what health conditions are felt at this time. If the patient chooses an unhealthy condition, the system will direct the patient to the display to include more detailed health conditions. In this view the patient chooses a part of his body that he feels unhealthy, then chooses how much pain is felt on that part of the body. The patient can enter a description of the pain to explain in more detail what the pain feels like. If the patient chooses a healthy condition, the patient does not need to fill in detailed health conditions. After the patient completes the data the health condition of the system will enter data into the database system. If successful, a notification will appear stating that the data is successfully saved and the patient will be directed to the application's home page. If it fails then a notification will appear stating that the data is not successfully saved and the patient will be asked to repeat the process of entering a health condition. Insert health condition activity diagram can be seen in Fig. 5.
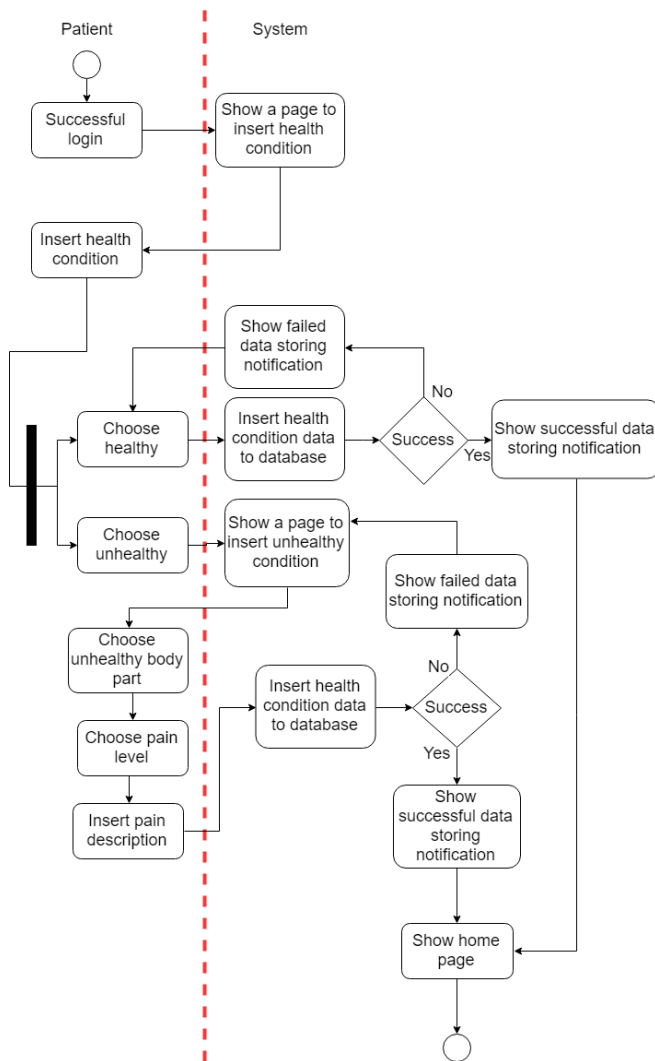
Fig. 5.   Activity diagram of insert health condition

The successful process of inserting health condition will direct the patient to the application's home page. The homepage display has several functions that can be selected by the patient as needed when using the application, including viewing health conditions, viewing the doctor's check-up schedule, viewing doctor's treatment and advice, viewing health articles, calling emergency numbers and viewing messages.

When patient selects the menu to view the health condition, the system will display a page containing information on the patient's health development, in the form of a graph of the patient's heart rate and the body temperature development. To display a graph of the health condition development, patient must first choose which part of the body to look at. Patients can insert the latest health condition through the same page.

When patient selects the menu to view the doctor's check-up schedule, system will display a page that contains information about the doctor's check-up schedule, such as the date of check-up, check-up session and the doctor who will be met upon check-up. Patients can create a new check-up schedule through the same page. If the patient wants to make a new check-up schedule, then the patient simply selects a menu to add the check-up schedule and the patient will be directed to a page to add a check-up schedule. On

the page, the patient needs to complete the data such as check-up date, options of check-up sessions and options with the doctor who will conduct the check-up session. After the patient completes the required data, the system will enter data into the database system. If successful, a notification will appear stating that the data has been successfully saved and the patient will be directed to the home screen. If it fails then a notification will appear stating that the data is not successfully saved and the patient will be asked to repeat the process of adding a new check-up schedule. Insert check-up schedule activity diagram can be seen in Fig. 6.
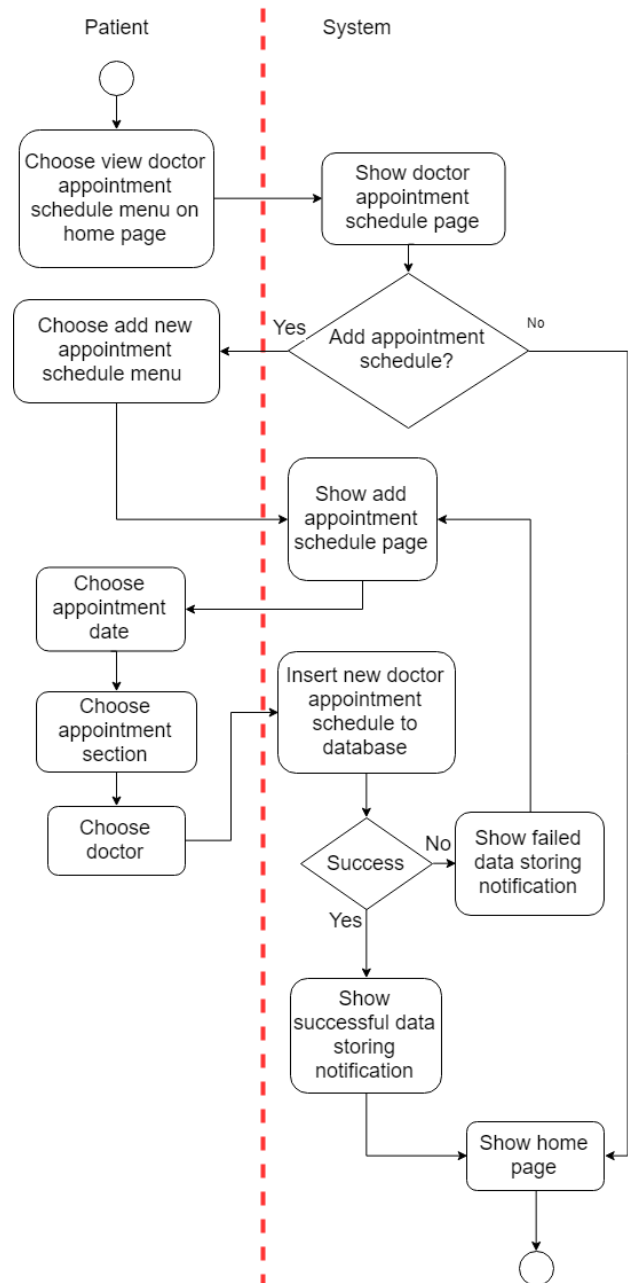

Fig. 6.   Activity diagram of insert check-up schedule

When patient selects the menu to view medical treatment and advice from doctor, system will display a page containing medical treatment information and doctor's advice. This information will be provided by the doctor when the patient checks his/her health condition in health clinic.

When patient selects the menu to view health articles, system will display a page that lists health articles taken through the API of health news website. The patient then chooses the desired article, then the system will direct the patient to the page that displays the contents of the article. Patients can repeat the same activity to read other health articles.

When patient selects the menu to call emergency number, system will display a page that lists emergency numbers. The patient then selects the desired number to be called and the system will call the number. Patient can repeat the same activity to call other emergency numbers.

When patient selects the menu to view a message, system will display a page that lists incoming message sent by doctor. To see the incoming message, patient must choose the sender's name and system will display sent and received message history both by patient and doctor. If patient want to send a reply message then patient has to type the message and press the send button, then the system will save the message in database. If message is successfully saved, the latest message will be added to the message history by the system. If the message is not saved successfully, the system will display a notification stating that the message failed to be saved and patient needs to type the reply message again. If the patient wants to send a message with another doctor, then the patient simply returns to the page that lists the incoming messages sent by the doctor. Send message activity diagram can be seen in Fig. 7.
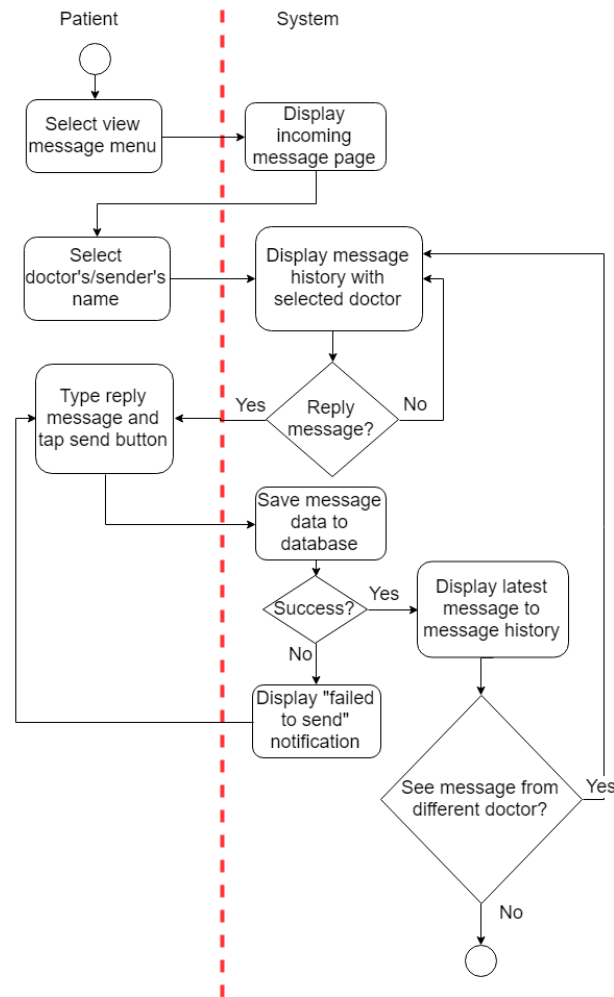

Fig. 7. Activity diagram of viewing and sending message

E. Application Interface Design

Based on the flowchart design from various activity diagram, features in this application are divided into several parts such as insert health condition, view health condition progress, request appointment with doctor feature, view appointment schedule feature, view medical treatments feature, view health article feature, call emergency number and send message. To be able to run these features, patients have to do the login process first. If the patient does not have an account, register feature is used to create a new account for the patient. Example of one of the application interfaces design is shown in Fig. 8.
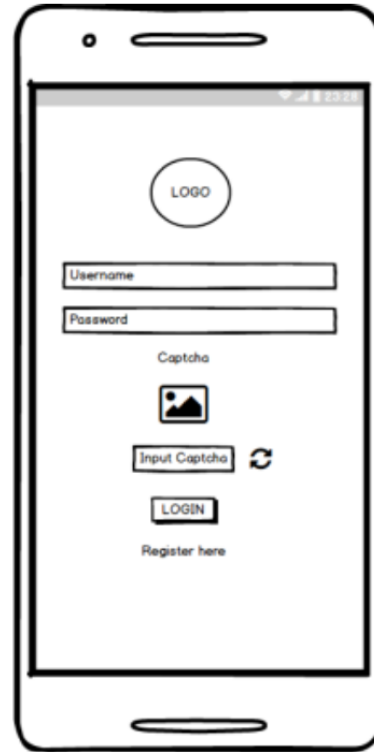

Fig. 8. Design of login feature

IV. DEVELOPMENT RESULT

Result of this study is a mobile application that can be used by patients. The evaluation of the android application design using black box evaluation approach by running several test cases and validating whether the output result of the test is as expected.

For register feature, the expected result is the application can create an account that does not have identical username to other accounts. For login feature, the expected result is patient can use the application after enter username and password. For insert health condition feature, the expected result is patient can choose body part and input its condition to system database. For view health report feature, the expected result is the application will show a graphic that contains information of patient's health condition progress. For request appointment with doctor feature, the expected result is the application can make a doctor appointment schedule. For view appointment schedule feature, the expected result is patient can see information about next doctor appointment schedule. For view medical treatments feature, the expected result is patient can see what medical treatments and advice from doctor. For view health article

feature, the expected result is the patient can access general information or news related to health sector. For view message from doctor feature, the expected result is patient can read message sent by the doctor and reply the message. For emergency call feature, the expected result is patient can call emergency number by tapping a button. Example of one of the application interface is shown in Fig. 9.
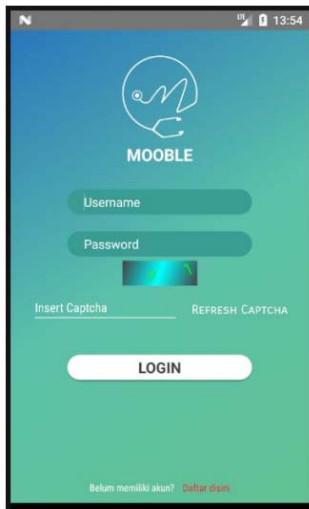

Fig. 9.   Interface of login feature

The test result of each feature is shown in Table I.

TABLE I.   TEST RESULT OF APPLICATION FEATURES

Test Case	Test Result
Register feature	As expected
Login feature	As expected
Insert health condition feature	As expected
View health report feature	As expected
Request appointment with doctor feature	As expected
View appointment schedule feature	As expected
View medical treatments feature	As expected
View health article feature	As expected
View message from doctor feature	As expected
Emergency call feature	As expected
Logout feature	As expected

V. CONCLUSION

The purpose of this study is to develop a health information system that is able to provide patient health information to the health workers using android platform and to help patients to schedule appointment with doctors. Based on the research that has been carried out, we can conclude that:

1. An android-based mobile application has been developed to monitor patient's health condition to carry out health care for patients as early as possible and to improve health services.
2. The developed android application has 11 features, they are patient registration, login, insert health condition, view health condition chart, request appointment with doctor, view appointment schedule, view medical treatments, view health article, view message from doctor, do emergency calls and logout feature. All features contained in the android application is fully function and have been tested using black box testing method.

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