

PAPER

M-Thyroid Care Mobile App: Virtual Video Consultation Application for Thyroid Clinic

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ABSTRACT

The present study aims to enhance thyroid clinics by proposing solutions through collaboration between medical experts and researchers, thereby enhancing the quality of healthcare services. To minimize unnecessary in-person consultations, a doctor requested the development of an app to address non-critical physical consultation appointments. Design-based research is a robust methodology that combines theory-driven inquiry with real-world problem-solving to develop interventions or serve as the basis for the research being discussed. M-Thyroid Care is designed to provide a practical and cost-effective platform for online consultations, facilitating video calls between patients and doctors. By leveraging this technology, the app aims to enhance patient monitoring and optimize the efficiency of thyroid clinic consultations. Moreover, the integrated chat feature allows for real-time communication, fostering effective doctor-patient interaction even outside of scheduled appointments. Additionally, the app enables the sharing of files, videos, and images, empowering doctors to review diagnostic reports and relevant visual data remotely. This further streamlines the consultation process. By reducing the reliance on physical visits for non-critical cases, the app has the potential to enhance access to specialized care, decrease wait times, and optimize resource utilization in the clinic setting. The prototype has the potential to enhance patient care, as demonstrated by this proactive engagement with stakeholders.

KEYWORDS

M-Thyroid Care, mobile app, virtual consultations

1 INTRODUCTION

The rapid growth of technology has created opportunities for innovative solutions in various industries, including healthcare. One notable advancement is the integration of telemedicine and telehealth technologies, which eliminate geographical obstacles and improve healthcare access, especially in underprivileged areas. These technologies enable patients to interact with medical specialists remotely, receive prompt advice, and utilize virtual health monitoring systems. Several studies

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have emphasized the convenience and accessibility of teleconsultations [1], [2]. These studies show that patients [3], [4], [5], and healthcare providers [5], [6], [7] are generally satisfied with this method of healthcare delivery. This not only improves efficiency [8], [9], [10], but also makes healthcare delivery more convenient and cost-effective.

From this perspective, M-Thyroid Care stands out as a promising prototype mobile application designed exclusively for thyroid clinics. Its primary goal is to transform healthcare by enabling virtual video call-based consultations, thereby minimizing unnecessary in-person visits for thyroid patients [11]. M-Thyroid Care enables patients and healthcare professionals to participate in virtual consultations, initiate dynamic chat sessions, and easily exchange important files, videos, and photographs.

This paper illustrates the design, development process, and potential benefits of M-Thyroid Care, emphasizing the significance of cutting-edge technology in transforming healthcare and enhancing patient outcomes. The app prototype, spearheaded by doctors aiming to reduce the number of unnecessary in-person appointments, offers a more convenient and efficient option for both patients and providers. It emphasizes the need to adopt innovation to meet the growing demands of modern healthcare delivery.

This paper is organized into several sections. It begins with an introduction that provides insight into the motivation for the development of M-Thyroid Care, aiming to eliminate non-critical physical appointments. The following sections will provide a literature review as well as current applications. The discussion will then shift focus to the methodology and results of the study. This paper aims to illuminate the transformative potential of mobile applications in revolutionizing healthcare practices by exploring their design and development. M-Thyroid Care, with its emphasis on improving access to specialized care and reducing wait times, represents a significant advancement in leveraging technology to enhance patient care and streamline clinical operations.

2 LITERATURE REVIEW

In recent years, the advancement of telecommunication technology has brought significant changes to the healthcare landscape. One notable development is the emergence of online teleconferencing platforms, which enable healthcare professionals to conduct remote consultations and collaborations. Online teleconferencing in the medical field has the potential to overcome geographical barriers, improve access to healthcare services, and enhance patient outcomes [12].

Online teleconferencing platforms enable healthcare providers to engage in real-time audio and video interactions with patients, colleagues, or specialists located remotely. Through these virtual consultations, medical professionals can diagnose, treat, and provide follow-up care to patients without the need for in-person visits. This not only improves access to healthcare, especially for individuals in underserved areas or with limited mobility, but also reduces the burden on healthcare facilities and mitigates the risk of disease transmission, as demonstrated during the COVID-19 pandemic.

Furthermore, online teleconferencing in the medical field enables effective collaboration among healthcare professionals. It enables interdisciplinary communication, remote case discussions, and the sharing of expertise and knowledge. Specialists from various locations can collaborate to analyze complex cases, offer second opinions, and enhance decision-making processes.

However, the implementation of online teleconferencing in medical practice is not without challenges. Technical considerations, such as performance, ensuring secure and reliable communication platforms, protecting patient privacy, and maintaining data integrity, must be carefully addressed [13]. Additionally, issues related

to licensing, reimbursement, and regulatory compliance may require attention to establish a framework that supports teleconferencing practices.

By exploring the benefits, challenges, and implications of online teleconferencing in the medical field, this paper aims to provide insights into the potential of these platforms to revolutionize healthcare delivery. It also emphasizes the need for continued research, policy development, and technological advancements to maximize the benefits and overcome the obstacles associated with online teleconferencing in medical practice.

2.1 Applications currently available

Telemedicine has emerged as a popular avenue for delivering healthcare services, providing convenient access to medical professionals remotely. Among the notable applications in this field are TeleDoc, Doctor on Demand, Amwell, HealthTap, and Midlive.

TeleDoc is a prominent telemedicine platform that enables virtual consultations with licensed doctors through video visits. Users can schedule appointments through the TeleDoc app or website, gaining access to a wide range of healthcare providers specializing in primary care, mental health, dermatology, and more. TeleDoc ensures 24/7 availability and boasts a substantial network of medical professionals.

Doctor on Demand is a prominent telemedicine application that allows patients to connect with board-certified physicians and psychologists through video calls. The platform caters to various medical concerns, including general health issues, mental health conditions, and chronic illnesses. Doctor on Demand serves individual patients, employers, and health plans by providing on-demand appointments at their convenience.

Amwell is a well-established telemedicine platform that facilitates virtual consultations with licensed healthcare providers. Users can schedule virtual appointments with doctors, therapists, and specialists to address a diverse range of medical conditions. Amwell's service offerings include urgent care, primary care, behavioral health, and pediatrics. The platform aims to provide high-quality and convenient healthcare through video visits.

HealthTap operates as an online healthcare platform that facilitates virtual consultations with licensed physicians through video, voice, or text chats. Patients can seek medical advice, ask questions, and receive personalized recommendations from a network of healthcare professionals. In addition, HealthTap offers an extensive health library comprising informative articles and resources to promote self-education on various health topics.

Table 1 below provides a comparison of teleconferencing applications with M-Thyroid Care, highlighting their features, functionalities, and benefits.

Table 1. Comparison of teleconferencing Apps with M-Thyroid Care

App Name	Description	Features	Platform
M-Thyroid Care	Allows virtual video call-based consultations for thyroid clinics	Video calls, chat, file sharing, appointment scheduling	iOS, Android
TeleDoc	Offers virtual consultations with licensed healthcare professionals	Video calls, secure messaging, e-prescriptions	iOS, Android
Doctor on Demand	Provides access to medical and mental health consultations	Video calls, chat, prescription services	iOS, Android
Amwell	Allows users to connect with doctors for telemedicine visits	Video calls, secure messaging, appointment scheduling	iOS, Android
HealthTap	Offers on-demand virtual consultations with doctors	Video calls, chat, symptom checker, electronic health records	iOS, Android
MDLIVE	Enables users to have video consultations with doctors	Video calls, chat, e-prescriptions	iOS, Android

3 METHODOLOGY

The utilization of design-based research as a robust research approach has been explored by numerous researchers in a variety of studies [14], [15], [16]. The conclusions of these studies consistently demonstrated that technical interventions and applications were the main focus of design-based research. For example, a study by [16] reported that 68% of interventions necessitated the integration of mobile and internet technologies. This represents a significant majority of treatments. The researchers in this study utilized the framework proposed by [17] to define design-based research as a systematic, four-step process.

In the first stage, known as the “analysis of practical problems,” researchers carefully review relevant literature to identify specific concerns. Following this analysis, important research questions were developed that focused on the components and features necessary to create a functional prototype system specifically tailored for follow-up consultations, particularly in the context of a thyroid clinic.

The “development of solutions” phase that follows focuses on creating solutions, setting research objectives, and determining research methods. To address the highlighted issue, researchers created a prototype that utilizes mobile technologies to enhance follow-up consultations.

“Evaluation and testing of solutions,” the next step, involves collaborating exclusively with doctors in virtual clinical settings. Doctors provide valuable feedback that guides the iterative refinement of prototypes through controlled evaluations and usability testing. The system’s utility in clinical settings is enhanced by prioritizing features that specifically cater to the needs of doctors.

Lastly, researchers meticulously document the benefits and shortcomings of the prototype during the “documentation and reflection” phase, guided by feedback from doctors.

4 RESULTS

The app was designed and developed in response to a doctor’s request to address the issue of non-critical physical consultation appointments, aiming to reduce unnecessary in-person sessions.

4.1 Analysis of practical problems

The first phase involved conducting stakeholder interviews to identify essential requirements and user needs. Following the analysis of the thyroid clinic issue, the following study questions were developed:

RQ1: What are the essential elements and characteristics required to develop a functional prototype system that is effective for follow-up consultations?

RQ2: How can a working prototype system for follow-up consultations be developed using mobile technology?

The app’s architecture, user experience, and feature set were determined through iterative design sessions. All the findings are being integrated into a user flow process. A user flow process diagram illustrated the sequence of steps and interactions that a user takes within a mobile application.

Login and registration. The login and registration user flow is illustrated in Figure 1. First, the user opens the M-Thyroid Care app, which triggers the login process. Users must enter their registration information, including their email address and password, in the appropriate fields on the login screen to access their account. The user clicks the “Login” button to proceed after entering the required data.

The application checks the entered credentials against the user data stored after submission. Users can access the main application screen if their credentials are verified as legitimate and match the records. Whether a user is a patient or a doctor, the main screen adjusts to their role within the app to offer a personalized experience tailored to their profile.

After that, the application validates the entered credentials against the user data that was previously saved. The application grants the user access to the main interface, provided that the credentials are verified and match the records. Whether a user is a doctor or a patient, this main screen is specifically designed for their role within the software. One of the most crucial steps in the M-Thyroid Care app enrollment process is email validation. The software sends an email confirmation to the address the user specified when submitting their registration form. This email is used to verify the user’s email address and ensure the accuracy of the data they have provided. To confirm their identity, the user is advised to check their email inbox and follow the instructions provided in the message.

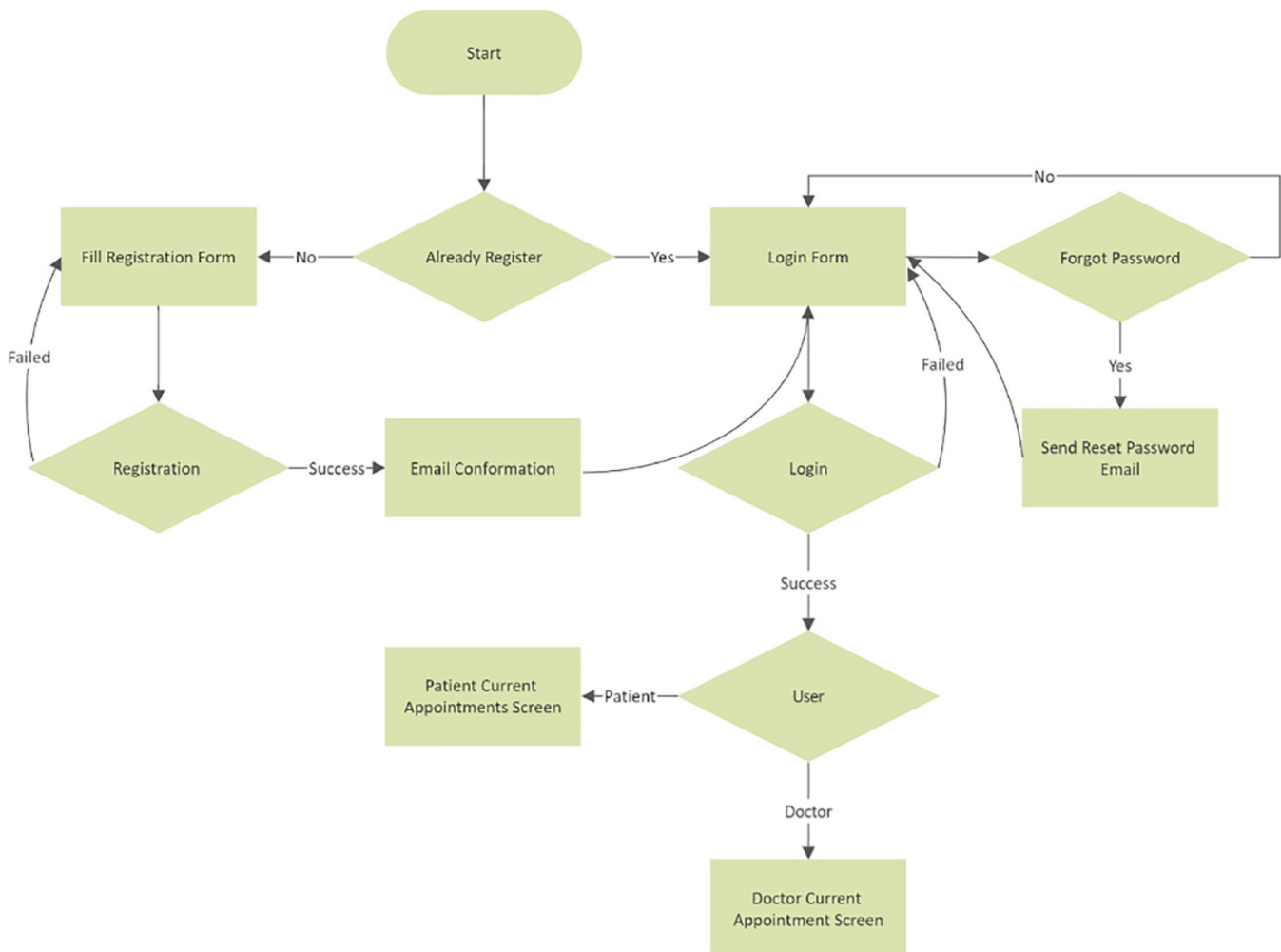


Fig. 1. User flow for login and registration

New appointment. When scheduling a virtual consultation on the M-Thyroid Care app, doctors need to access the current appointment screen and add new appointments for their patients. Doctors can search for the patient, select a date and time, and enter any required information. Once the appointment is scheduled, the patient receives an email notification containing the appointment details. Additionally, the patient can view the appointment details on their current appointment screen within the app. This process ensures efficient communication, enabling doctors to easily schedule appointments with their patients while keeping patients informed about their upcoming meetings.

Appointment management. The M-Thyroid Care app’s appointment details screen is a crucial tool for helping patients and physicians efficiently schedule follow-up visits. Additional aspects of the user flow procedure are depicted in Figure 2. Through this interface, physicians can initiate video conferences with their patients, facilitating seamless communication and enabling online consultations. Additionally, patients can message their doctors directly, which promotes continuous connection and enables quick responses to any concerns or updates.

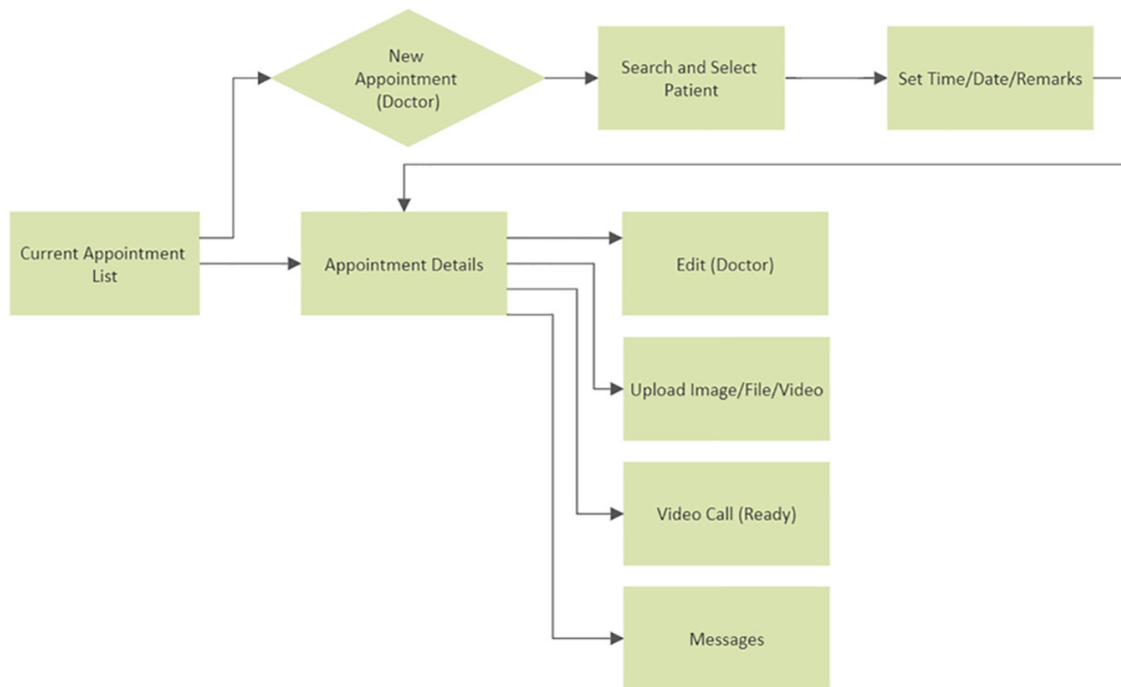


Fig. 2. User flow for user appointment and details

Moreover, there is a file management option on the appointment details screen. It simplifies the exchange of crucial images, documents, and videos between patients and physicians. By exchanging critical test results and medical information, this improves their ability to collaborate. It is simpler for users to manage their healthcare using this menu, which enables them to securely save and find appointment-related documents.

In the appointment system, doctors can also adjust appointment details when necessary. This means they can change the appointment time, reason, or other important information. This flexibility helps healthcare providers adapt appointments quickly to different situations or special requirements, making the process more efficient and improving patient care.

4.2 Development of solutions

After that, the “development of solutions” for the identified problem was the focus of the second phase. The app’s development process involves designing and implementing several critical interfaces. The app was designed using Flutter to ensure seamless interoperability between iOS and Android devices. PHP powers the backend, ensuring a seamless transition between frontend and backend features for rapid data transfer. MySQL is a reliable database management system that securely stores and retrieves data in an encrypted manner. Additionally, PHP develops essential APIs that support functions such as chat messaging, file sharing, user authentication, and appointment booking, all while safeguarding patient privacy and data integrity.

Login and registration interface. The M-Thyroid Care user login interface is a critical component of the digital system, enabling users to securely access their accounts and utilize the associated functionality. This interface, designed with usability and security in mind, includes crucial elements such as email and password input fields, a “Forgot Password” option, and a language selection menu (see Figure 3).

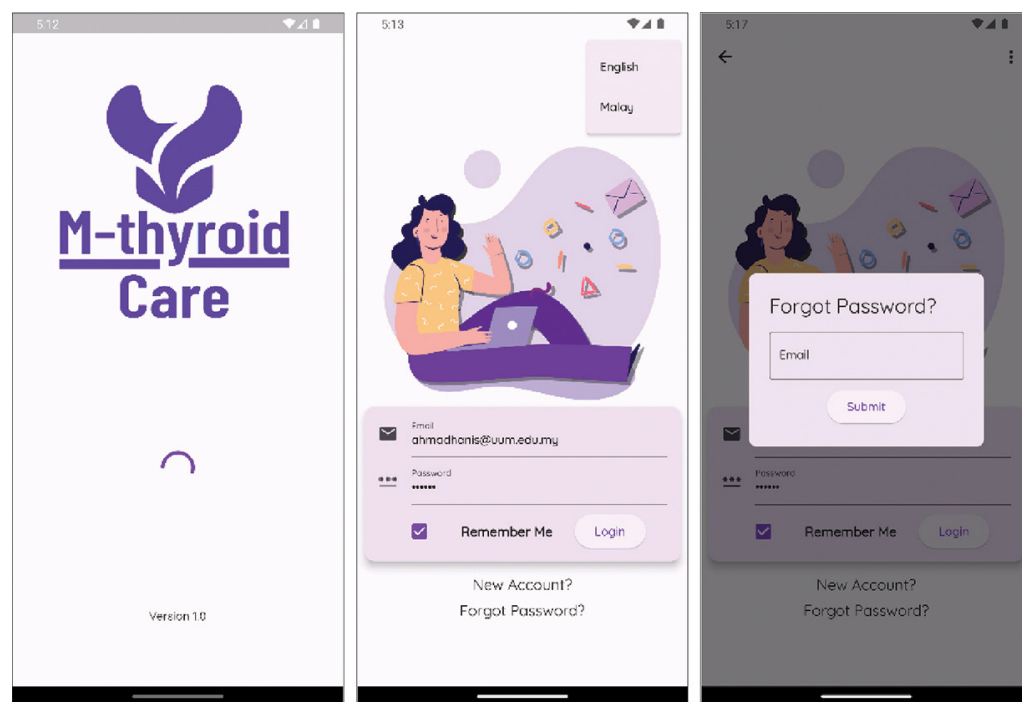


Fig. 3. M-Thyroid Care login interface

The first step in the user registration process is to choose a user type. The interface provides a simple and easy way for users to select either “Patient” or “Doctor” as their roles within the M-Thyroid Care system. This option controls the privileges, features, and access levels offered to the user after successful registration. Upon the user’s selection, the interface allows users to enter their email address, which will serve as a unique identifier for their M-Thyroid Care account. The email input box ensures accurate data entry and may include validation procedures to guarantee that the provided email address is correctly formatted and legitimate.

In addition to the email address, the interface includes a password input box where users can create a secure and confidential passphrase to protect their accounts. To enhance data security, password fields typically include security

constraints like minimum length or complexity. Also, the user registration screen includes a name input section where users can enter their full names. This form is used to personalize the user’s account and facilitate future communication between the user and healthcare experts in the M-Thyroid Care system.

Application main screen. Upon successful login and registration, the main screen of M-Thyroid Care serves as the digital system’s nucleus, functioning as a vital hub where users can access essential information and seamlessly navigate through various features. This screen is meticulously designed to provide a user-centric experience for both patients and healthcare providers, offering personalized features and straightforward navigation options.

The current appointments section is prominently displayed on the main screen, providing users with quick access to their upcoming appointments. This crucial function keeps consumers informed and organized, providing a sense of security and convenience. Furthermore, menu access is prominently displayed, offering users a comprehensive set of appointment-related features, user profiles, and a logout option. This streamlined menu layout allows for easy navigation and access to the tools and information needed to properly manage one’s healthcare journey.

Crucially, the main interface separates the patient and doctor perspectives (see Figure 4), acknowledging each user’s unique requirements and responsibilities. For doctors, supplementary features are seamlessly integrated, offering enhanced functionality, such as the ability to effortlessly create new appointments. This distinction ensures that users have an interface tailored to their responsibilities and objectives within the system. Furthermore, to enhance the user experience and accessibility, doctors are provided with a floating button that allows them to create new appointments with unprecedented ease and speed. This unique feature simplifies the appointment scheduling process, enabling doctors to manage their schedules more efficiently while prioritizing patient care. On the main patient screen, this floating button is absent because appointment creation is usually handled by healthcare providers.

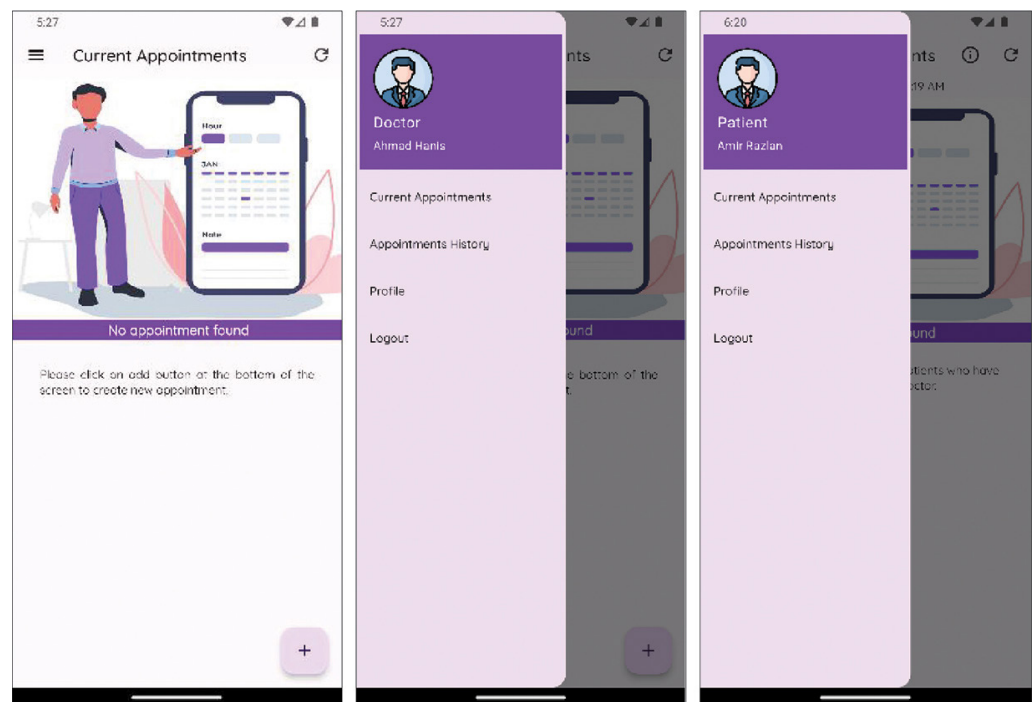


Fig. 4. M-Thyroid Care main screen

New appointment screen. The M-Thyroid Care system's New Appointment screen allows doctors to set appointments with patients, promoting efficient scheduling and successful healthcare management (see Figure 5). This page enables doctors to search for patients using various identifiers, such as names, IDs, phone numbers, and email addresses. These search tools enable clinicians to quickly find the required patient, ensuring accurate selection for appointment scheduling.

Once the patient has been identified, the New Appointment screen allows doctors to schedule the day and time of the appointment. Doctors can easily access calendar options and enter the necessary appointment date through a simple user interface, with time slots available for selection. This tool enables doctors to effectively manage their schedules and reserve suitable time slots for patient consultations.

The M-Thyroid Care system's "Add to Calendar" interface integrates seamlessly with the device calendar, enabling convenient scheduling of appointment reminders. This dialogue provides a user-friendly interface that enables users to effortlessly input appointment details into their device's calendar system. Furthermore, the New Appointment screen includes a notes section that enables doctors to enter relevant information for the patient. This tool enables doctors to communicate specific instructions, recommendations, or other appointment-related information. Doctors can utilize this functionality to enhance patient communication, prepare for emergencies, and promote a more personalized healthcare experience.

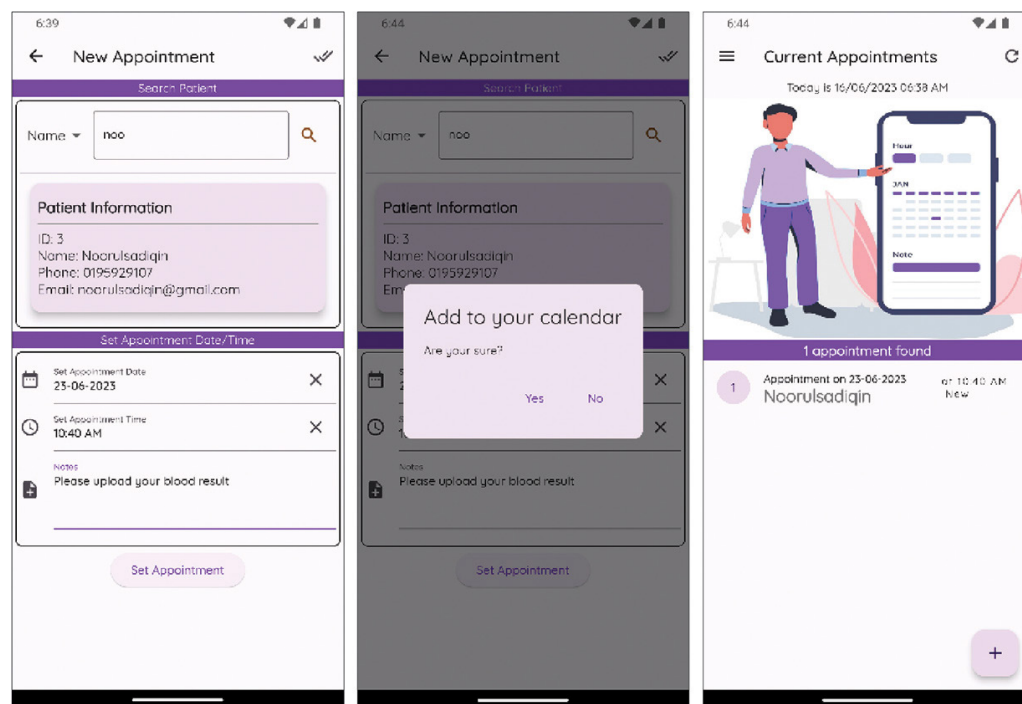


Fig. 5. M-Thyroid Care new appointment screen

Appointment details screen. The Appointment Details page in the M-Thyroid Care system is a crucial interface for patients and doctors to access comprehensive

information about their appointments (Figure 6). After creating a new appointment, users can navigate to the main screen list and choose the appointment they wish to view the details of. The Appointment Details screen displays important information for patients, such as the appointment time and date, as well as any accompanying remarks.

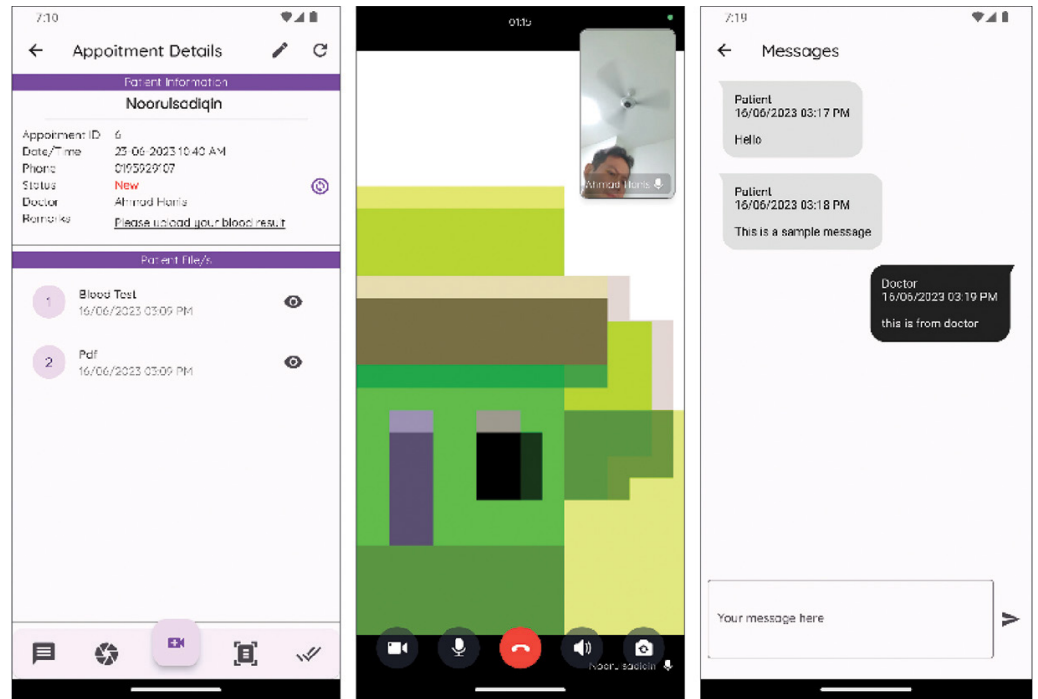


Fig. 6. M-Thyroid Care appointment details screen

However, several features on this screen are only accessible to doctors. Doctors have exclusive access to the Appointment Details screen that patients do not. They can change the appointment status to “Ready” to indicate that they are available and prepared for the appointment. This status update indicates to patients that their doctor is available for a video call or consultation.

Profile screens. Users can adjust their experience, control account security and privacy, and modify program interactions to meet their needs and preferences by using the profile screen, which is an essential tool. The Profile panel in the M-Thyroid Care program allows users to update their name, phone number, password, and other profile details (see Figure 7). Maintaining up-to-date and accurate user profiles, facilitating efficient communication, and providing secure access to the platform’s services all rely on this page. On the profile screen, users are greeted with an easy-to-use interface that enables them to quickly update their data. Users can easily modify the screen by using customized input forms tailored to each profile’s information, including the user’s phone number and name.

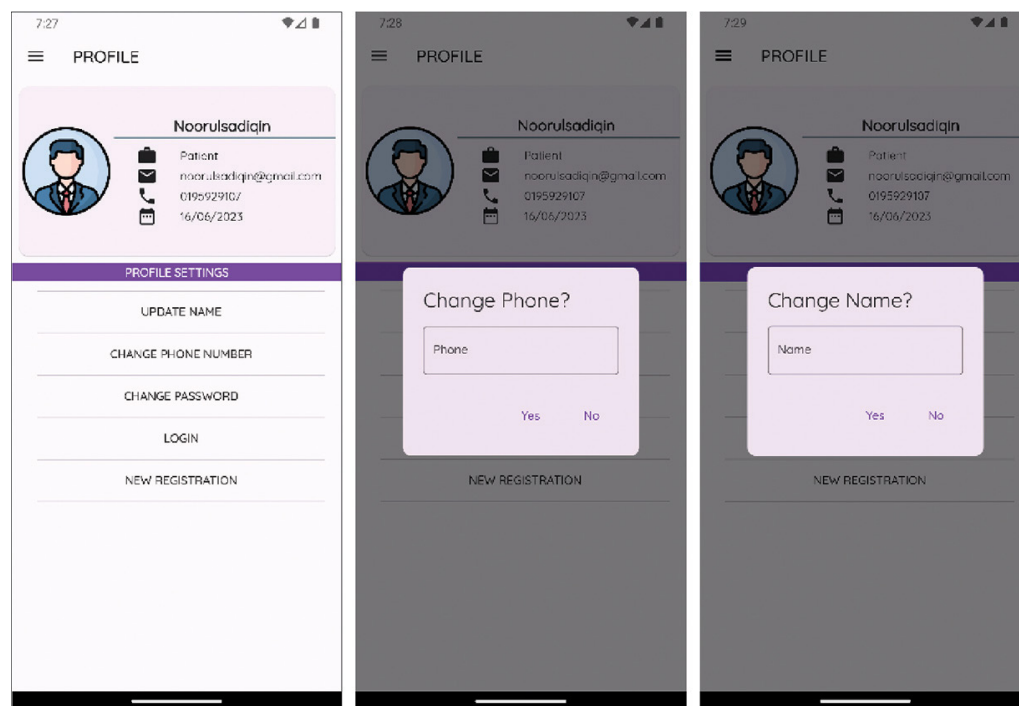


Fig. 7. M-Thyroid Care profile screen

4.3 Evaluation and testing of solutions with doctor

In the third phase, researchers shifted their focus to evaluating and testing the functional prototype solely with doctors in simulated clinical environments. Working closely with medical professionals specializing in thyroid care, we conducted structured evaluations and usability testing sessions. During these sessions, doctors interacted with the prototype to evaluate its functionality, user interface, and relevance for facilitating follow-up consultations. The feedbacks provided areas for improvement and additional features tailored for doctors' use.

Appointment reminder: Doctors emphasized the significance of including an appointment reminder feature in the prototype. This functionality would assist doctors in managing their schedules, ensuring they are promptly notified of upcoming consultations, and minimizing the risk of missed appointments.

Data sharing with clinic nurses or medical assistants: Doctors have emphasized the necessity of a feature that allows seamless data sharing, specifically among doctors and clinic staff, including nurses and medical assistants. This functionality would streamline communication and facilitate collaboration among healthcare providers, enhancing the efficiency of patient care processes.

Notification System for incoming messages: Doctors have recognized the significance of incorporating a notification system into the prototype to alert them about any incoming messages or updates regarding patient consultations. This feature would enable doctors to stay informed in real time, ensuring timely responses and enhancing overall communication effectiveness.

Compatibility with iPhone: Although the prototype was exclusively tested with doctors, researchers acknowledged the potential use of iOS devices, particularly iPhones, among doctors. Recognizing this, compatibility with iOS devices was

prioritized to ensure seamless integration and usability for doctors who prefer using iPhones for professional tasks.

Incorporating these feedback, researchers iteratively refined the prototype, integrating the suggested features and enhancements tailored specifically to meet the needs of doctors.

4.4 Documentation and reflection

After the testing and assessment phase, the researchers documented the results and conducted an analysis of the project's progress. The functioning prototype's merits and drawbacks were meticulously documented, considering the input from doctors. These insights proved to be invaluable in guiding future modifications. Researchers proposed to the doctors that they promote the prototype within the hospital. Given its potential benefits, the doctors expressed interest in advocating for its acceptance, even though formal recommendations had not yet been made.

5 DISCUSSION AND CONCLUSION

The M-Thyroid Care application prototype exhibits several promising characteristics that have the potential to greatly benefit doctors and patients at thyroid clinics. From an advantage perspective, the M-Thyroid Care application offers several benefits to patients and healthcare providers. Firstly, it significantly improves access to healthcare services by providing a convenient platform for remote consultations. Patients can easily connect with doctors regardless of their geographical location, which is especially advantageous for individuals with limited mobility or those residing in remote areas. Moreover, the application facilitates access to specialized medical expertise that may not be readily available locally, enabling patients to receive high-quality care tailored to their specific needs.

Secondly, the M-Thyroid Care application offers an extended reach and increased availability of healthcare providers. Patients can connect with doctors from different locations, enabling them to access a broader range of healthcare professionals and specialists. This expanded reach enables patients to receive expert opinions, second opinions, and specialized treatments without the need for long-distance travel, thereby enhancing overall healthcare outcomes.

Lastly, the convenience and flexibility provided by the application are noteworthy advantages. Patients have the flexibility to schedule appointments at their convenience, often with flexible time slots, which reduces the need to take time off work or rearrange their schedules. Additionally, the application enables asynchronous communication, allowing patients to exchange messages or upload relevant medical documents at their convenience. This promotes efficient and seamless communication with healthcare providers.

Despite its advantages, there are some potential disadvantages to consider. One such disadvantage is the need for a strong network connection and robust backend infrastructure to support real-time communication. Video calls and seamless data transmission heavily rely on a stable and high-speed internet connection. In regions with limited network coverage or unreliable internet connectivity, the functionality and user experience of the app may be compromised. Additionally, the application's backend infrastructure must be robust enough to support multiple simultaneous video calls and guarantee data security and privacy.

Despite these limitations, the prototype of the M-Thyroid Care application exhibits promising features that can benefit healthcare providers and offer alternative options for doctors. The app's ability to facilitate remote consultations, offer flexibility in scheduling appointments, and provide access to specialized medical expertise can be advantageous for both patients and doctors. It enables efficient communication, reduces the need for physical visits, and enhances convenience for all parties involved.

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