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THEME

Design and implementation of a telemedicine platform

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Dedication

I dedicate this work to the people who've been supportive all the way through this immensely fruitful journey,

my dear parents, my brothers and sisters.

My colleague who was the right person to be held accountable for cooperating in the development of such a huge prosperous project that's yet to grow insha Allah.

Last but not least, I want to firmly express all my gratefulness to the institution and teachers who were an important factor in guiding us through the infinite labyrinth of knowledge of computer science,

A guide that made this project happen.

Thank you

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Dedication

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Yacine

Acknowledgment

This dissertation, like any other, has a wide background of experiences and people that have shaped our thinking over the past years, therefore it is frankly accurate to say that this work began a long while ago.

Despite our technical qualification, what follows is a result of numerous previous projects, problems solved and of course a myriad of courses taken throughout our educational years in Mohamed El Bachir El Ibrahimi University, a period in which we have profited immensely from working with many distinct theorists and implementers.

However, we would be wrongful if we did not specifically mention some brilliant individuals who unconsciously contributed to our development.

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Before you go any further let us elaborate upon what you will notice as you proceed reading.

We wish to assure the readers that we have "painted with a broad brush" so that we can give you the big image of our project as briefly as possible regarding its vastness.

Abstract

This thesis focuses on the conception and realization of a platform website and a mobile app in telemedicine. The aim is to develop a user-friendly platform that can facilitate remote medical consultations, online prescriptions, and medical records keeping.

Our platform, called Doctian, is created to meet the needs of healthcare professionals and patients, and will provide a secure and efficient means for delivering medical care remotely without requiring in-person visits.

This platform is an effective solution that can improve access to healthcare, reduce transportation costs and increase patient satisfaction.

Résumé

Ce mémoire porte sur la conception et la réalisation d'une plateforme web et d'une application mobile en télémédecine. L'objectif est de développer une plate-forme conviviale pouvant faciliter les consultations médicales à distance, les ordonnances en ligne et la tenue de dossiers médicaux.

Notre plate-forme, appelée Doctian, est créée pour répondre aux besoins des professionnels de la santé et des patients, et fournira un moyen sûr et efficace pour procéder à fournir des soins médicaux à distance sans nécessiter de visites en personne.

Cette plateforme est une solution efficace qui peut améliorer l'accès aux soins de santé, réduire les coûts de transport et augmenter la satisfaction des patients

ملخص

نعمل في هذه الأطروحة على تصميم وتنفيذ منصة ويب وكذا تطبيق للهاتف المحمول في المعالجة عن بعد. الهدف هو تطوير منصة سهلة الاستخدام يمكنها تسهيل الاستشارات الطبية عن بعد والوصفات الطبية عبر الإنترنت وحفظ السجلات الطبية.

تم إنشاء منصتنا ، المسماة Doctian ، لتلبية احتياجات المتخصصين في الرعاية الصحية والمرضى ، وستوفر طريقة آمنة وفعالة للمضي قدما في تقديم الرعاية الطبية عن بعد دون الحاجة إلى زيارات شخصية .

هذه المنصة هي حل فعال يمكنه تحسين الوصول إلى الرعاية الصحية وتقليل تكاليف النقل وزيادة رضا المرضى.

Table of contents

Table of Contents

List of figures ..... **x**

List of tables ..... **xii**

General Introduction **1**

Chapter 01: Telemedicine **3**

I.1 Introduction 3
I.2 Telemedicine 3
I.2.1 Definition 3
I.2.2 Telemedicine history 3
I.2.3 Telemedicine Advantages 4
I.2.4 Teleconsultation 4
I.3 Telemedicine implementation in Android applications 5
I.3.1 Enhanced Accessibility to Healthcare 5
I.3.2 Remote Consultations and Diagnoses 6
I.3.3 Efficient Healthcare Delivery 6
I.3.4 Remote Monitoring and Health Tracking 6
I.3.5 Continuity of Care and Follow-up 6
I.3.6 Improved Patient Engagement and Empowerment 7
I.3.7 Privacy and Security Considerations 7
I.3.8 Challenges and Considerations 7
I.4 Conclusion 7

Chapter 02: System Architecture and Design **9**

II.1 Introduction 9
II.2 Functional and non-functional features: 10
II.2.1 Functional features 10
II.2.2 Non-functional features 11
II.3 System's key stakeholders 12
II.4 Doctian system architecture 13

II.4.1 High level system design 13
II.4.2 Data Design 15
II.4.3 Integration and Connectivity 15
II.4.4 Security and Privacy 16
II.5 Doctian design 17
II.5.1 Model View Controller 17
II.5.2 RESTful services 18
II.5.3 UML (Unified Modeling language) 19
Chapter 03: Implementation 26
III.1 Introduction 26
III.2 development frameworks, tools and APIs 26
III.2.1 Languages 26
III.2.2 Frameworks 27
III.2.3 Tools 28
III.3 Doctian: potential accessibilities and implementation 31
III.3.1 Mobile App functionalities 31
III.3.2 Web Application UI & functionalities: 39
General conclusion 53
References 55
Annexes 57

List of figures

Figure II-1. High level design that shows Doctian architecture and components. 14

Figure II-2: Model-view-controller architecture. In this case there are two types of controllers: API controller for mobile app and WEB controller for web app. 18

Figure II-3 use-cases diagram related to the Doctian system 20

Figure II-4. Doctian sequence diagram of the use-case “Verify prescription” related to the Pharmacist. 22

Figure II-5. Doctain sequence diagram for regrouped use cases related to the patient in interaction with a doctor 23

Figure II-6. Doctian class diagram..... 25

Figure III-1 postman welcome page. 29

Figure III-2 phpMyAdmin welcome page. 30

Figure III-3 Doctian system icons for website and Android app..... 31

Figure III-4. Medication intake notification 32

Figure III-5. Types of persistent work. 33

Figure III-6. Mobile app login UI..... 34

Figure III-7 Mobile app login and information fill..... 35

Figure III-8.Mobile app Home UI 36

Figure III-9. Mobile app DocGPT chat UI 36

Figure III-10.Mobile app doctor profile UI 37

Figure III-11 Appointment booking on Doctian mobile app 37

Figure III-12.Video chat (Web app client). 38

Figure III-13. Video chat (mobile client doctor user type UI)..... 38

Figure III-14. Electronic prescription fill UI 39

Figure III-15.Doctian home page..... 40

Figure III-16. Patient' common and additional information..... 41

Figure III-17.: Doctor's additional info. 41

Figure III-18. Login page..... 42

Figure III-19. Search result page (This is a fake data generated for tests). 42

Figure III-20. Doctor public profile. 43

Figure III-21. Doctor's dashboard. 44

Figure III-22. Doctor's Patients 44

Figure III-23.Prescription page. 45

Figure III-24. Electronic prescription (pdf format)..... 46

Figure III-25. All appointments taken by the patient..... 47

Figure III-26. Appointment details pop-up. 47

Figure III-27. Patient medical record. 48

Figure III-28. Patient medical files. 49

Figure III-29 DICOM file structure 49

Figure III-30. The Doctian built-in DICOM file viewer..... 51

List of tables

Table II-1. Doctian uses cases details 21

General Introduction

In recent years, technology advancements have scrupulously revolutionized a myriad of industries, and of course the healthcare sector is no exception. With the copious proliferation of smartphones and internet connectivity, telemedicine has proved itself as a transformative solution that bridges the different gaps between patients and healthcare providers. Telemedicine, or e-health, refers to the remote delivery of healthcare services through the use of telecommunication technologies, enabling patients to closely get in contact with medical professionals without the need for in- person visits.

This dissertation depicts the potential impact of Doctian e- health application in shifting healthcare delivery. Doctian serves as a comprehensive user-friendly platform that enables patients to overwhelmingly enhance connection with healthcare providers in real-time, access medical advice, receive diagnoses, share medical files and examinations and even obtain electronic prescriptions, all from the comfort of their own accommodations. We will delve into the multifaceted aspects of telemedicine, examining its benefits, foreseeing future challenges and treat the current ones and outline implications for both patients and healthcare professionals.

The overarching objective of this dissertation is to shed light on the potential of enhancing healthcare accessibility, improving doctor-patient relationship outcomes, and reducing healthcare costs and time. By examining various case studies and real-world implementations, the report will provide valuable insights into the practical applications of telemedicine and e-health systems, including the impact on healthcare disparities, patient satisfaction, and the overall quality of care.

The thesis is written in three chapters that cover both the research and development aspects of the Doctian App. Its structure is as follows:

Chapter 1: in the opening chapter, we will discuss telemedicine's immense impact on numerous occupations such as the military and astronomy throughout history, also the late pandemic that drastically affected each life while simultaneously clarifying the need for such an approach for dealing with endless healthcare delivery cases.

Chapter 2: in this chapter, we will provide an overview about a system and its functionality before diving into the details. We will discuss the functional and non-functional features that our system will guarantee besides the architectural design for both web app and the mobile app. Next, we will describe the architecture of our solution which we will use in order to clarify how the system will function. In addition, we will identify the actors who will interact with our future system as well as the related use cases for each actor. Each of the use cases will be described by sequence diagrams which will allow us to establish the class diagram.

Chapter 3: this chapter is devoted to the implementation phase, in which we will introduce the platform development environment by specifying the programming languages and the tools used during the development process and finally expose the

In our overall conclusion we highlight the advantages that this platform will provide for both patients and doctors throughout the utilization of these features.

Chapter 01: Telemedicine

I.1 Introduction

The COVID-19 pandemic has further highlighted the importance of telemedicine, as it has become a crucial tool for delivering medical care while minimizing the risk of infection. As a result, there has been a significant increase in the adoption of telemedicine solutions by healthcare providers and patients.

Telemedicine is a rapidly growing field that has the potential to revolutionize the way healthcare is delivered. With the advent of new technologies, it is now possible to provide medical care remotely, using video conferencing, remote monitoring, and mobile health applications.

I.2 Telemedicine

I.2.1 Definition

Telemedicine is the distribution of health-related services and information via electronic information and telecommunication technologies. It allows long-distance patient and health-care providers contact, care, advice, reminders, education, intervention and monitoring (5).

It is part of the world of e-health professionals. It makes easy the provision of health services to human beings by experts (doctors, nurses, …) where distances and isolation of the patients are critical factors.

I.2.2 Telemedicine history

Telemedicine evolved in the 20th century with the development of new technologies, including the telephone and radio. During World War II, the military used telemedicine to provide medical care to soldiers in remote locations (1). The first documented use of videoconferencing for medical purposes was in the late 1960s when a closed-circuit television system was used to transmit images between medical facilities (2).

In the 1970s and 1980s, telemedicine began to gain wider acceptance as a means of providing medical care to patients in remote areas. NASA, for example, used telemedicine to provide medical care to astronauts in space (3). In the 1990s, the development of the internet and high-speed telecommunications networks allowed for the widespread adoption of telemedicine (4).

Today, telemedicine has become an increasingly popular way to deliver healthcare services to patients. With the continued advancement of technology, it is likely that telemedicine will continue to play an important role in the delivery of healthcare services in the coming years.

I.2.3 Telemedicine Advantages

Here are some of the key benefits of a remote healthcare services:

- **Improved Access to healthcare:** Telemedicine allows patients to receive medical care from the comfort of their own homes, eliminating the need for them to travel to healthcare facilities.
- **Provides quicker access to healthcare:** Getting a doctor's appointment can take weeks or months. But many doctors have reserved part of their schedules for telemedicine visits. Scheduling a video or phone appointment often gets you the help you need faster.
- **Reduced wait times and reduced risk of contracting infectious diseases:** Patients no longer need to sit in waiting rooms for hours in a row and risk catching an infectious disease. Especially for patients with health problems such as chronic diseases or heart failure, telemedicine services may be life-saving.
- **Chronic diseases follow-up:** Remote health monitoring improves patient care and allows for the efficient treatment of patients with chronic diseases without needing to go to a hospital.

I.2.4 Teleconsultation

According to the World Health Organization (WHO), teleconsultation is the delivery of healthcare services using telecommunication technologies, such as videoconferencing, remote monitoring, electronic consultation, and wireless communications.

It enables healthcare providers to remotely connect with patients to diagnose, treat, and manage health conditions without requiring in-person visits, thereby increasing access to

healthcare services, particularly in underserved areas (6). The possible use-cases of teleconsultation can be summarized in the following cases:

- Infections and inflammations
  - Colds, Coughs and flu syndromes.
  - Allergies.
- Mental Health:
  - Remote psychotherapy sessions.
  - Mental health counseling.
- Women's Health:
  - Remote consultation for pregnancy.
  - Follow up appointments for breast cancer childbirth.
- Chronic diseases:
  - Remote monitoring of chronic diseases such as diabetes and heart disease.
  - Follow up appointments.

I.3 Telemedicine implementation in Android applications

The use of telecommunications technology to provide remote healthcare services, has emerged as a transformative solution in the healthcare industry. With the widespread adoption of smartphones and the dominance of the Android operating system, integrating telemedicine into Android applications has revolutionized healthcare delivery. This section explores the impact of telemedicine implementation in Android applications, highlighting its benefits, challenges, and potential for transforming the way healthcare services are delivered (16).

I.3.1 Enhanced Accessibility to Healthcare

Telemedicine implemented in Android applications has significantly improved accessibility to healthcare services. With the availability of telemedicine apps, patients can conveniently consult healthcare professionals remotely, eliminating geographical barriers and reducing the need for in-person visits. This accessibility is particularly beneficial for individuals

in rural or remote areas, those with mobility limitations, or patients seeking specialist consultations (17).

I.3.2 Remote Consultations and Diagnoses

Telemedicine applications in Android devices enable real-time remote consultations between healthcare providers and patients. Through video conferencing, patients can receive medical advice, discuss symptoms, and even undergo virtual examinations. This functionality allows healthcare professionals to provide timely diagnosis, prescribe medications, offer preventive care, and monitor chronic conditions without requiring physical visits.

I.3.3 Efficient Healthcare Delivery

Implementing telemedicine in Android applications streamlines healthcare delivery and improves efficiency. Doctors can manage their schedules effectively, reduce waiting times, and handle a higher volume of patients remotely. By reducing the burden on healthcare facilities, telemedicine enhances overall operational efficiency and optimizes resource allocation, ensuring that patients receive timely care (18).

I.3.4 Remote Monitoring and Health Tracking

Telemedicine applications integrated with Android devices empower patients to monitor their health remotely. With the help of connected devices, such as wearable sensors and Bluetooth-enabled medical devices, patients can measure vital signs, track medication adherence, and record symptoms. This real-time data can be securely transmitted to healthcare providers, facilitating accurate assessments, personalized treatment plans, and early intervention when necessary.

I.3.5 Continuity of Care and Follow-up

Telemedicine in Android applications facilitates seamless continuity of care and follow-up for patients. After an initial consultation, doctors can schedule virtual follow-up visits, monitor treatment progress, and address any concerns remotely. This ongoing connection between patients

and healthcare providers promotes better patient engagement, adherence to treatment plans, and improved health outcomes.

I.3.6 Improved Patient Engagement and Empowerment

Android telemedicine applications encourage patient engagement and empower individuals to take an active role in their healthcare. Through educational resources, remote consultations, and access to personal health records, patients can make informed decisions about their health and actively participate in their treatment plans. This empowerment fosters a sense of ownership and improves overall patient satisfaction (19).

I.3.7 Privacy and Security Considerations

Telemedicine implementation in Android applications requires robust security measures to protect patient data and ensure privacy. Developers must adhere to healthcare data protection regulations, implement encryption protocols, and establish secure communication channels. By prioritizing privacy and security, telemedicine applications can build trust and confidence among patients and healthcare providers.

I.3.8 Challenges and Considerations

While telemedicine implementation in Android applications offers significant advantages, certain challenges must be addressed. These include internet connectivity issues, variations in device capabilities, regulatory compliance, and the need for user-friendly interfaces. Additionally, ensuring interoperability with electronic health record systems and maintaining data integrity are essential considerations for successful telemedicine integration.

I.4 Conclusion

The use of telecommunications technology to provide remote healthcare services has revolutionized healthcare delivery by enhancing accessibility, enabling remote consultations and diagnoses, improving efficiency, and promoting patient engagement. Mobile devices, in particular those based on Android, provide a versatile platform for implementing telemedicine, empowering

both patients and healthcare providers to overcome geographical barriers and transform the way healthcare services are accessed and delivered. As technology continues to advance, the future holds immense potential for further innovation in telemedicine, enabling improved patient outcomes and enhanced healthcare experiences.

Chapter 02: System Architecture and Design

II.1 Introduction

The proposed solution, called Doctian app, will play a crucial role in improving healthcare accessibility, resource utilization, and patient outcomes making a significant development in healthcare systems for a more modern sophisticated health care delivery. That significance lies in explicitly overcoming barriers of time, distance and limited healthcare resources, which introduce us to a future that makes healthcare accessible to individuals in remote areas and to those with limited mobility. Additionally, it makes people able to access medical consultations and services from the comfort of their homes, hence reducing the need for travel and waiting times. This convenience leads to improved patient satisfaction and faster access to healthcare.

At the others-side, Doctian can be a cost-effective option for healthcare systems. Remote consultations can eliminate the need for transportation expenses and reduce hospital readmissions by enabling early intervention and continuous monitoring.

The accessibility that our system offers is perpetually beneficial in emergency situations where immediate medical attention is required. It enables rapid communication and remote triage, allowing healthcare professionals to follow-up consultations and chronic disease management, ensuring continuity of care for patients and enabling them to monitor patients remotely, review test results, and adjust treatment plans when necessary.

The demand for such a system has been steadily increasing regarding the versatile advantages it provides, the paralyzing disparities it eliminates for the users and the impact it will have on the overall health care accessibility.

By overcoming geographical barriers, providing remote care for chronic conditions, supporting emergency situations, and promoting healthcare equity, Doctian will have a significant impact on improving healthcare outcomes for individuals worldwide.

II.2 Functional and non-functional features:

Functional and non-functional features are crucial characteristics that describe the system behavior that directly contribute to fulfill the intended purpose besides the qualities provided in order to ensure performance, reliability and security.

II.2.1 Functional features

- **Efficient online Appointment scheduling:** Doctian streamlines the appointment scheduling process for both patients and healthcare providers. It allows patients to book appointments easily, view available time slots, and receive reminders. For healthcare providers, this offers a centralized system for managing appointments, availability, and patient queues.
- **Teleconsultation throughout video call:** this feature enables remote medical consultations between healthcare providers and patients using video communication technology via a third secure party called *agora*. It allows patients to connect with healthcare professionals in real-time, using audio and video capabilities.
- **Medication intake reminder:** A medication intake reminder is a system or a component that helps individuals to remember to take their medications on time. This feature allows users to set up their medication schedule within the system, including details such as medication name, dosage and specific timing. The system then uses this information to generate reminders at the designated times, ensuring that users are alerted and prompted to take their medications as prescribed.
- **Safe electronic prescription issuing and reception:** safe electronic prescription feature is a functionality within Doctian that enables healthcare professionals to generate and transmit electronic prescriptions in a secure and reliable manner. This feature aims to improve the accuracy, efficiency, and safety of the prescription process while ensuring the confidentiality of patient information.
- **Built-in DICOM, PDF and Image viewer:** these features allow users to view and interact with different image types (DICOM, PDF,..) for both patients and healthcare professionals in order to enhance the diagnostic capabilities and efficiency.
- **Built-in QR generator and scanner for electronic prescriptions:** this feature allows healthcare professionals to scan and retrieve prescription information using QR code

scanning technology which offers convenience, accuracy, and efficiency in the electronic prescription workflow. By incorporating a built-in QR generator and scanner for electronic prescriptions, healthcare professionals can simplify the prescription transfer process, reduce errors and improve patient safety.

- **Text message with a text-davinci-003 openAi model for health related advices:** integrating chat-Gpt in a software program is very advantageous regarding the tool's positive impacts it would have on such an advice-demanding field. Doctian's DocGPT is constrained by a health-care context so all its possible responses will be given in a suitable health-care form even if the question asked would somehow be out of the general context.
- **Electronic Medical Record (EMR):** It is a digital version of a patient's medical information, including their medical history, medical files and patient information. EMR will facilitate better communication and coordination among healthcare providers and also enhance health-care outcomes.

II.2.2 Non-functional features

The goals and objectives of a Doctian platform system design encompass providing convenient and accessible healthcare services remotely while ensuring a seamless and secure user experience. Our key goals and objectives are:

- **Accessibility and Convenience:** the primary goal of Doctian is to make healthcare services easily accessible to patients regardless of their physical location. The platform is user-friendly, intuitive, and compatible with various devices and operating systems to ensure convenience and widespread adoption.
- **Secure Electronic Health Records (EHR):** the telemedicine platform integrates a secure and robust EHR system to store and manage patient data. The design ensures compliance with privacy regulations, such as HIPAA or GDPR, to protect patient confidentiality. EHR is limited only for the patient and the allowed healthcare professionals by the patient.

- **Collaborative Care and Referrals:** the telemedicine app should facilitate collaboration among healthcare providers by enabling secure communication and consultations between

specialists. It should also support referral processes, allowing primary care providers to refer patients to specialists when necessary, ensuring continuity of care.

- **Security and Privacy:** a fundamental objective of the telemedicine app system design is to ensure the security and privacy of patient data. The design incorporates authentication and authorization mechanisms, access controls, and compliance with relevant regulations to protect patient information from unauthorized access.
- **Scalability and Integration:** the adopted design has taken into consideration the scalability of the system in terms of data and space to accommodate the growing user bases and evolving healthcare needs. Hence, we can migrate to other scalable architecture like microservices. This design also allows for the integration with existing healthcare systems, such as laboratory information systems, to facilitate seamless data exchange and interoperability.

II.3 System's key stakeholders

The Doctian app involves various stakeholders who play different roles in the development, deployment, and utilization of the application. The key stakeholders in a telemedicine application typically include:

- **Patients:** these are the primary users of the telemedicine application. They use the app to schedule appointments, communicate with healthcare providers, access medical services remotely, and manage their health information.
- **Healthcare Providers:** including doctors, nurses, specialists, and other medical professionals. They utilize the Doctian application to deliver virtual consultations, diagnose patients, prescribe medications, monitor progress, and provide follow-up care.
- **Healthcare Organizations and Institutions:** Hospitals, clinics, medical practices, and healthcare systems adopt the Doctian app to offer remote healthcare services to their patients. These organizations provide the necessary infrastructure, support, and integration with existing systems.
- **Telecommunications Providers:** Telecommunications companies play a vital role in telemedicine applications by providing the necessary network infrastructure, bandwidth, and

connectivity to facilitate smooth audio and video communication between patients and healthcare providers.

- **Regulatory Authorities and Compliance Bodies:** Government regulatory bodies and compliance organizations ensure that telemedicine applications comply with relevant privacy, security, and legal requirements. They establish guidelines and standards to protect patient confidentiality and data security.
- **Health Insurance Providers**: Health insurance companies are stakeholders in telemedicine applications as they may offer coverage and reimbursement for virtual consultations and telehealth services. They may work closely with healthcare providers and telemedicine app developers to establish billing and reimbursement processes.
- **Pharmacists and Pharmacies:** In cases where telemedicine applications include electronic prescription capabilities, pharmacists and pharmacies become stakeholders. They receive and fulfill prescriptions digitally, ensuring patients have access to necessary medications.
- **Research Institutions and Academia:** Researchers and academic institutions may use telemedicine applications for data collection, remote consultations, clinical trials, and medical research. They contribute to the advancement of telemedicine technology and evaluate its effectiveness in healthcare delivery.
- **Patients' Family and Caregivers**: Family members of patients using telemedicine applications are indirect stakeholders. They may assist patients in using the app, provide support during consultations, and access relevant health information. They outline the desired outcomes, such as improved patient experience, efficient healthcare delivery, and secure communication.

II.4 Doctian system architecture

II.4.1 High level system design

The high-level system design refers to the process of conceptualizing and outlining the architecture and components of a system at a broad level. The goal is to provide an overview about a system and its functionality before diving into the details.

Figure 0-1 illustrates the main components that constitutes our system.

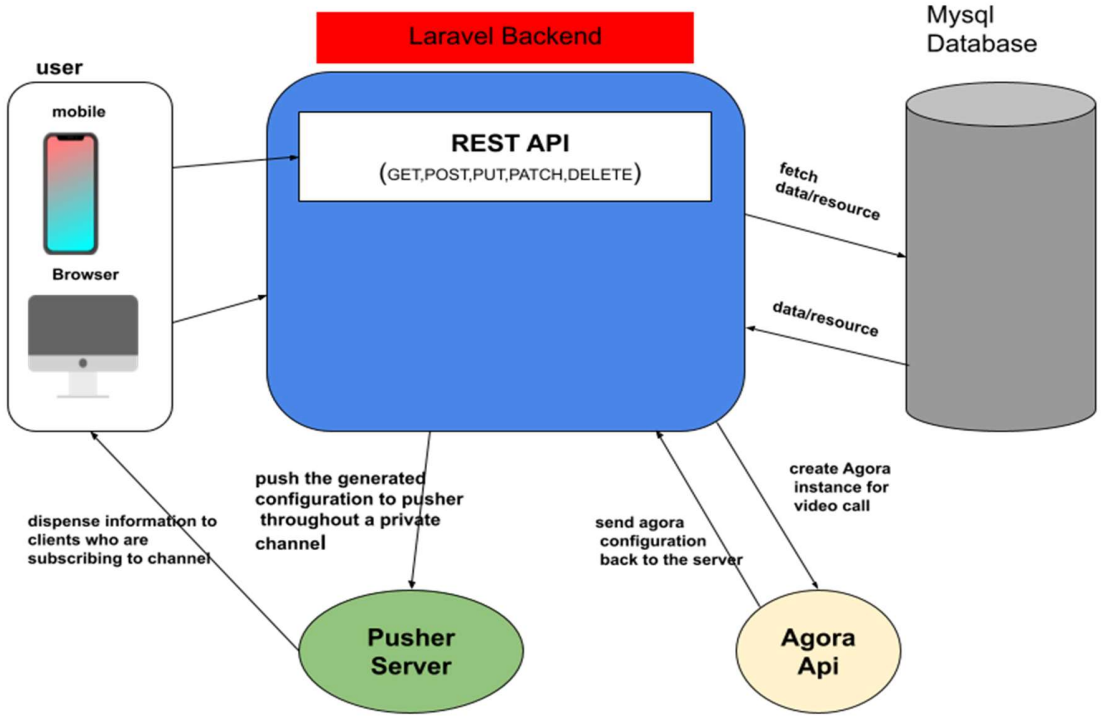


Figure 0-1. High level design that shows Doctian architecture and components.

The system contains three major components that are the mobile and Web UI sharing a Laravel server with Rest API within, to reinforce its scalability, flexibility and most vitally its secure data processing and transferring.

II.4.1.1 Mobile client application

For numerous conveniences and statistics that we'll be discussing later, we have chosen the android platform as an initial mobile operating system to build and deploy the Doctian app on, with a powerful user-friendly intuitive UI/UX illustrated in the next part with a detailed implementation chapter.

II.4.1.2 Web client application

The web client will interact with the server through client-server architecture. The Website's interface has a friendly interface with 3 different languages (Arabic, French, English)

so the different users will interact with the system easily. Website client app is protected against common web vulnerabilities. It uses the HTTPS protocol in order to ensure secure and reliable communication and secure data transmitting between the client and the server

II.4.1.3 Server-Side

On the server side we've used Laravel framework which is one of the most popular frameworks in web development. Laravel provides many helpful technologies that help to develop scalable and secure systems. It uses MVC architecture as it will be mentioned farther this architecture helps separate the concerns of the application into three distinct components.

Separating these components from each other helps improving the maintainability and the extensibility of the application. A change in one component can be implemented without impacting the other components.

II.4.2 Data Design

Laravel provides a robust data handling framework through its built-in support for the Eloquent ORM (Object-Relational Mapping) and database migrations. It uses Eloquent models; each one should correspond to a table and define relationships between models as needed. It implements data validation rules to ensure the integrity and consistency of the data and meet the required format and constraints before storing it in the database.

Laravel also implements authentication and authorization mechanisms to control access to sensitive data and functionalities such as gates and policies to manage user permissions.

II.4.3 Integration and Connectivity

Designing a scalable telemedicine system must take into consideration to explore its integrability with other healthcare systems. This involves to:

- Discuss interoperability standards, such as HL7 or FHIR, to ensure seamless data exchange with existing electronic health record (EHR) systems.
- Consider integration with external services, such as pharmacy databases or medical device APIs.

II.4.4 Security and Privacy

In the digital age, telemedicine has emerged as an invaluable tool, providing accessible healthcare services to patients remotely. However, the sensitive nature of patient data involves a strict adherence to privacy and security regulations, such as the Health Insurance Portability and Accountability Act (HIPAA).

- **Secure Communication:** one of the fundamental aspects of HIPAA compliance is secure communication. Implementing Transport Layer Security (TLS) or Secure Sockets Layer (SSL) protocols ensures encryption of data transmitted between the Android app and the server. Utilizing HTTPS for network communication prevents eavesdropping and data tampering.
- **User Authentication and Authorization:** robust user authentication mechanisms are crucial to ensure that only authorized individuals can access the telemedicine app and patient data. Implementing strong passwords, two-factor authentication (2FA). Enforcing secure password policies and periodic password changes further enhances user security.
- **Role-based access control (RBAC)**: it ensures appropriate access levels and permissions based on user roles and responsibilities.
- **Data Encryption:** encrypting sensitive patient data is essential for protecting PHI both during transmission and storage. Strong encryption algorithms should be employed to secure data at rest and in transit. The platform offers encryption libraries and best practices for secure data handling. Additionally, implementing secure key management practices further protects encryption keys.
- **Secure Code Development:** Developing secure code is paramount to prevent common vulnerabilities and ensure the overall integrity of the telemedicine app. Following secure coding practices, such as input validation, output encoding, and secure API usage, mitigates risks associated with common vulnerabilities like SQL injection or cross-site scripting (XSS). Regularly updating and patching the app addresses any identified security vulnerabilities.
- **Security Auditing and Monitoring:** Implementing robust auditing and monitoring mechanisms enables proactive detection and response to security incidents. Logging and monitoring app activities helps track and analyze potential security threats. Regularly

reviewing logs for suspicious activities, multiple failed login attempts, or unauthorized access attempts ensures prompt mitigation.

II.5 Doctian design

For the sake of ubiquity our proposed solution system, called *Doctian*, needs to be thoroughly accessible in the most versatile ways. Therefore, we instigated the project's development cycle by designing a web and a mobile solution (particularly on Android OS).

A model-view-controller architecture is adopted for the web clients; this architecture helps separate concerns and provides a structured way to manage the application logic. As for the mobile client, it is based on a RESTful API that guarantees secure, fast and agile exchange of data between the server and the android UI application.

The following sections give more details about the design of the proposed system.

II.5.1 Model View Controller

The model-view-controller (MVC) architecture (Figure 0-2) is a software design pattern that separates an application into three interconnected components: the model, the view and the controller; each component has its own responsibility and handles a specific aspect.

- **Model**: represents the data and business logic of the application. It is responsible for handling and managing any data manipulation.
- **View**: responsible for rendering the user interface and presenting data to the user. It displays the information obtained from the model.
- **Controller**: acts as an intermediary between the model and the view. It is responsible for processing inputs from users, determining the appropriate view to display and also triggering the appropriate actions or changes in the model.

The flow of data and interactions in MVC typically follows this pattern: the user interacts with the View, which triggers a request that is then handled by the Controller. The Controller updates the Model based on the request, and the View retrieves the updated data from the Model and displays it to the user.

MVC allows for the separation of the concerns, code reusability and easier maintenance. A change that might occur in one component won't affect the others, promoting a more flexible and scalable architecture.

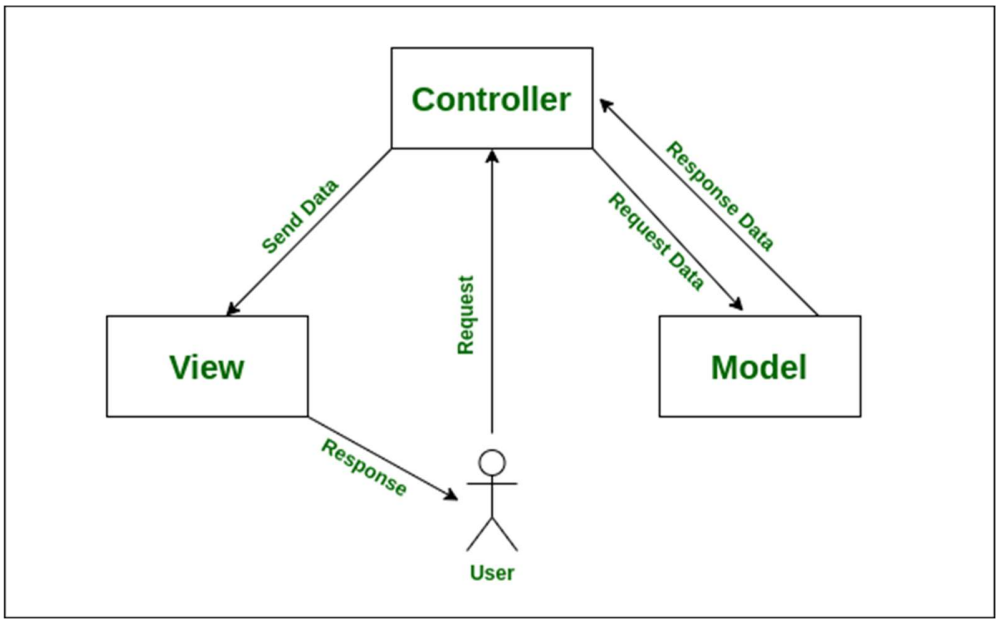


Figure 0-2: Model-view-controller architecture. In this case there are two types of controllers: API controller for mobile app and WEB controller for web app.

II.5.2 RESTful services

A RESTful API is a software architectural style for building web services that are lightweight, scalable, and maintainable.

Typically, when we've built the RESTful API, we used the MVC architecture on the server side to handle the API requests. The requests would be routed to the appropriate controllers, which would interact with the models to retrieve or manipulate data, and then return the response in a format that the mobile app can consume (JSON). Here are some reasons why RESTful APIs are popular:

- **Simplicity**: RESTful APIs are easy to understand and implement since they use standard HTTP methods like GET, POST, PUT, and DELETE to manipulate resources.

- Scalability: RESTful APIs can handle large amounts of traffic because they are stateless and cacheable. This means that requests can be distributed across multiple servers, which makes it easier to scale the application as demand grows.
- Flexibility: RESTful APIs can be used with any programming language or platform since they rely on standard protocols like HTTP and JSON.
- Easy integration: RESTful APIs can be integrated easily with other systems, as they use standard web protocols that are widely supported.
- Security: RESTful APIs can be secured using standard authentication methods like OAuth, which ensures that only authorized users can access resources.

The RESTful APIs provide a flexible and scalable way to build web services that can be integrated easily with other systems and provide a high level of security.

II.5.3 UML (Unified Modeling language)

In order to provide a comprehensive visual representation of our software system from a different perspective we have used UML diagrams particularly (use case, class, sequence).

UML (Unified Modeling Language) is a standardized visual modeling language used in software engineering to design, visualize, and document software systems. It provides a set of notations and diagrams (Use case, class, sequence) that help communicate and capture different aspects of a system's structure, behavior, and interactions.

II.5.3.1 Use Case Diagram

Use case diagrams depict the main anticipated interactions between users and a system not only including software. Many actors could be considered as users of the Doctian system; they principal ones are: the patient, the doctor and the pharmacist. Figure 0-3**Error! Reference source not found.** illustrates various functional requirements for our system and how each user will interact with it. More details about each actor action are given in Table 0-1.

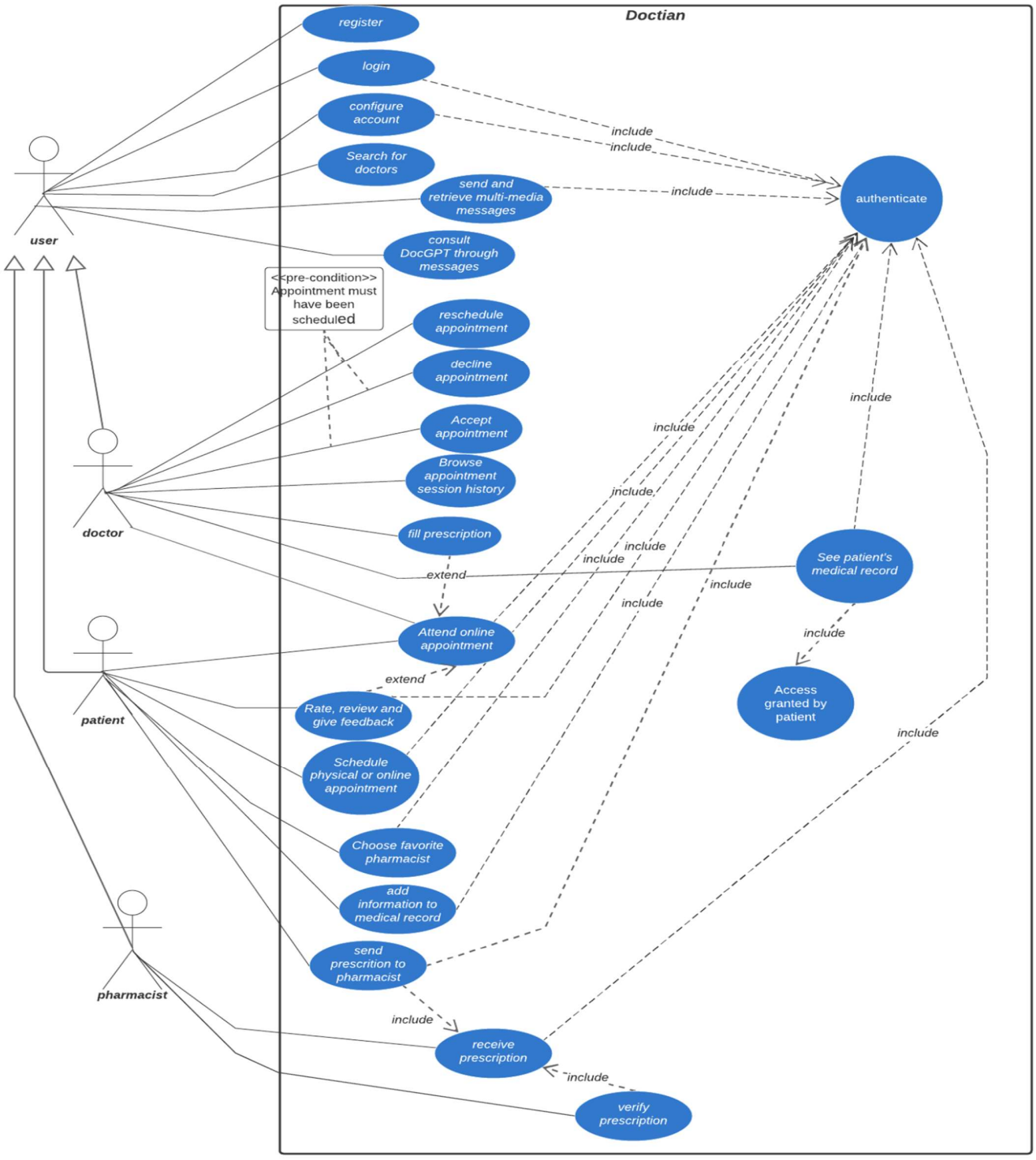


Figure 0-3 use-cases diagram related to the Doctian system

Table 0-1. Doctian uses cases details

Actor	Actions	Docs
Patient	● Create an account ● Search and consult a doctor ● Schedule an appointment ● Attend Virtual appointment ● Share medical records with doctors -Choose his favorite pharmacist ● (the pharmacist must be on the platform) ● Send a prescription to his favorite pharmacy. ● Mark his favorite pharmacy doctor nurse or lab ● Generate a healthy diet according to his proper genetics and goals ● in-App video calling ● in-App messaging ● Rate review and give feedback	lab report, prescription, Chifa card, EMRs ,
Doctor	● Create an account ● Accepting appointment ● Providing prescriptions ● Reviewing a patient's medical files and ● take notes. ● Browse appointment sessions history with his patients ● Set Availability ● Write medical articles ● in-App Write and send electronic prescriptions to the patient. ● Multi way video conferences	Prescription. Verification ID. Medical license.
Pharmacist	● Create an account ● Receive prescription from a patient (must be a client belonging to this pharmacy). ● Verify prescription ● Fill the prescription and dispense the medications ● Send medication to the patient	prescription

II.5.3.2 Sequence Diagram

Sequence diagram is one of the most important UML's diagrams. Using it helps to explain the main objects participating within the system. The actors

responsible for launching processes inside the system, the process flow in general and the total period of which an object is active during the interaction between the actor and the system. Figure 0-4 and Figure 0-5 illustrate two of Doctian's brief sequence diagrams of how potentially a patient can interact with Doctian UI in relation to two of the system's main actors who are the doctor and pharmacist.

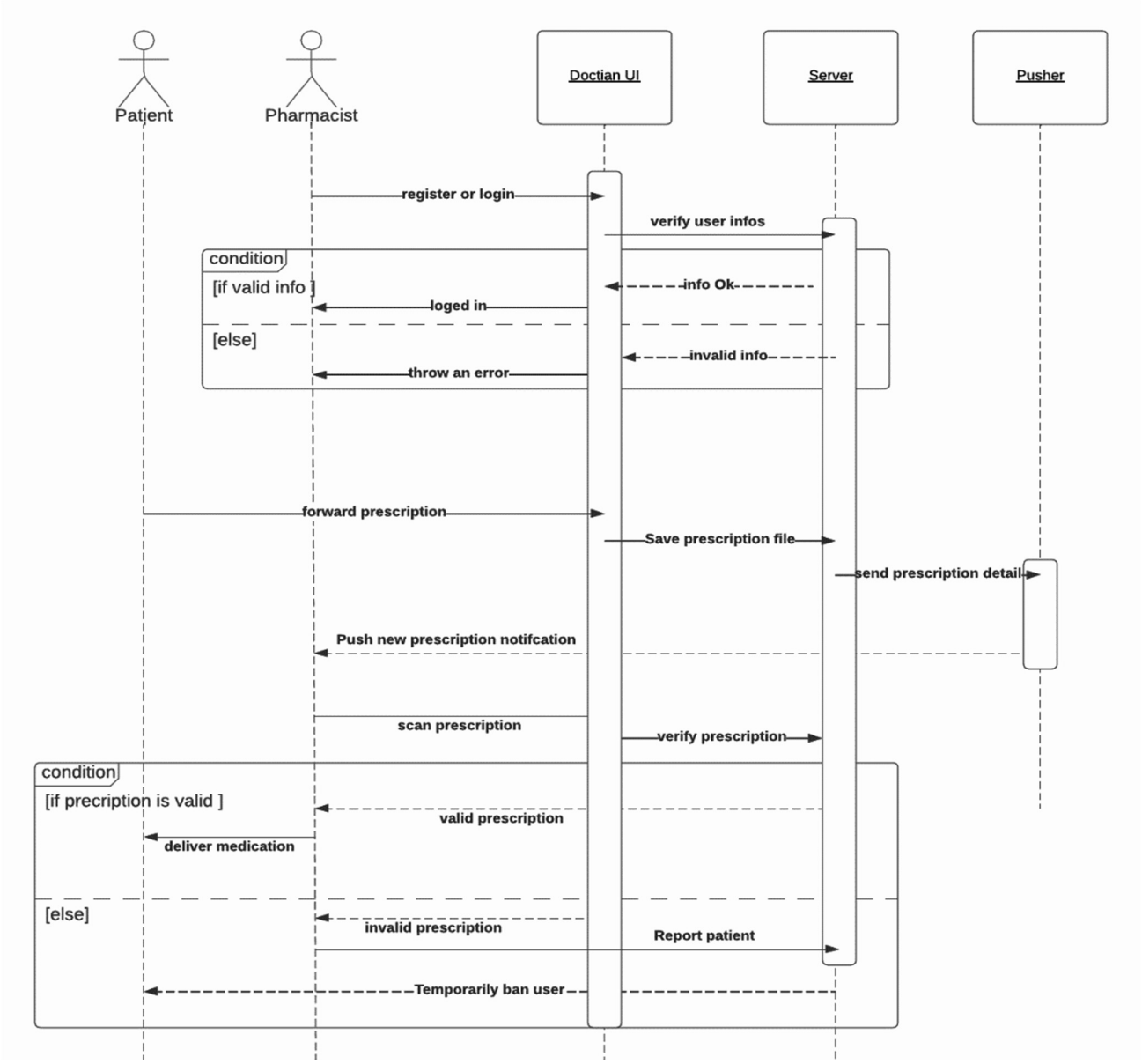


Figure 0-4. Doctian sequence diagram of the use-case "Verify prescription" related to the Pharmacist.

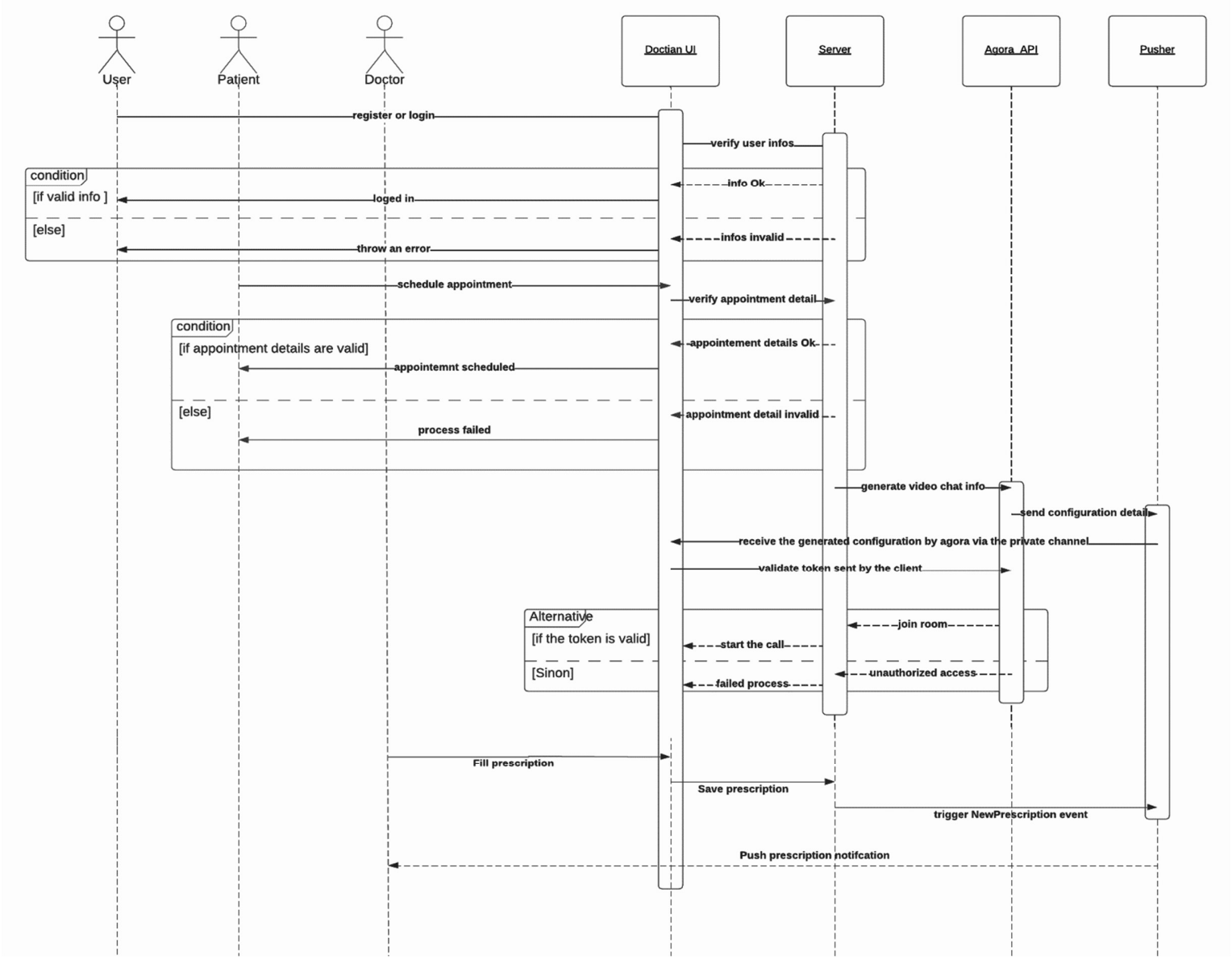


Figure 0-5. Doctain sequence diagram for regrouped use cases related to the patient in interaction with a doctor

II.5.3.3 Class Diagram

The class diagram is a representation that describes the static structure of a system by illustrating classes, their attributes, methods, relationships. it gives an overview about the system's object-oriented design by clarifying the relationships and interactions between classes. Figure 0-6 illustrates a detailed-like class diagram of the Doctian System. It provides a brief explanation of the classes targeted by our system, the relationships between them and highlights the most important actions performed by each class.

The user class is the inherited class of patient and doctor classes, for it contains common fields such as name and email along with methods like login and subscribe. The building class is the inherited of three classes that are Hospital affiliation, Laboratory and pharmacist since these classes share multiple fields such as the address of the building.

The prescription class will contain the necessary attributes in order to exchange prescription’s details between the doctor, patient, and the pharmacist classes.

The medical File class is responsible for manipulating a patient’s medical file by performing various methods (save, update, delete) on the patient's medical file stored in the file system.

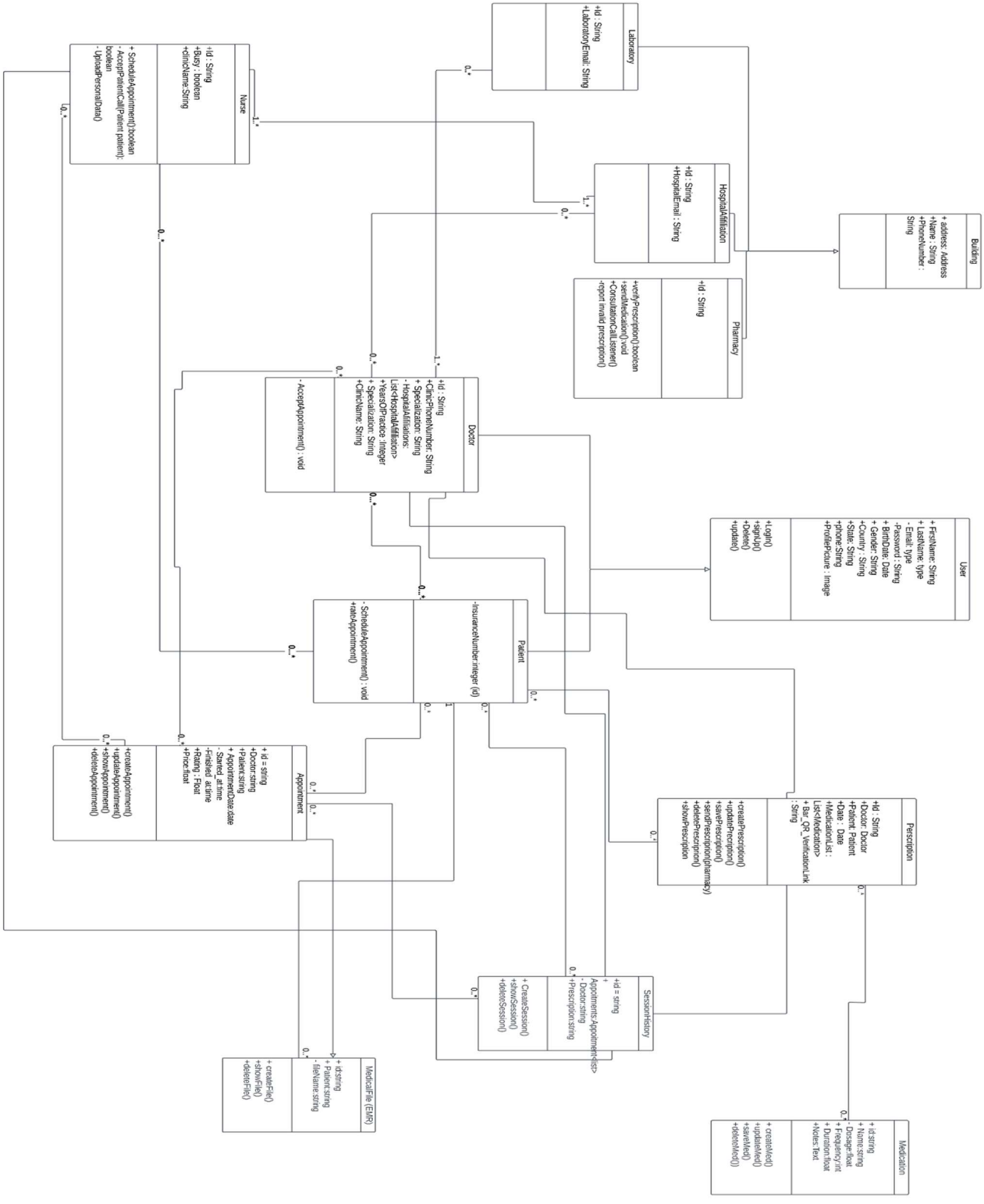


Figure 0-6. Doctian class diagram

Chapter 03: Implementation

III.1 Introduction

To concretize our work, we finish with the construction phase that allows us to materialize all that has been planned, modeled and obtained as a result in previous phases. This chapter will be divided into three parts: the first one will be devoted to the description of the development frameworks, tools and APIs used to build the proposed system. The second part will deal in details with the realization of our solution for both mobile app and website platform. Finally, the third part will contain the presentation of the platform with some interfaces that have been realized for both mobile apps and web apps.

III.2 development frameworks, tools and APIs

III.2.1 Languages

We used six essential languages which we quote below:

III.2.1.1 HTML

HTML (Hypertext Markup Language) is a standard markup language used for creating the structure and presentation of web pages. It is the basic building block of web pages and is interpreted by web browsers to display content on the Internet (7).

III.2.1.2 CSS

CSS (Cascading Style Sheets) is a style sheet language used to describe the presentation and formatting of HTML documents. It is responsible for controlling the visual appearance of web pages, including the layout, colors, fonts, and other design aspects (8).

III.2.1.3 JavaScript

JavaScript is a high-level, interpreted programming language that is primarily used to add interactivity and dynamic behavior to web pages. It enables you to create interactive features, validate forms, manipulate HTML elements, handle events, and communicate with servers, among many other functionalities (9).

III.2.1.4 PHP

PHP (Hypertext Preprocessor) is a widely-used server-side scripting language designed for web development. It is particularly well-suited for creating dynamic web pages and building web applications (10).

III.2.1.5 Java

Java is a widely-used, platform-independent programming language known for its simplicity, readability, and versatility. It supports object-oriented programming and provides a rich standard library for common tasks. With its "write once, run anywhere" approach, Java enables developers to create robust applications for various platforms and devices (11).

III.2.1.6 XML

XML refers to the XML-based markup language used in Android app development for defining user interface layouts, resources, and configurations. with abilities to separate the presentation and logic of an Android application, allowing for flexible and dynamic UI design, localization support, and easy management of app resources (12).

III.2.2 Frameworks

III.2.2.1 Tailwind CSS

CSS framework that provides a set of pre-designed utility classes that can be applied directly in HTML to style and design web interfaces. It offers a highly customizable and efficient way to build modern, responsive websites and applications (13).

III.2.2.2 Alpine JS

Alpine.js is a JavaScript framework that provides a declarative and approachable way to add interactivity to web pages. It allows to enhance HTML with dynamic behavior and interactive components without the need for a complex setup or heavy dependencies (14).

III.2.2.3 LARAVEL

Laravel is a popular open-source PHP web framework. It provides a solid foundation for building modern web applications by offering a wide range of tools and libraries that streamline common development tasks.

Laravel follows the Model-View-Controller (MVC) architectural pattern, making it easy to separate business logic from presentation. It comes with features such as routing, caching, validation, database abstraction, queuing, and more, which greatly simplify the development process and improve productivity (15).

III.2.3 Tools

III.2.3.1 Visual Studio code

Visual Studio Code (VS Code) is an open-source code editor developed by Microsoft. It has gained immense popularity among developers due to its extensive features, powerful customization options, and a vibrant ecosystem of extensions.

VS Code provides a lightweight and versatile environment for writing code in various programming languages. It supports syntax highlighting, intelligent code completion, code formatting, debugging, version control integration, and more.

III.2.3.2 Postman

Postman () is a popular collaboration platform and API development tool that simplifies the process of building, testing, documenting, and sharing APIs. It provides a user-friendly interface and a powerful set of features that enable developers to streamline their API development workflow.

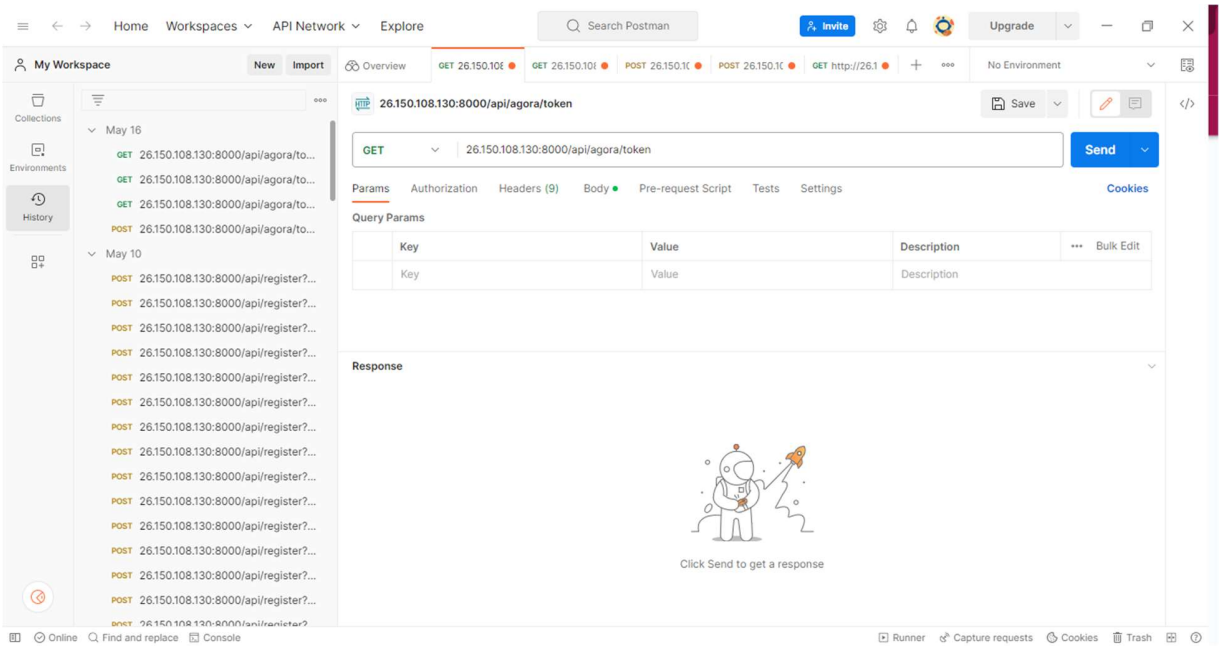


Figure 0-1 postman welcome page.

III.2.3.3 Agora API

Agora is a real-time engagement platform that provides developers with APIs and SDKs for both mobile and web to add voice, video, and interactive broadcasting capabilities to their applications. It offers a scalable and reliable infrastructure for building applications with live audio and video communication features.

III.2.3.4 MYSQL

MySQL is an open-source relational database management system (RDBMS) that is used for storing and managing structured data. It is known for its speed, reliability, and scalability, making it a popular choice for a wide range of applications, from small websites to large enterprise systems. We adopt phpMyAdmin tool for managing and administering MySQL databases.

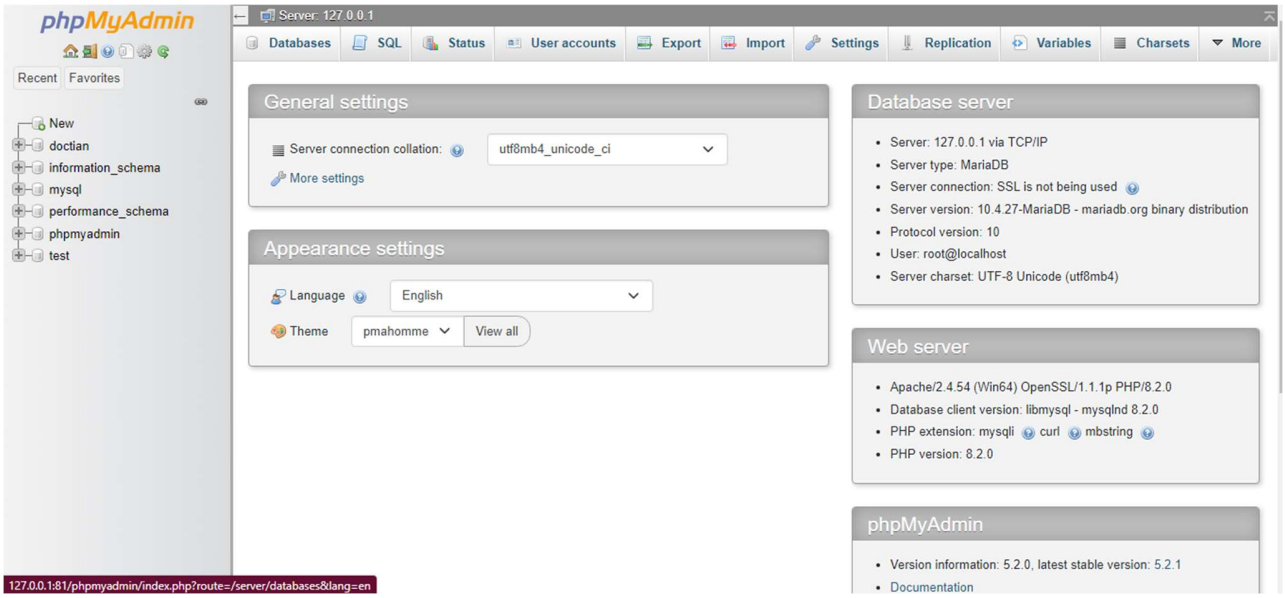


Figure 0-2 phpMyAdmin welcome page.

III.2.3.5 Pusher Server:

Pusher is a cloud-based real-time messaging platform that provides developers with APIs and SDKs to add real-time functionality to their applications. It allows you to send and receive messages in real time between clients and servers, enabling features like instant messaging, live updates, and notifications throughout channels (private and public).

III.2.3.6 Android Studio

A Powerful Integrated Development Environment, and the official IDE for Android development, has significantly influenced the app development landscape. Its comprehensive suite of tools and features streamlines the development process, making it easier for developers to create high-quality, feature-rich applications. Android Studio's robust debugging capabilities, intelligent code editor, and emulator allow and facilitate the Doctian App test efficiently and enhance its overall quality. Among the Android studio IDE powerful advantages, we may name:

- **Enhanced Productivity**: Android Studio's intuitive interface and developer-friendly features have greatly enhanced productivity in the development workflow. With features such as code auto-completion, code generation, and extensive libraries, developers can build apps faster and more efficiently. Additionally, Android Studio's integration with version

control systems facilitates collaborative development, enabling teams to work seamlessly on the same project.

- **Integration of Advanced Technologies:** Android development and Android Studio have facilitated the integration of advanced technologies into mobile apps. The availability of rich APIs, frameworks and libraries allows developers to leverage cutting-edge technologies such as : augmented reality, machine learning and artificial intelligence such as the GPT-3 (Generative pretrained transformer) text-DaVinci-003 model. This integration has led to the creation of innovative and immersive applications that cater to various industries, including gaming, healthcare, education, and finance.
- **Monetization Opportunities:** The impact of Android development extends beyond technical aspects; it has also revolutionized the monetization landscape for us developers. Android's app distribution platform, Google Play Store, offers a vast marketplace where we can publish and monetize our applications. By leveraging in-app purchases, subscriptions, advertisements, and other revenue models related to healthcare and telemedicine, it incarnates a sustainable evolution and prosperity paving ways to generate substantial income.

III.3 Doctian: potential accessibilities and implementation

Figure 0-3 Doctian system icons for website and Android app

III.3.1 Mobile App functionalities

III.3.1.1 Medication intake reminder for Android

Medication intake reminder (Figure 0-4) is one of Doctian's core features for ensuring effective patient medical treatment after receiving a prescription, this mechanism is attained using

the *WorkManager* android API for task scheduling, by notifying the patient according to an ongoing prescription medication intake frequency using *NotificationCompat* library and *Pusher API* for cloud messaging.

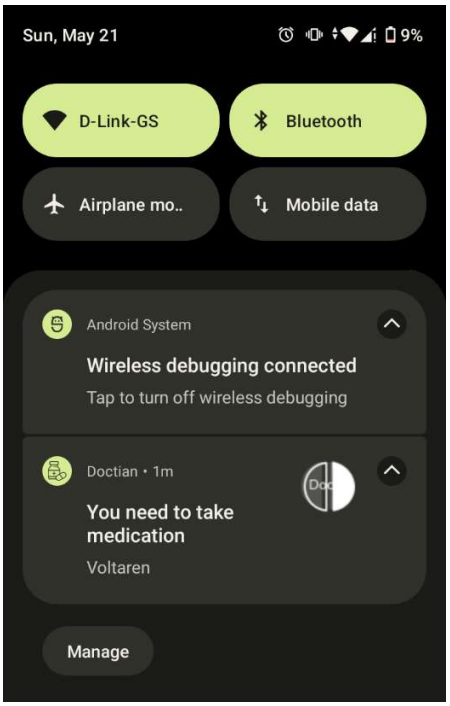


Figure 0-4. Medication intake notification

As a versatile and powerful tool, WorkManager empowers us to make Doctian meet the expectations of modern mobile users. In fact, task scheduling using WorkManager in Android provides a powerful and efficient solution to manage background work effectively. Work is persistent when it remains scheduled through app restarts and system reboots (Figure 0-5). Because most background processing is best accomplished through persistent work, WorkManager is the primary recommended API for background processing.

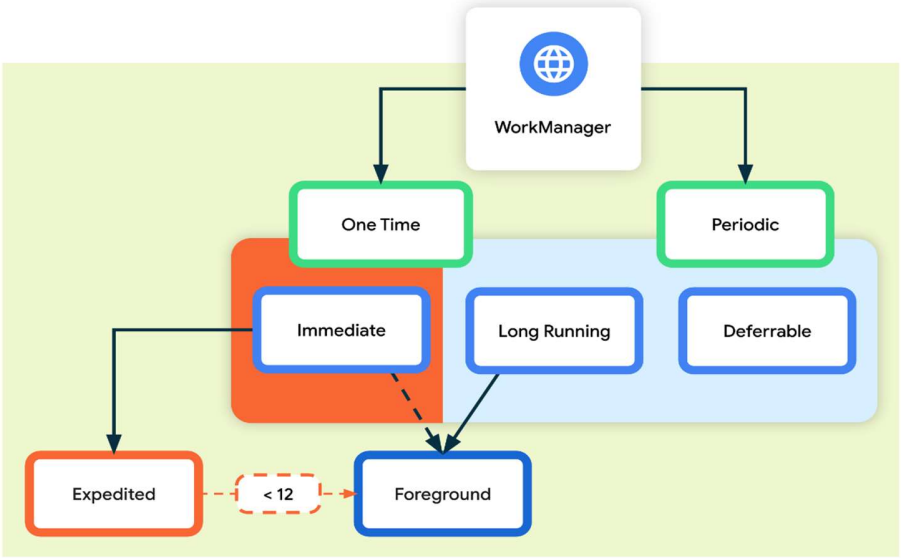


Figure 0-5. Types of persistent work.

Task scheduling using WorkManager in Android is essential for optimizing background processing and delivering a seamless user experience. By leveraging WorkManager's flexibility, reliability, constraint-based execution, observability, and workflow management capabilities, we can efficiently manage and execute background tasks. This results in improved performance, reduced resource consumption, and enhanced responsiveness of Android applications.

III.3.1.2 Virtual consultation logic and implementation

Virtual consultation refers to the practice of connecting patients and healthcare professionals through digital channels, to provide medical assistance, diagnosis, and treatment. By leveraging the capabilities of Android devices, patients can have a direct line of communication with doctors, nurses, and other healthcare practitioners, enabling them to seek timely medical advice from the comfort of their homes. Implementing virtual consultation in Android brings forth a myriad of benefits for both patients and healthcare providers. Patients can access medical care without the constraints of distance, time, or mobility issues, leading to enhanced convenience and accessibility. They can schedule appointments, share their medical history, and engage in real-time conversations with healthcare professionals through secure and encrypted channels, ensuring the privacy and confidentiality of sensitive health information.

For healthcare providers, the implementation of virtual consultation in Android streamlines the delivery of care, allowing them to reach a larger patient base and improve overall efficiency.

With features such as video calling which we will be discussing in the next part, chat functionality, medical record and file sharing, healthcare professionals can conduct virtual examinations, provide remote diagnosis, improve medication prescribing and delivery, along with monitoring patients' progress, all within a digital ecosystem that prioritizes patient safety and satisfaction. As the demand for remote healthcare services continues to grow, virtual consultation implemented on the Doctian application represents a powerful tool that bridges the gap between patients and healthcare providers. The convenience, accessibility, and flexibility offered by this technology have the potential to enhance healthcare delivery, particularly in regions where access to quality medical services is limited. By harnessing the capabilities of Android devices, virtual consultation empowers individuals to take charge of their health and well-being, fostering a new era of patient-centered care.

The following figures display the modern UI/UX that Doctian app provides for our patient user type to login, sign up, search for doctors and interact with them.

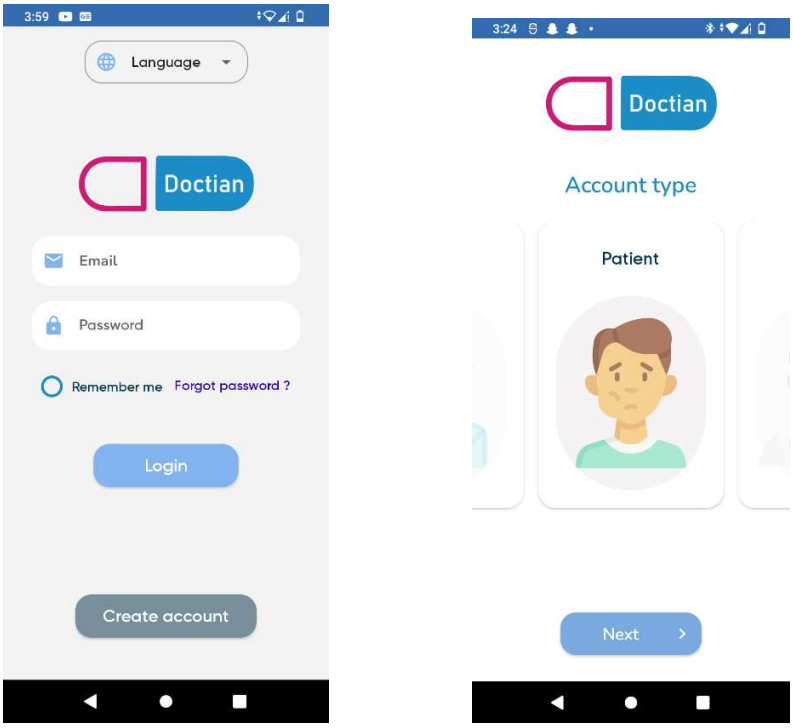


Figure 0-6. Mobile app login UI

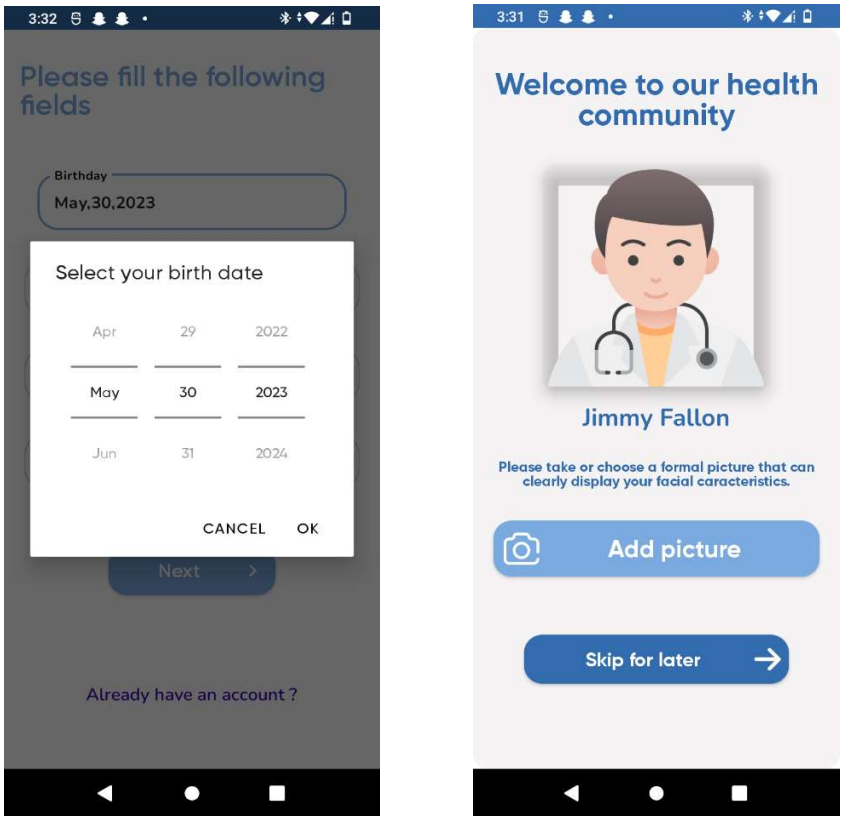


Figure 0-7 Mobile app login and information fill

After a successful account creation and authentication procedures; the user will be introduced to the following home interfaces:

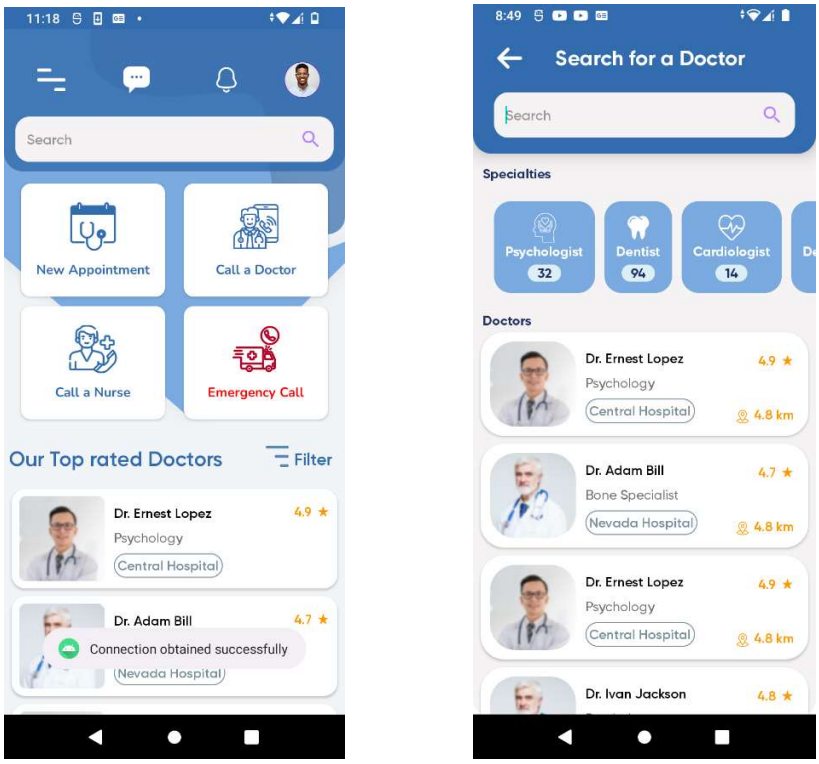


Figure 0-8.Mobile app Home UI

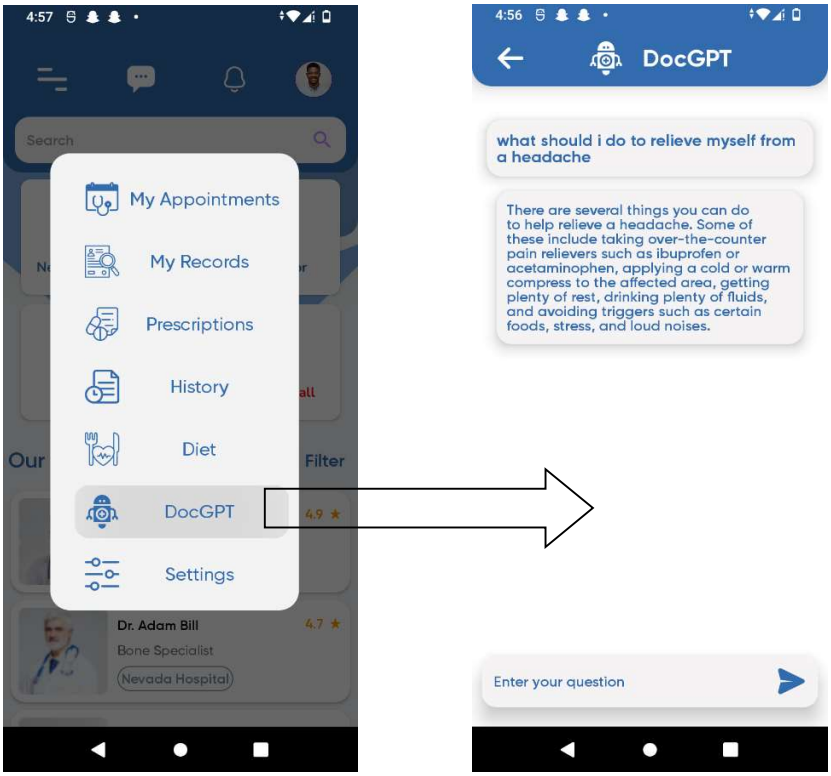


Figure 0-9. Mobile app DocGPT chat UI

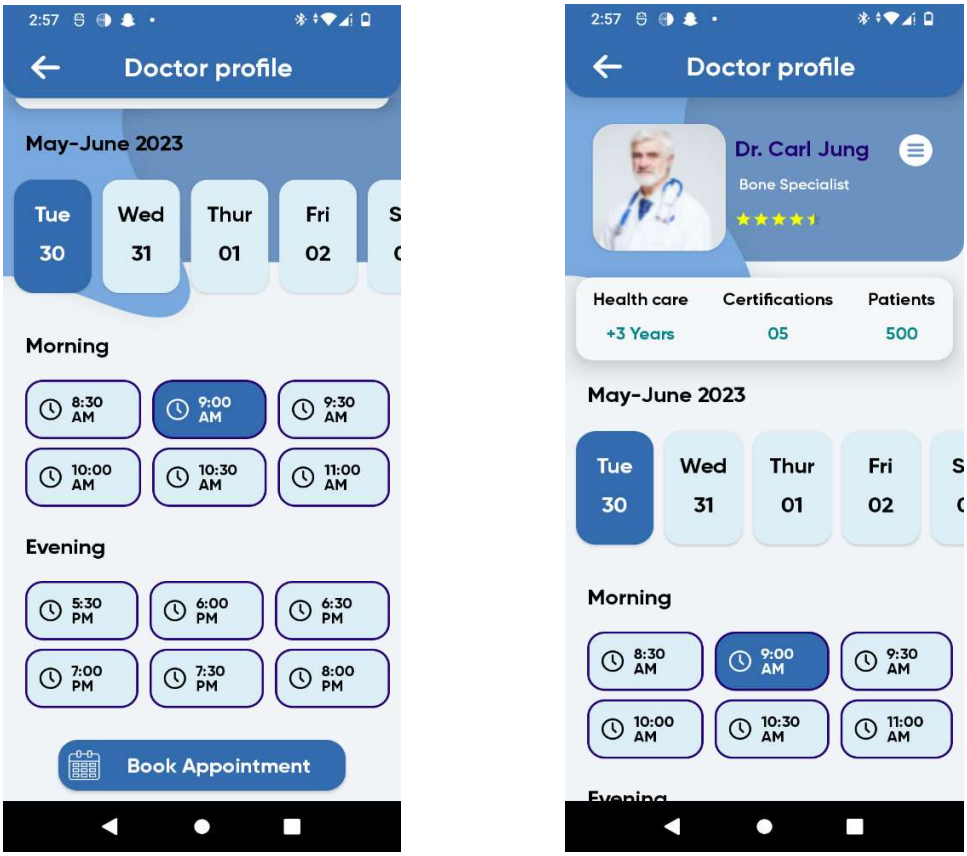


Figure 0-10.Mobile app doctor profile UI

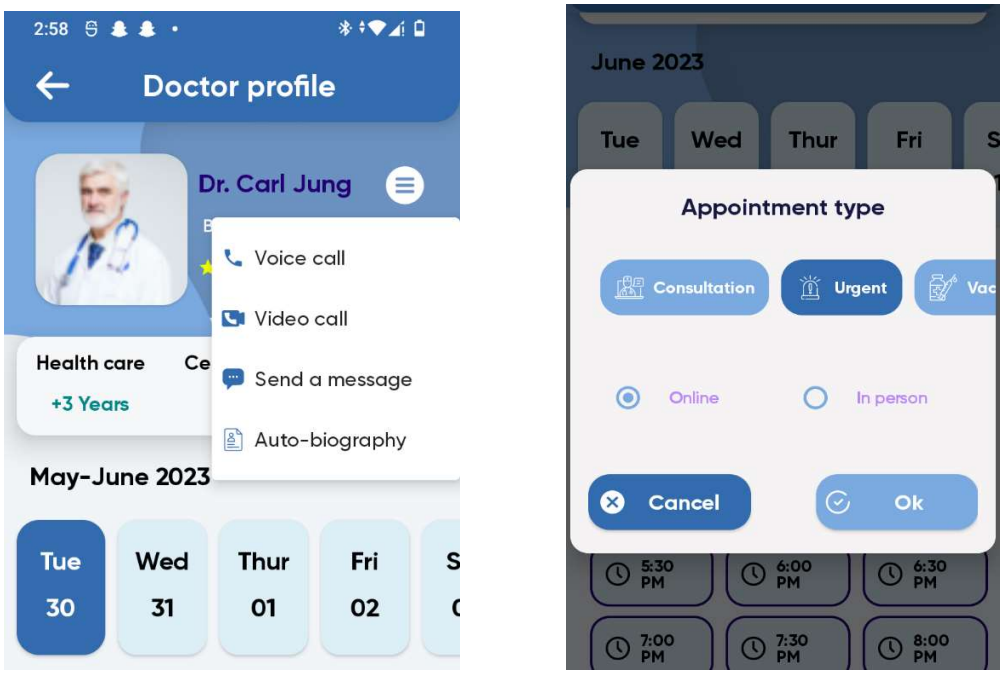


Figure 0-11 Appointment booking on Doctian mobile app

When the appointment time comes, both the patient and the doctor will receive a video call notification inviting them to join a private channel where the online video appointment takes place, the bottom figures illustrate the overall views and outcomes of an online medical appointment such as the electronic prescription.

Figure 0-12.Video chat (Web app client).

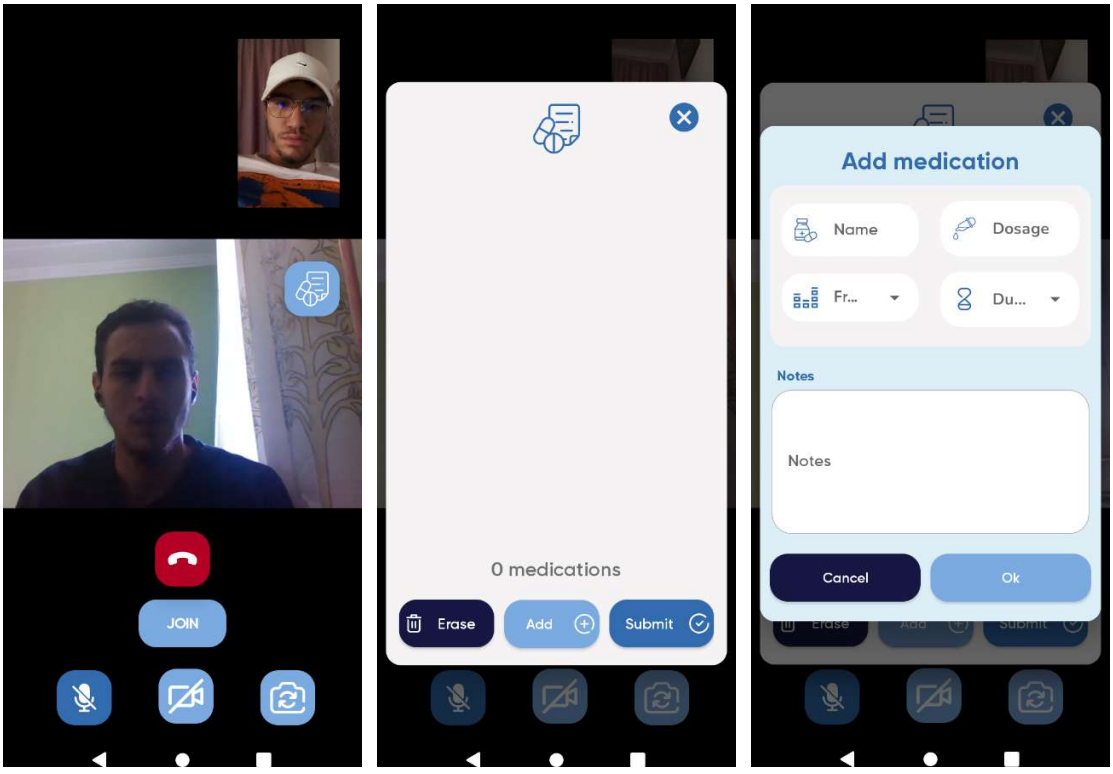


Figure 0-13. Video chat (mobile client doctor user type UI)

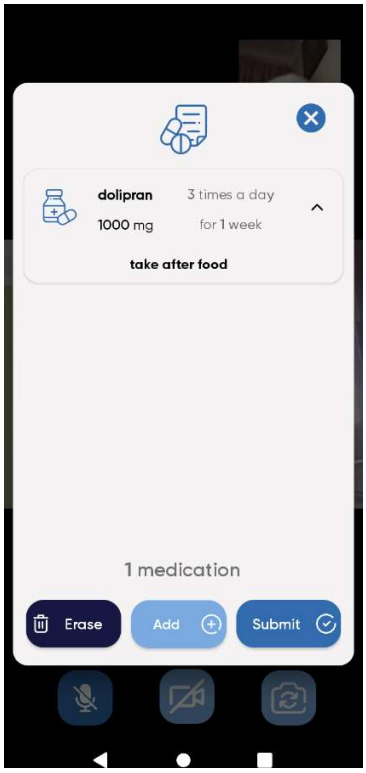


Figure 0-14. Electronic prescription fill UI

III.3.2 Web Application UI & functionalities:

Web application makes healthcare accessible to individuals who may be unable to visit a physical clinic or hospital due to geographical limitations, transportation issues, or physical disabilities.

Among the reasons that make web application of vital importance in telemedicine we cite:

- **Medical History and Documentation**: web application enables the storage and retrieval of patient medical records and history in a secure and organized manner. Doctors can access patient information, including previous diagnoses, test results. This ensures accurate and comprehensive medical care.
- **Appointment Scheduling**: web application simplifies the process of scheduling appointments, enabling patients to book and manage their healthcare visits online.
- **Cross-platform compatibility**: users can access web application on their preferred devices. They can use any device with a compatible web browser and internet connection to access the

same web application, ensuring a consistent user experience and functionality across platforms.

The main functionalities of the Doctian platform are

III.3.2.1 Home page

The user's initial interface when the site first launches is the "home" page, where they may instantly search for a doctor or register as a patient or doctor.

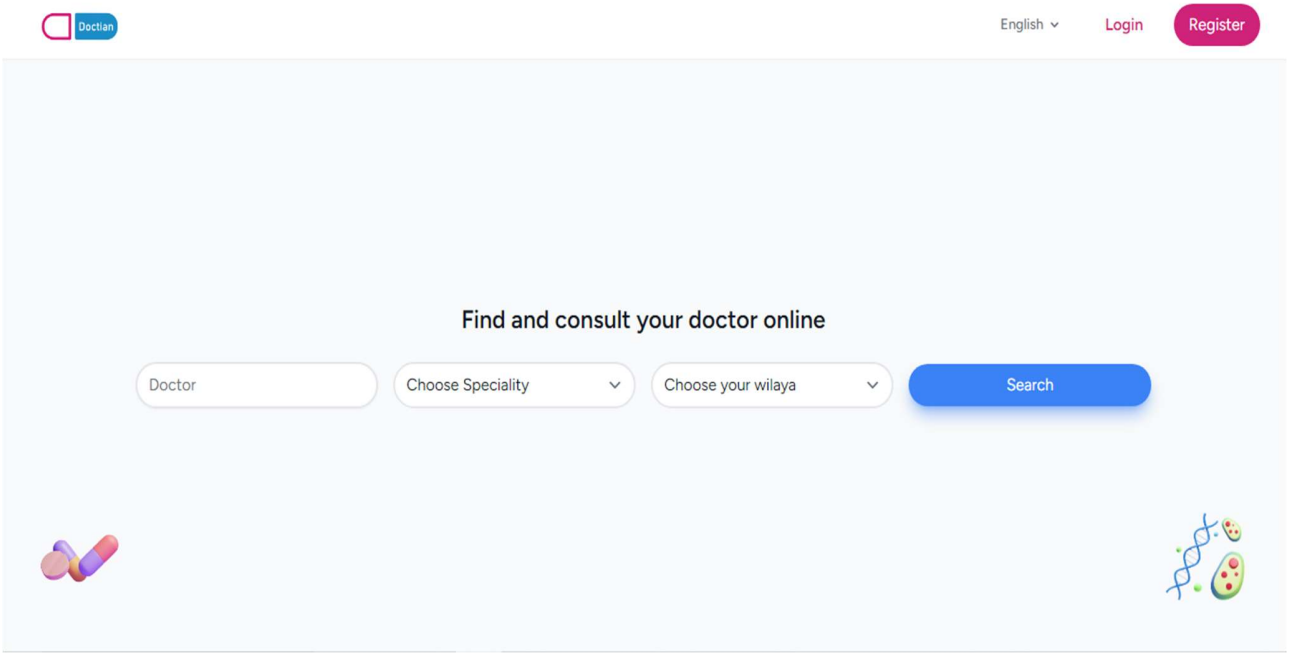


Figure 0-15.Doctian home page

III.3.2.2 Register page

Both patient and doctor have common information as users to fill and then specific information for each.

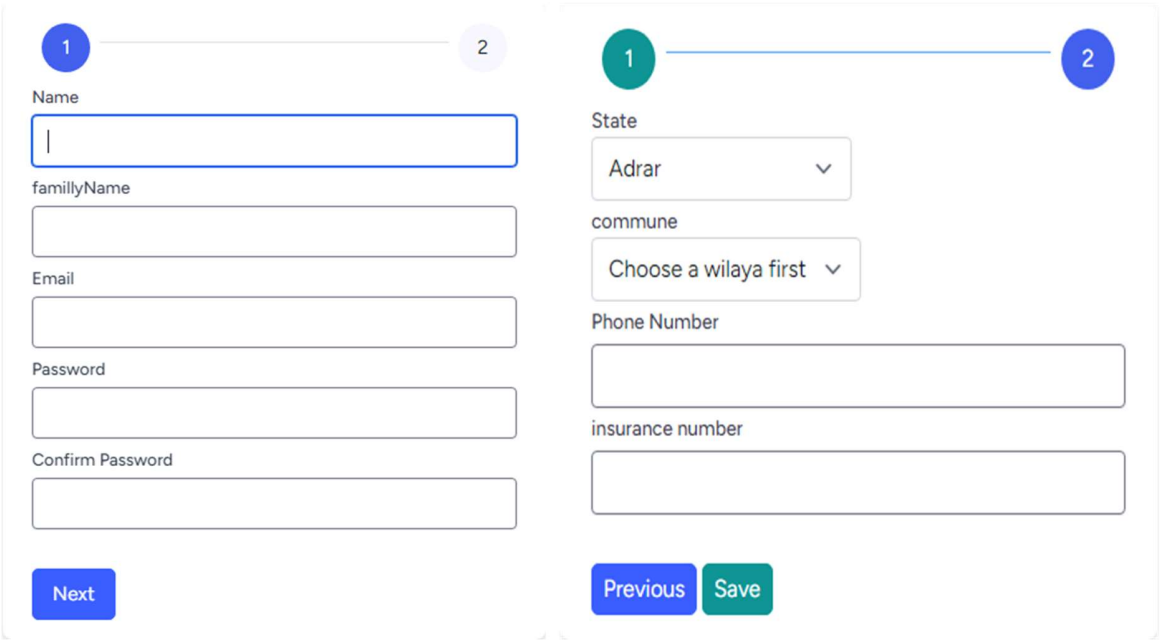


Figure 0-16. Patient' common and additional information.

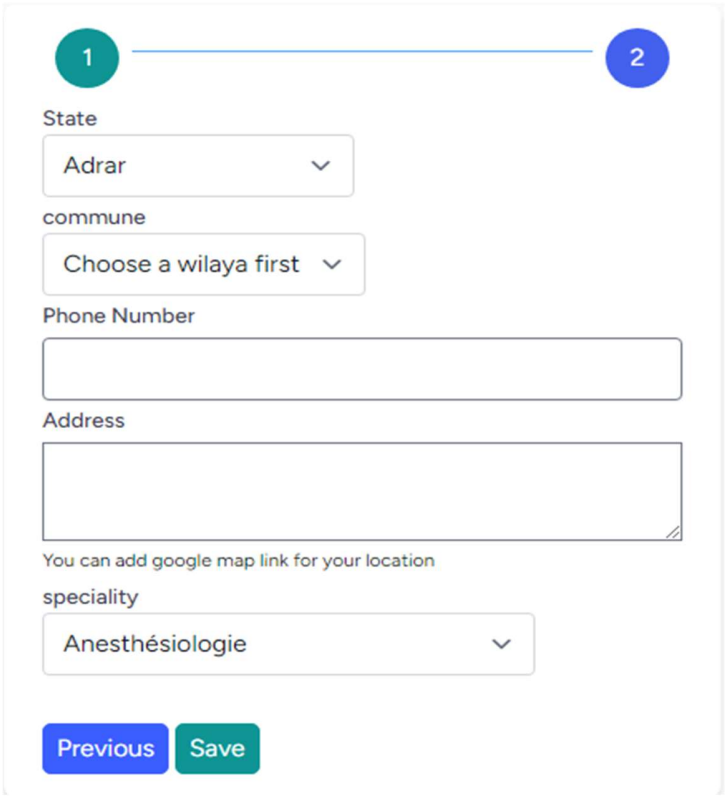


Figure 0-17.: Doctor's additional info.

III.3.2.3 Login page

All Users will login using this interface after that, each one of them will be redirected to his appropriate dashboard

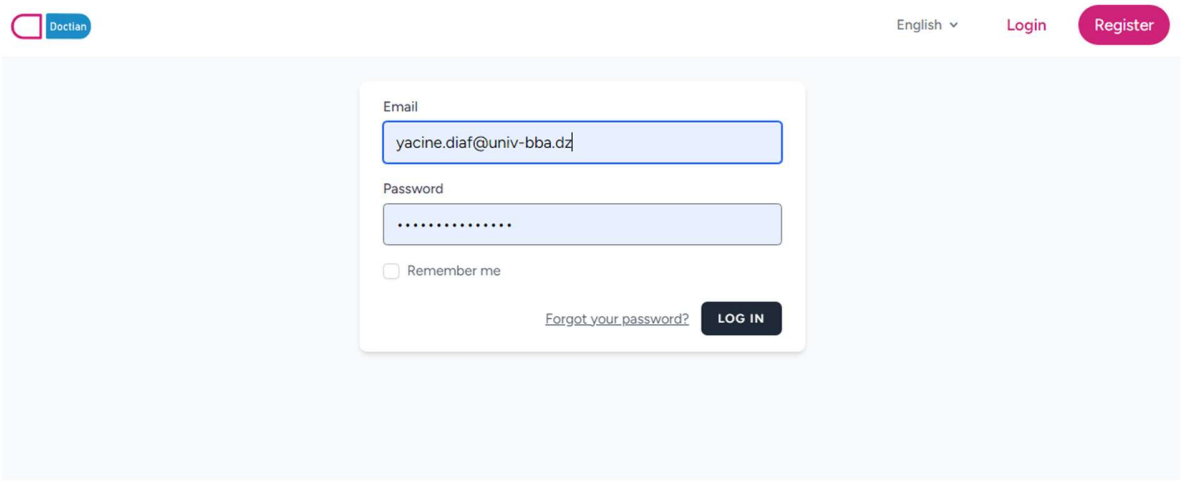


Figure 0-18. Login page.

III.3.2.4 Doctor research result page

Each user visiting the Doctian web application will have the ability to search for a doctor without the need for an account. The visitor can use wilaya and specialty as parameters for his search.

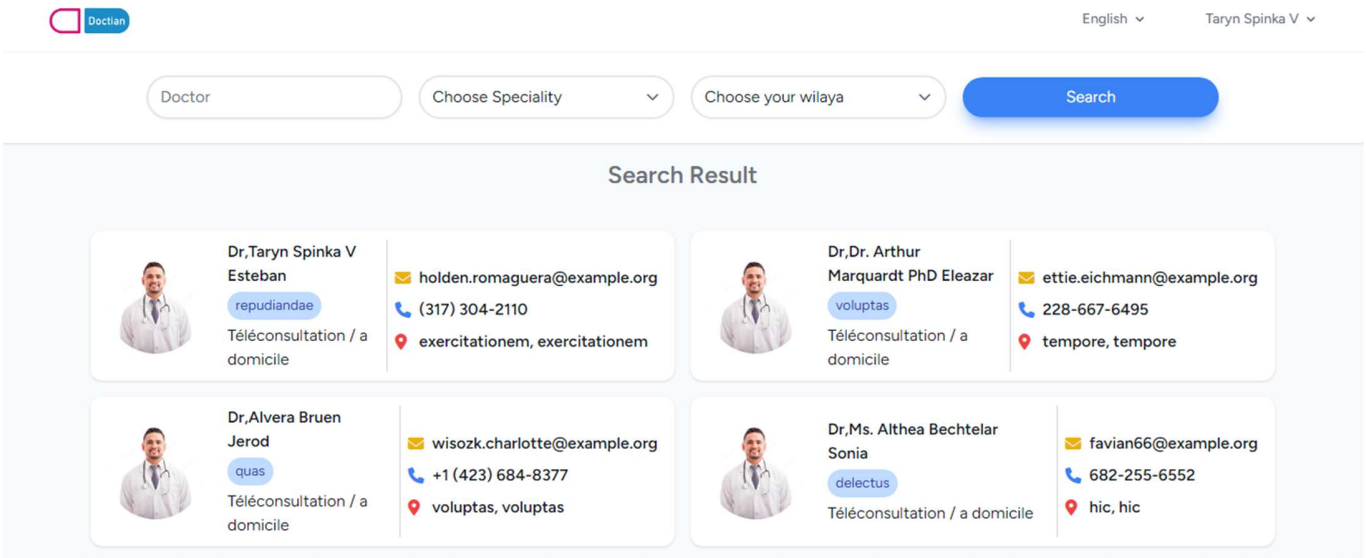


Figure 0-19. Search result page (This is a fake data generated for tests).

III.3.2.5 Doctor's information page

Each doctor has a profile that contains his professional information, with the ability of appointment scheduling when the user is authenticated.

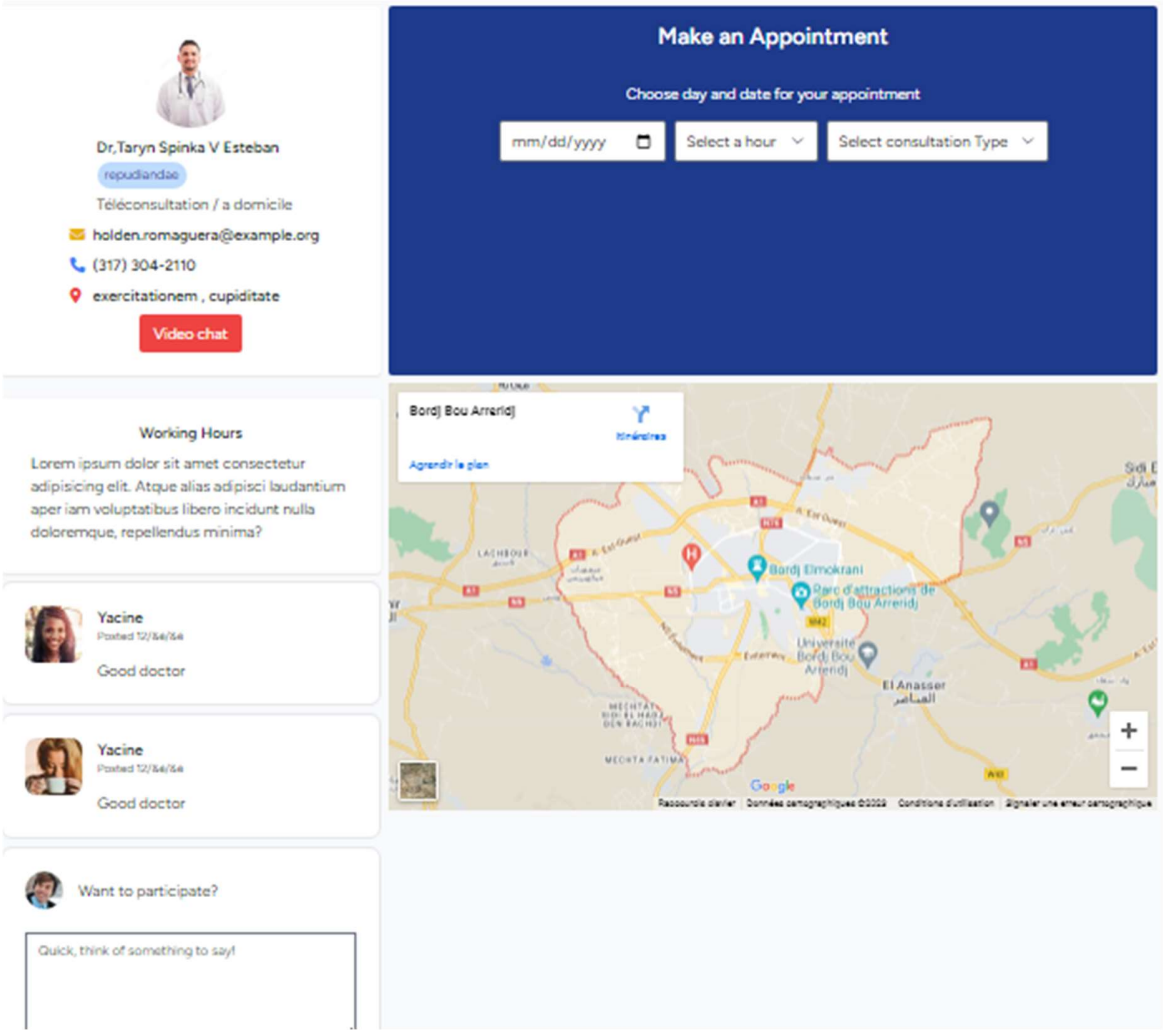


Figure 0-20. Doctor public profile.

III.3.2.6 Doctor's Dashboard

It gives the doctor an overview about appointment requests, coming appointments and Activity history.

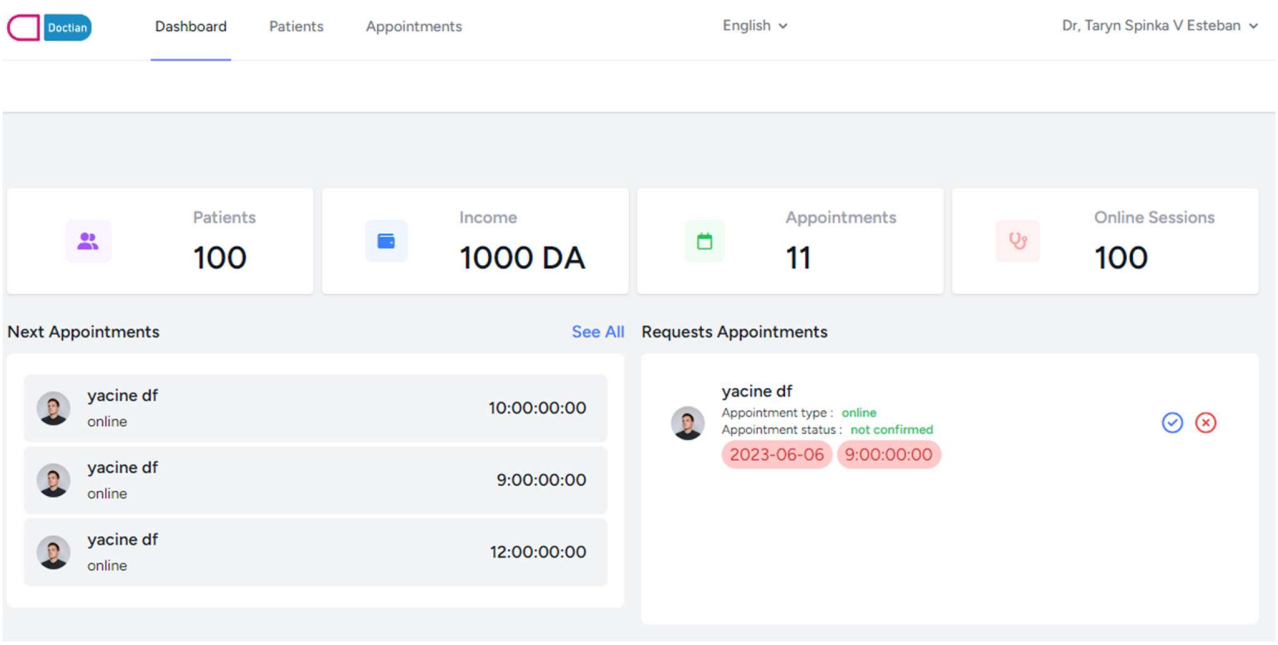


Figure 0-21. Doctor's dashboard.

4.7.2.6 Doctor's patient's page

On this page the doctor has the ability to view a patient's medical record if he has the access granted by the patient and makes a prescription for a specific patient.

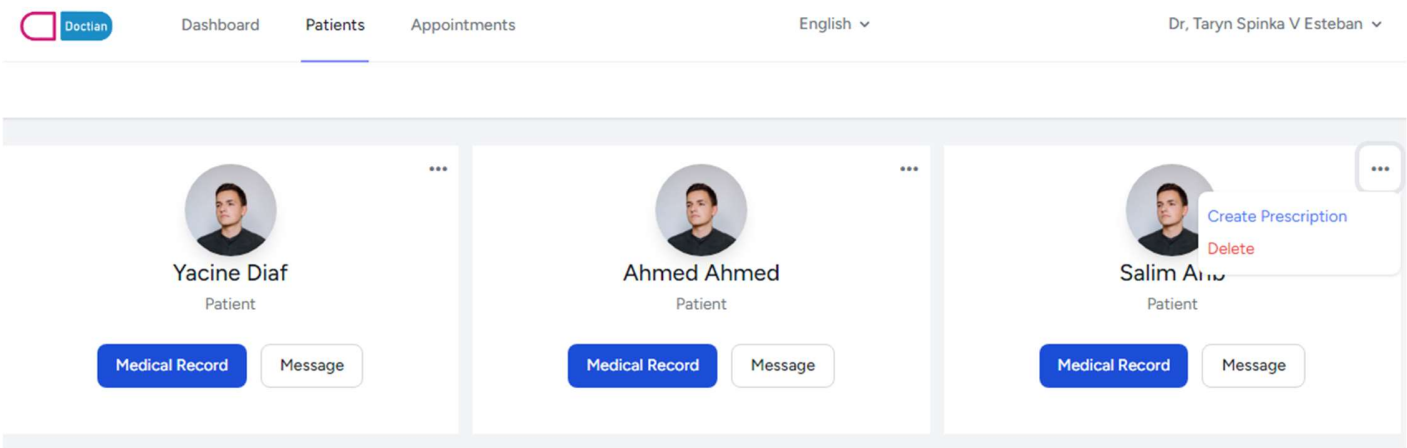


Figure 0-22. Doctor's Patients

III.3.2.7 Prescription page (Doctor space):

The doctor can make a prescription for his patient. Each prescription contains medications, medication type, dosage, frequency and duration.

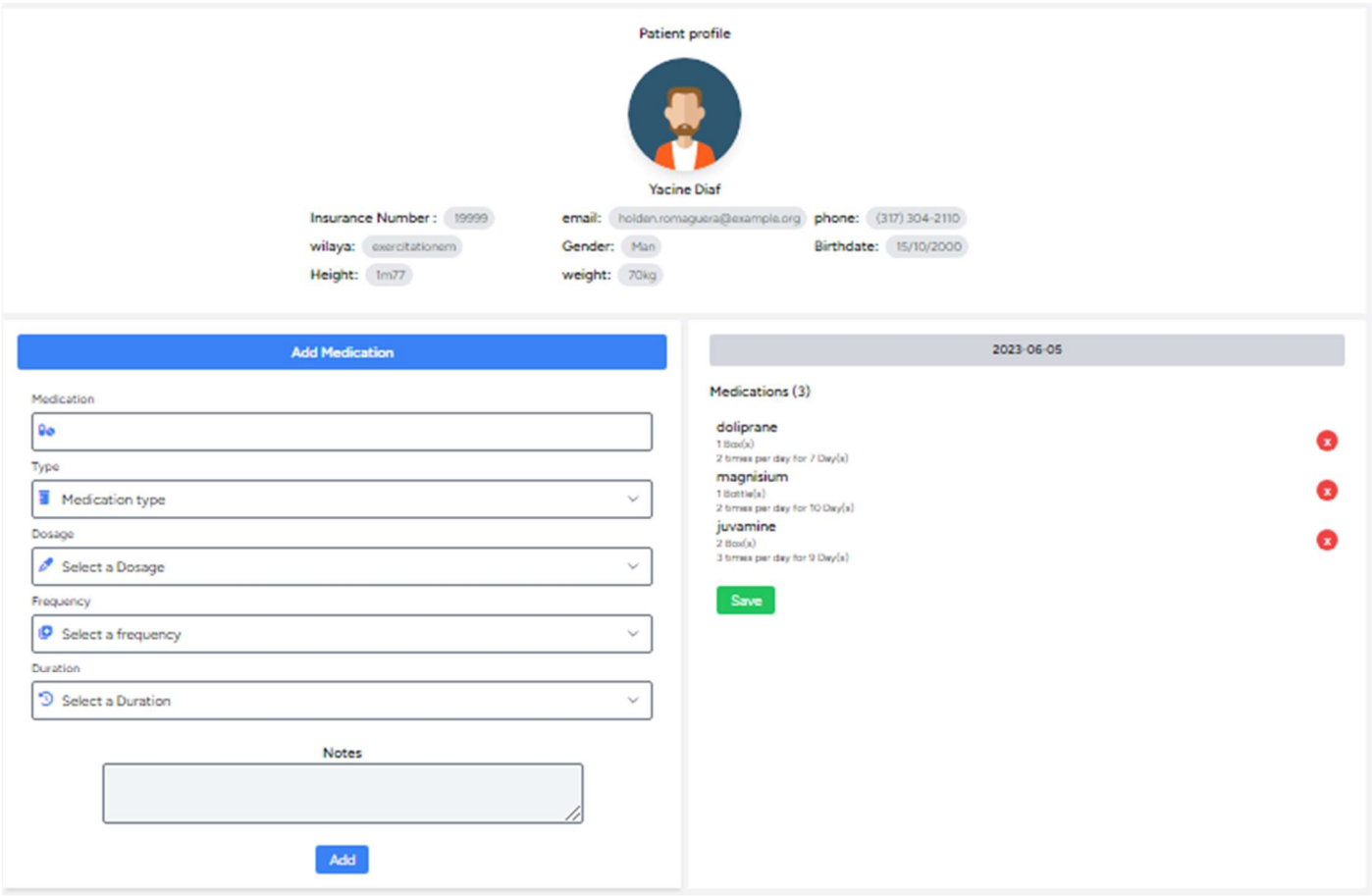
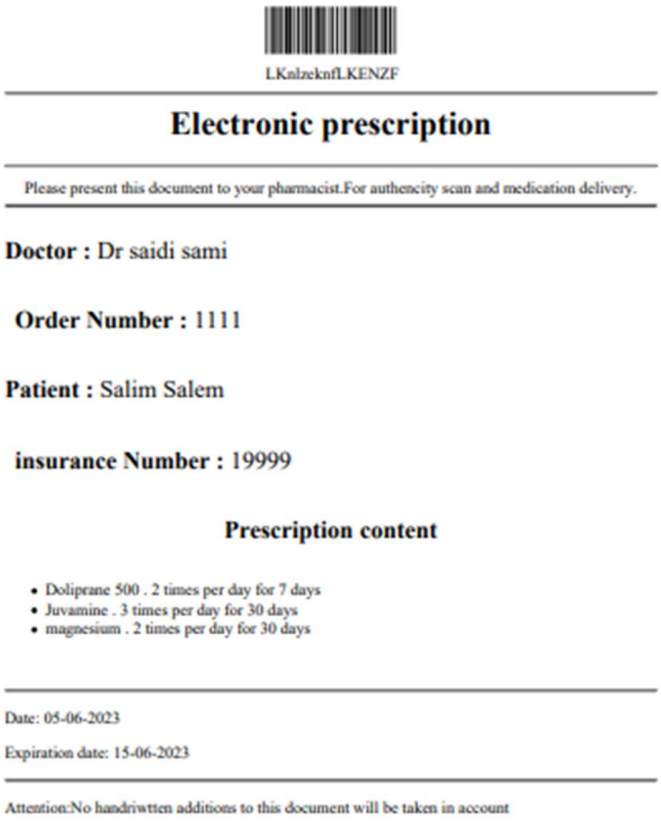


Figure 0-23.Prescription page.

When the doctor finishes the prescription for the patient. Prescription will be saved in the patient's medical record, also the doctor will have a pdf copy.



LKnlzeknfLKENZF

Electronic prescription

Please present this document to your pharmacist.For authencity scan and medication delivery.

Doctor : Dr saidi sami

Order Number : 1111

Patient : Salim Salem

insurance Number : 19999

Prescription content

- Doliprane 500 . 2 times per day for 7 days
- Juvamine . 3 times per day for 30 days
- magnesium . 2 times per day for 30 days

Date: 05-06-2023

Expiration date: 15-06-2023

Attention:No handriwtten additions to this document will be taken in account

Figure 0-24. Electronic prescription (pdf format).

III.3.2.8 Patient's appointments

All the appointments scheduled by the patient will appear in the appointment section. It also informs the patient about the status of the appointment scheduled (confirmed, rejected).

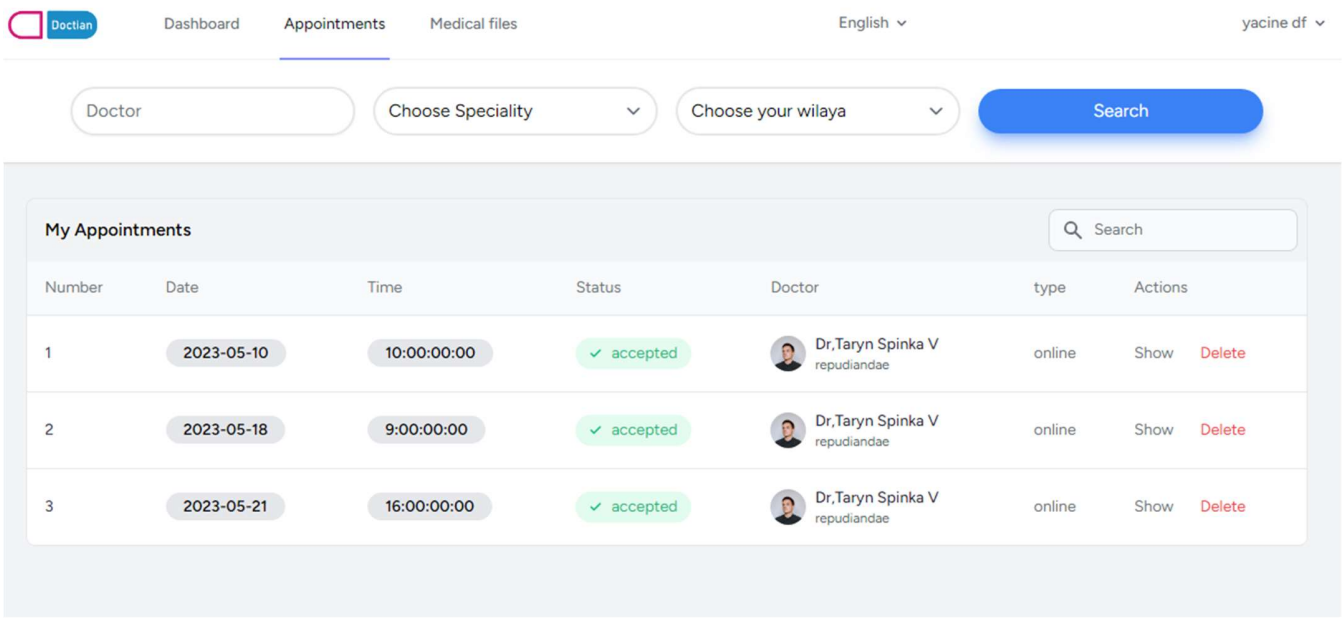


Figure 0-25. All appointments taken by the patient.

When the patient wants to see more details on a specific appointment he can simply click on show and a pop-up that contains all the details will appear.

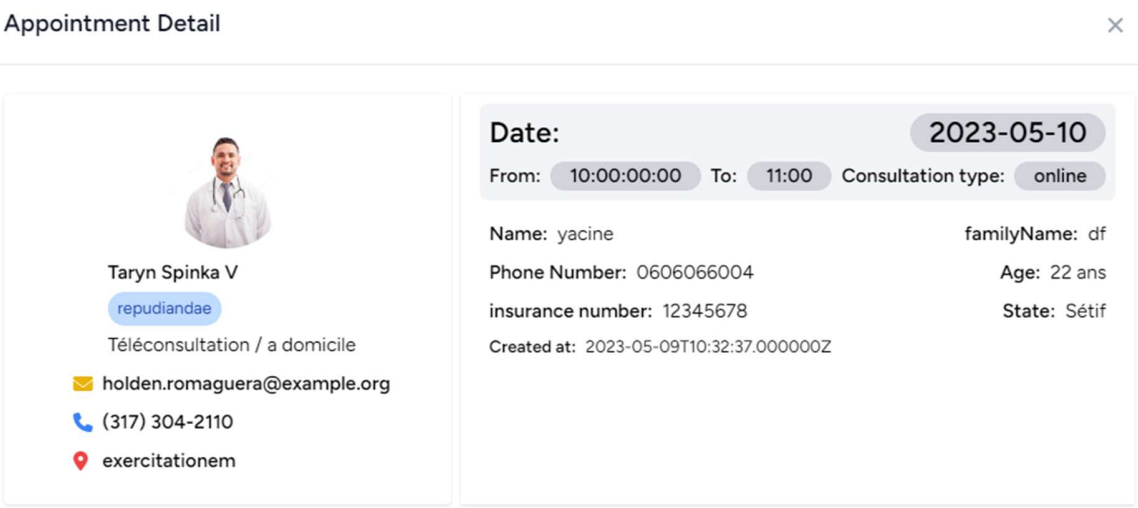


Figure 0-26. Appointment details pop-up.

III.3.2.9 Patient's medical record

Each patient registered on Doctian will have a private medical record saved within a private file in the filesystem. This file is protected from unauthorized users via middlewares and policies.

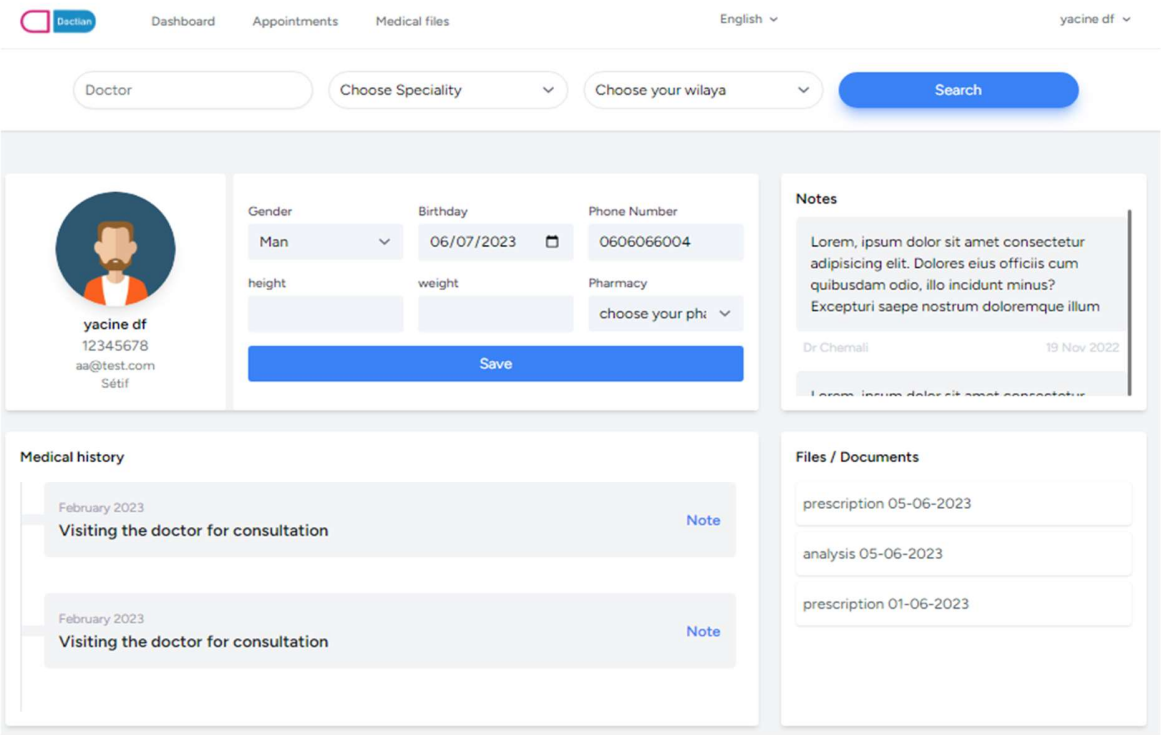


Figure 0-27. Patient medical record.

III.3.2.10 Patient's medical files

All the medical files uploaded will be stored within the medical record so they're secure from unauthorized access from third parties.

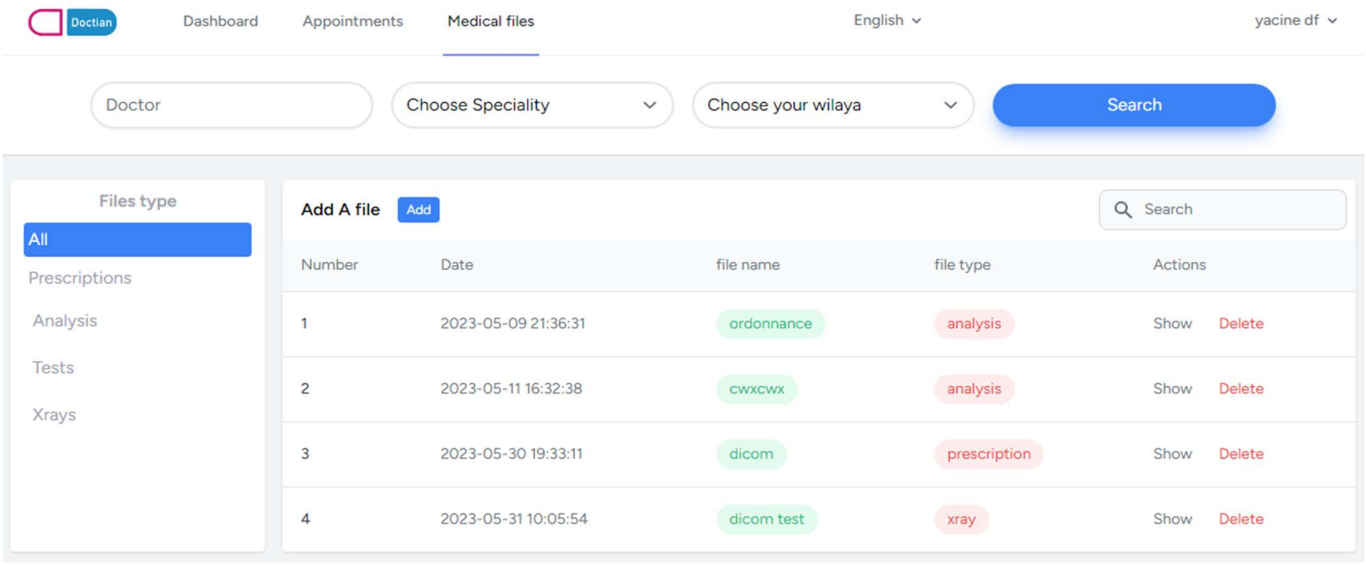


Figure 0-28. Patient medical files.

III.3.2.11 Built-in Android DICOM file viewer

Digital Imaging and Communications in Medicine (DICOM) is the standard for the communication and management of medical imaging information and related data. DICOM is most commonly used for storing and transmitting medical images enabling the integration of medical imaging devices such as scanners, servers, workstations, printers, network hardware, and picture archiving and communication systems (PACS) from multiple manufacturers. It has been widely adopted by hospitals and is making inroads into smaller applications such as dentists' and doctors' offices (26). The structure of its most important components is illustrated below:

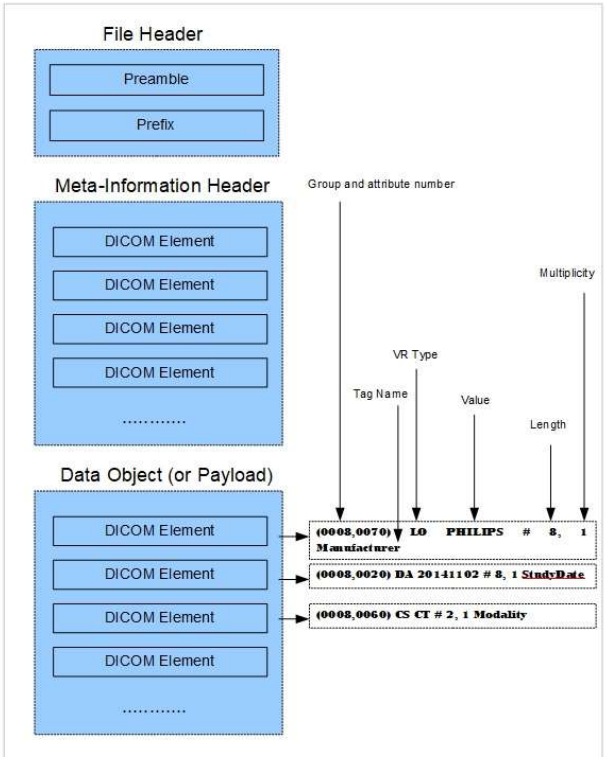


Figure 0-29 DICOM file structure

- **DICOM Preamble:** The DICOM preamble is a fixed-length section at the beginning of a DICOM file. It consists of 128 bytes and serves as a placeholder for specific

information about the file, such as the DICOM file format, the transfer syntax used, and other identification information. The preamble is typically followed by the DICOM header.

- **DICOM Header:** The DICOM header immediately follows the DICOM preamble and contains metadata and information about the DICOM file. It consists of a series of data elements that describe various attributes of the medical image and related information. The DICOM header is organized in a tag-value format, where each data element has a unique tag (a pair of numbers representing the group and element IDs) and a value that represents the attribute's content.
- **Data Element:** A data element in DICOM refers to a specific attribute or piece of information about the medical image or related data. Each data element has a tag, which is a unique identifier consisting of a group number and an element number. The group number represents a particular category of attributes, such as patient information or image acquisition details, while the element number represents a specific attribute within that group. For example, the data element (0010,0010) represents the Patient's Name attribute.
- **Data Object:** In DICOM, a data object refers to a collection of data elements that form a cohesive entity. It represents a specific DICOM object, such as a patient, study, series, or image. For example, a patient data object may consist of data elements like Patient's Name, Patient ID, and Date of Birth. Similarly, an image data object may contain attributes like Image Position, Pixel Data, and Image Orientation.

Medical imaging plays a vital role in diagnosis, treatment, and research. DICOM is the standard format for storing and transmitting medical images.

Doctian’s DICOM file viewer provides healthcare professionals with a portable solution for efficient and convenient medical image analysis. This functionality is enabled in the Doctian Android app so that the doctor could analyze each medical files using his tablet without the need to print them. The built-in Doctian DICOM viewer UI is illustrated in the next three figures.

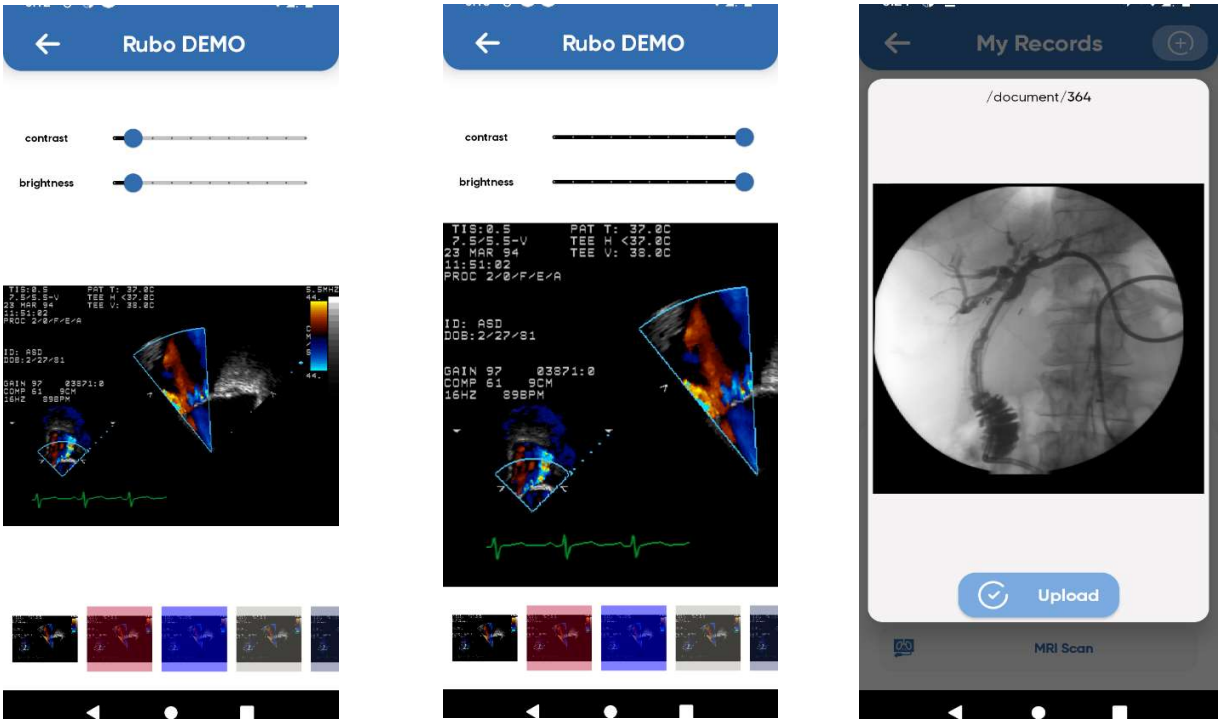


Figure 0-30. The Doctian built-in DICOM file viewer

Among the key features and benefits of an Android DICOM file viewer we mention:

- **Compatibility**: Doctian's DICOM file viewer adheres to the DICOM standard, ensuring compatibility with medical imaging devices and systems. It supports reading and displaying DICOM files, including various image modalities such as X-rays, CT scans, MRIs, and ultrasounds.
- **Image Viewing and Manipulation:** The viewer provides comprehensive tools for image viewing and manipulation. Users are able to zoom in and out, pan through images, adjust brightness and contrast, and apply image filters to enhance visualization. Additionally, support for multi-frame and multi-planar reconstruction allows users to navigate through different image series and slices, which is in the way to come.
- **Measurement and Annotation Tools:** To facilitate accurate analysis, the DICOM file viewer should offer measurement and annotation tools. Users should be able to measure distances, angles, and regions of interest directly on the images. Annotation capabilities, including adding text labels and markers, enable clinicians to document findings and communicate with colleagues.
- **Windowing and Presets:** DICOM images often require different windowing settings to visualize specific structures or pathologies. The viewer should provide windowing controls

and preset configurations, allowing users to adjust the window width and level to optimize image contrast and detail representation. Predefined presets for different imaging modalities enhance usability and efficiency.

- **Integration with PACS and EHR Systems:** Seamless integration with Picture Archiving and Communication Systems (PACS) and Electronic Health Record (EHR) systems is essential for efficient workflow and data management. The DICOM file viewer should support importing and exporting DICOM files to and from PACS, enabling access to a patient's complete imaging history. Integration with EHR systems allows clinicians to associate images with patient records and provide a comprehensive view of a patient's medical data.
- **Secure Data Handling:** Given the sensitive nature of medical imaging data, security measures should be implemented. The DICOM file viewer should employ secure data transmission protocols, such as TLS, when importing or exporting images. User authentication and access control mechanisms should be in place to ensure authorized access and protect patient privacy.
- **DICOM Tag and Metadata Display:** A robust DICOM file viewer should display relevant metadata and DICOM tags associated with the images. This includes patient information, study details, acquisition parameters, and image-specific attributes. Presenting this information aids in accurate interpretation and analysis of medical images.
- **Performance and Speed:** Efficient rendering and fast image loading are critical for a smooth user experience. The viewer should leverage hardware acceleration and optimize image loading algorithms to minimize loading times, especially for large and multi-frame DICOM files. Smooth navigation and real-time interaction with the images enhance productivity.
- **Customization and Integration:** Flexibility and customization options are valuable in an Android DICOM file viewer. Users should be able to configure the viewer's interface, layout, and preferences to match their workflow and preferences. Integration with other medical apps and platforms, such as medical imaging analysis tools or telemedicine apps, can further enhance functionality and productivity.
- In summary Doctian’s DICOM file viewer empowers healthcare professionals with the ability to view, analyze, and interpret medical images conveniently on their Android devices. By providing comprehensive features, DICOM compatibility, secure data handling, and integration capabilities, the viewer streamlines the medical imaging workflow and improves patient care.

General conclusion

The Doctian app discussed in this dissertation represents a significant advancement in the healthcare industry, offering numerous benefits for both patients and healthcare providers. Through the integration of modern technology and medical expertise, this app has the potential to revolutionize the way healthcare services are delivered.

The research conducted throughout this dissertation has demonstrated that telemedicine apps can enhance accessibility to healthcare services, particularly for individuals residing in remote areas or facing mobility challenges. By eliminating geographical barriers, this level of accessibility has the potential to improve healthcare outcomes and enhance patient satisfaction.

Moreover, Doctian shows great promise in facilitating early detection and prevention of diseases. With the ability to remotely monitor patients' vital signs, symptoms, and overall health conditions, healthcare providers can intervene promptly and proactively, leading to more effective disease management and prevention. This has the potential to reduce the burden on healthcare systems, minimize hospitalizations, and ultimately improve patient well-being.

The app's features, such as secure messaging, video consultations, and electronic health record integration, provide a seamless and efficient means of communication between patients and healthcare professionals. This streamlined approach not only saves time for both parties, but also ensures accurate and comprehensive documentation of medical history and treatment plans. Additionally, the app's user-friendly interface and intuitive design make it accessible to individuals of varying technological literacy, thus promoting widespread adoption.

While this dissertation has highlighted the numerous benefits of telemedicine, it is important to acknowledge that there are still challenges to overcome. Concerns regarding data privacy and security, as well as issues related to reimbursement and insurance coverage, need to be addressed to ensure the long-term viability and sustainability of telemedicine practices. Further research and collaboration among stakeholders are essential to developing policies and guidelines that safeguard patient information while promoting the widespread implementation of telemedicine.

In summary, the Doctian telemedicine system discussed in this dissertation represents a significant step forward in healthcare delivery. Its ability to enhance accessibility, enable early detection and prevention, and streamline communication between patients and healthcare providers has the potential to improve healthcare outcomes and transform the way healthcare services are delivered. As the field of telemedicine continues to evolve, it is imperative for researchers, policymakers, and healthcare professionals to collaborate and address the challenges to ensure that telemedicine remains a vital component of modern healthcare systems.

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Annexes

الجمهورية الجزائرية الديمقراطية الشعبية

وزارة التعليم العالي و البحث العلمي

جامعة برج بوعريريج.

الاسم التجاري

Doctian

صورة العلامة التجارية

Doctian

:عنوان المشروع

منصة ذكية لمقدمي الخدمات الصحية

مشروع لنيل شهادة مؤسسة ناشئة في إطار القرار الوزاري 1275

بطاقة معلومات:

حول فريق الإشراف وفريق العمل

1- فريق الإشراف:

فريق الإشراف	
(01): المشرف الرئيسي بلحاج فوضيل	:التخصص اعلام الي
(01): المشرف الرئيسي	:التخصص .....
:المشرف المساعد	:التخصص .....

2- فريق العمل:

فريق المشروع	التخصص	الكلية
الطالب: ضياف ياسين	تكنولوجيا الإعلام و الاتصال	اعلام الي
الطالب: قاسة ايمن	تكنولوجيا الإعلام و الاتصال	اعلام الي

1. فكرة المشروع:

هي عبارة عن منصة تقدم خدمة للمرضى. بدأت هذه الفكرة في جائحة كورونا التي كانت المولد الاول لهذه الفكرة بالاضافة الى المشاكل التي يعاني منها المرضى في قاعات الانتظار وكذا التنقل حيث تضمن المنصة اتصالًا مرئيا عالي الجودة في الوقت الآني بين الطرفين الأطباء ومرضاهم، جنبًا إلى جنب مع الإمدادات الطبية المعدلة بدوام كامل أثناء تواجد كلاهما في مكان إقامته

2. القيم المقترحة:

- الحداثة: حجز مختلف أنواع المواعيد سواء (عن بعد او حضوريا) وكل هذا يكون من خلال المنصة, بالاضافة الى الاتصال المرئي عالي الجودة بين الطبيب و المريض وكذا ملف طبي رقمي لكل مريض
- الأداء:تتوفر واجهة المنصة على واجهة سهلة الاستخدام و مفهومة
- التكييف: تدعم الواجهة كل من اللغة العربية الفرنسية والانجليزية بالاضافة الى توفرها لتطبيق اندرويد وموقع ويب
- إنجاز المهمة: مساعدة الطبيب على التعريف بنفسه ومكان عمله من خلال المنصة للحصول على أكبر عدد من الزبائن, أما بالنسبة للمريض حجز مواعيد سواء عن بعد للتواصل مع الطبيب من خلال تقنية التواصل المرئي او حجز موعد حضوريا وكل هذا من البيت فقط.
- خفض التكاليف: مساعدة المريض على التخلص من مصاريف التنقل خاصة المقيمين منهم في المناطق النائية وكذا اشهار مجاني للأطباء على المنصة من خلال عرض المعلومات المهنية وأماكن العمل.
- الحد من المخاطر: تقليص احتمال تعرض العملاء للمخاطر لدى شرائهم المنتجات أو الخدمات بتقديم ضمانات.
- سهولة الوصول:المراقبة و المرافقة الطبية الآنية للمرضى دون الحاجة للتنقل للعيادة الا للضرورة القصوى.

3. عرض القطاع السوقي:

في الجزائر هناك :

- 27.28 مليون مستعمل انترنت في جانفي 2022.
- 10,7 مليون مواطن حامل للبطاقة الذهبية قيد الاستعمال .
- 40% من مستعملي الانترنت هم حاملين للبطاقة الذهبية.
- من خلال الاحصائيات المقدمة من طرف الحكومة الأنشطة التي شهدت النمو الأكثر اتساقا في عام 2022 من حيث الدفع عبر الإنترنت هي:

- تلك الخاصة بالتأمين مع تطور بنسبة 181.54٪ على أساس سنوي بإجمالي 23571 معاملة مقابل 8372 معاملة فقط في عام 2021،
- يليه قطاع النقل بنمو قدره 170.89٪ خلال نفس الفترة، بإجمالي 195490 مدفوعات عبر الإنترنت العام الماضي مقابل 72164 في العام السابق. ومن هذه الاحصائيات نلاحظ ان عملية الدفع الالكتروني في تزايد مستمر.

- السوق المحتمل: السوق المحتمل يتمثل في مجموعة الأفراد المرضى نذكر منهم خاصة : المهنيين النشطين,كبار السن,ذوي الأمراض المزمنة والنساء الحوامل وكذا الأطفال المصابين بالتوحد.
- السوق المستهدف (الشريحة):يتمثل السوق المستهدف في كل من الأطباء والصيادلة لتقديم الخدمات و المرافقة الطبية لهذه الفئة الحساسة من المجتمع حيث ستكون هته الأخيرة في تواصل دائم مع المرضى من خلال المنصة لرفع مستوى العناية الطبية وتحقيق نتائج أفضل.

✓ مبررات اختيار السوق المستهدف :

الفئات المستهدفة من العملاء المبينة في عنوان السوق المحتمل يلمح لحصة مثمرة من سوق الخدمات الصحية الرقمية الذي يعد أرضا خصبة من حيث تزايد استعمال الدفع الالكتروني في الجزائر والهاتف الذكي عموما بعدد من الاشتراكات الخلوية بلغ 47,02 مليون مشترك في 2021 (1).

و هذا ما يعدنا بإيرادات لا بأس بها في بداية مشروع قابلة حتميا لتزايد أسي اعتمادا على خططنا التسويقية التي ستقنع كلا من الطبيب و الصيدلي للاشتراك معنا و توفير مصادر دخل مغرية نظرا للتسهيلات الكبيرة في العمل التي يقدمها تطبيقنا و سرعة تقديم الخدمة لزبائننا.

4. التكاليف والأعباء :

✓ عناصر التكلفة في المشروع هي تكاليف تطوير النظام

- التكاليف الثابتة:
  - من ناحية المعدات:
    - خوادم الويب
    - معدات حفظ البيانات
  - من ناحية البرامج:
    - تكاليف التطوير (بيئات التطوير، النشر على بلاي ستور، استضافة الموقع ونشره على الانترنت)
    - تكاليف واجهات برمجة التطبيقات الموظفة في النظام

- التكاليف المتغيرة:
- من ناحية المعدات والموارد البشرية:
  - رواتب المطورين، المهندسين والمصممين
  - معدات معالجة البيانات وحمايتها

- من ناحية التشهير بالتطبيق :
  - تكاليف الإشهارات و الإعلانات على أرض الواقع , على الويب و على التلفاز
  - تكاليف تجسيد أحداث خاصة للتوعية و التشهير بالتطبيق

5. فريق العمل:

✓ فريق العمل حاليا يتكون من مطورَيْن شاملين محترفين (قاسة أيمن , ضياف ياسين) يختصان في تطوير مواقع ويب , تسيير قواعد البيانات , تطوير تطبيقات الهواتف و تصميم واجهات و تجربة المستخدم بكفاءات متكاملة مع بعضها البعض وخبرة ملحوظة من خلال جودة النموذج الأولي للنظام حيث أن ياسين اهتم بجانب الويب لكونه متمكن في المجال بخبرة أكثر من 3 سنوات عمل أما أيمن فتكفل بجانب التطبيق لخبرته في لغات البرمجة و أنظمة التشغيل الخاصة بالمجال ناتجة عن خبرة أكثر من 3 سنوات عمل , نقوم بالتفاعل والتواصل عن طريق منصات العمل الجماعي عن بعد ووسائل التواصل بشتى أنواعها كالبريد الالكتروني.

6. أهداف المشروع:

يهدف المشروع إلى:

- تسهيل التواصل الدائم بين الطبيب ومريضه
- ربح الوقت و المال
- فك العزلة عن سكان المناطق النائية
- رقمنة الملفات الطبية للمرضى

7. رقم الأعمال:

نموذج العمل التجاري

شرائح العملاء	العلاقات مع العملاء	القيمة المضافة	الأنشطة الرئيسية	الشراكات الرئيسية
1. جميع المرضى (الأشخاص البالغين, الغير قادرين على التنقل والانتظار , النساء الحوامل, الأطفال المصابين بالتوحد, ذوي الأمراض المزمنة, المهنيين النشطين)	1. الرسائل عبر وسائل التواصل الاجتماعي 2. الهاتف 3. منصة دوكشان 4. المعارض و الفعاليات 5. customer relationship management **القنوات** 1. وسائل التواصل الاجتماعي 2. اللوحات الإعلانية	1. استشارات طبية عن بعد عالية الجودة باستعمال تقنية التواصل المرئي. 2. توزيع الأدوية للمرضى الى منازلهم 3. تقديم النصائح 4. حجز مختلف أنواع المواعيد من المنزل فقط. 5. تقليص المال و الوقت المستغرق في التنقل.	1. تطوير و صيانة منصة دوكشان 2. تسويق المنصة **الموارد الرئيسية** الأطباء,منصة الكترونية,الصيادلة,المقر الرئيسي	1. وزارة الصحة 2. الصيادلة 3. الأطباء 4. Chargily pay

الإيرادات	هيكل التكاليف
1. عمولة مع الاطباء عن كل استشارة طبية 2. عمولة مع الصيادلة عن كل وصفة 3. عمولة 4. الاشتراكات في الميزات الخاصة	تكلفة تطوير المنصة, تكلفة الاعلانات و الترويج راتب الطبيب