DISTRIBUTED HEALTH CARE FRAMEWORK FOR PATIENT HEALTH RECORD MANAGEMENT AND PHARMACEUTICAL DIAGNOSIS

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Specializing in Software Engineering

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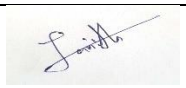
Declaration

We declare that this is our work, and this proposal does not incorporate without acknowledgment any material previously submitted for a degree or diploma in any other university or institute of higher learning, and to the best of our knowledge and belief, it does not contain any material previously published or written by another person except where the acknowledgment is made in the text.

Name	Student ID	Signature
Chathuranga S.J	IT19043388	

The above candidates are researching the undergraduate Dissertation under my supervision.

Name of supervisor: Mr. Jeewaka Perera

Name of co-supervisor: Ms. Laneesha Ruggahakotuwa

…….. Date :……

Signature of the supervisor:

(Mr. Jeewaka Perera)

…….. Date :……

Signature of the supervisor:

(Ms. Laneesha Ruggahakotuwa)

Abstract

People have become very busy with their current day-to-day activities. They tend to focus more on their work rather than their personal lives. Some people have to work overtime in order to complete the work assigned to them. As a result, they often forget to get their medication on time and often have no one to remind them of it. On the other hand, taking medication on time is very important for maintaining good health, and also taking medication on time improves the effective rate of the medication being taken. These days, almost every person in the world has a smartphone. They may use it for their day-to-day activities, education, or entertainment. People always keep their smartphones with them at all times and with technology unlocking things every day, these two factors can be combined in order to create a health care assistant that is compatible with the smartphone to help people in taking their medication effectively. A smart chatbot will be developed using Machine Learning and Natural Language Processing for healthcare assistance. The proposed chatbot will be able to identify the message and respond appropriately to the patient, identify the patient's prescription, and provide a schedule that would help the patient in taking his/her medication accordingly. If the patient needs real-time notifications, the chatbot will provide them according to the medication schedule that the user provides. The users will be able to chat with the proposed chatbot and get details about medications. In addition, users can know information about prescriptions, and also it allows users to interact with the system using natural language queries, and to enter questions through a friendly user interface. The proposed system will be created, providing users with a good user experience while requiring only basic knowledge in order to utilize the features of the proposed system, thus making it easier for users with less smartphone experience to learn the features of the proposed system.

Keywords: Natural Language Processing, Machine Learning, Healthcare

Acknowledgement

I would like to express our sincere gratitude to our supervisor Mr. Jeewaka Perera for the constant guidance and support which always helped us for the successful completion of our research. Besides our supervisor, our sincere thanks also go to Ms. Laneesha Ruggahakotuwa, the co-supervisor of this research project for being willing to help whenever it was needed and guided us.

I owe my parents heartfelt thanks for their love, care, and sacrifices in teaching and preparing me for the future.

Finally, I want to express my gratitude to everyone who has helped me complete the research work directly and indirectly.

Dedication

The author essentially wishes to dedicate this information to the scientific community kind of is constantly working to find answers to improve health care outcomes.

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Abbreviations	Description
NLP	Natural Language Processing
ML	Machine Learning
AI	Artificial Intelligent
EER	Electronic Health Reporting
LSTM	Long Short-Term Memory
RNN	Recurrent Neural Network

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1. Introduction

1.1 Background Study

With the COVID-19 pandemic affecting every corner of the world, people all around the world are facing various health problems, and the need to automate healthcare services is now more crucial than ever with the hope of reducing interactions between people thus reducing the spread of COVID-19. The limitations of digital health care systems were exposed that would have been viable to handle public health emergencies while maintaining social distance and continuing services while at home during this pandemic. Currently, the records of the total population of Sri Lanka are not fully recorded in a healthcare facility. As a result, there is a communication gap due to inadequate care coordination. EHR (Electronic Health Reporting) systems are becoming increasingly popular which enables hospitals to share the medical-related information of patients across other hospitals easily, but it can be a challenge when it is required to access data that is scattered across different systems. Many of these medical records and documents are in print and manual entry into EHR systems can be time-consuming and erroneous. Pharmacological error is not only a critical health problem but can even be risky to see a doctor for a pharmacological diagnosis in an epidemic. The purpose of this research is to introduce a solution to the health problems that may arise during an epidemic while providing a distributed health care framework and virtual assistants to keep medical records safe. As the world needs virtual healthcare assistants at this time, this research is conducted to create a solution utilizing ML (Machine learning) and NLP (Natural Language Processing) which enables the solution in understanding the medication-related questions that the user asks and providing answers to them appropriately. The solution will be able to maintain the medication schedules of the user and provide real-time notifications at times when the users are required to take their medications.in addition to that user can know about their prescription information within the health care assistant.

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1.2 Literature Survey

Numerous virtual healthcare assistants in the world are being used for an assortment of purposes, this examination is being led to make an answer utilizing ML (Machine Learning), NLP (Natural Language Processing), and AI (Artificial Intelligent) man-made brainpower. Healthcare Assistants should be developed in a way that they are able to interpret the messages that are provided by the users and respond to them accordingly. The arrangement will want to keep up with the client's drug plan and furnish clients with constant warnings when they need to take their medicine.

Borah, B., Pathak, D., Sarmah, P., Som, B., and Nandi, [1] proposed this reference Text-based Chatbot in Perspective of Recent Technologies. In the present world, Chatbots are gaining a lot of attention, particularly in the industries and in the wellbeing areas as they can automate administration tasks and provide services beyond the limitations of humans. Development of Artificial Intelligence (AI) advancements, and a combination of Natural Language Processing (NLP) fuel the development of chatbots. Currently, different models of chatbots built with the most recent technologies are available in the market performing functions relevant to marketing, customer support, and functions that can be more effective when performed via a chatbot. By using the three-layer architecture, we have given insights on how the Natural Language Processing, Natural Language Understanding (NLU), and Decision-Making engine combined with a Knowledge Base can be used to achieve AI using Recurrent Neural Network (RNN) and Long Short-Term Memory (LSTM). Furthermore, we also discuss the different chatbot platforms and the development frameworks that have been used to develop chatbots in recent times.

Kandpal, P., Jasnani, K., Raut, R. and Bhorge [2] proposed Contextual Chatbot for Healthcare Purposes. The proposed chatbot utilizes ML(Machine Learning) and AI (Artificial Intelligence) strategies to store and deal with the preparation models which help the chatbot to give a superior and proper reaction when the client provides inquiries to the bot. Medical care assumes a wide part in our day-to-day routines,

Chatbots can assume a significant part in reshaping the medical care industry by giving precise analysis according to symptoms being provided or some other functions like booking an appointment.

Kidwai, B. and Nadesh, R.K [3] discussed how Innovation has changed how patients speak with specialists as well as how medical care is directed. Artificial Intelligence along with Neural Networks can be used to create Chatbots that have the ability to change how patients and specialists see medical services. In order to make the current medical service more effective and more efficient, a chatbot can be planned and created involving the latest algorithm that has proven to create highly intelligent Artificially Intelligent programs, along with good decision-making algorithms that can assist the client with providing an accurate description about their condition according to the symptoms provided. The AI will be provided accurate information regarding the symptoms along with the medication that can be provided to treat certain illnesses.

Palanica, A., Flaschner, P., Thommandram, A., Li, M. and Fossat, Y., 2019. Physicians'[4] According to this survey research Various definitely positive and negative perspectives on the use of healthcare catboats mostly have been reported, including the importance of patients managing they're for all intents and purposes own health and the benefits of physical, psychological and behavioral health outcomes. There was a more consistent agreement on the administrative benefits associated with chatbot; Many physicians believed that catboats would be more useful for scheduling medical appointments (78%, 78/100), locating health clinics (76%, 76/100) or providing medication information (71%, 71/100). On the other hand, many physicians believed that chatbots could not effectively meet all the needs of patients (76%, 76/100), could not display human emotions (72%, 72/100) and unknowingly provided detailed diagnostics and treatment. That cannot be given. All personal factors related to the patient (71%, 71/100). Many physicians claim that healthcare chatbots are often self-diagnosed (714%, 74/100) and that patients are at risk if the diagnosis is not properly understood (74%, 74/100).

1.3 Research Gap

In below figure is summary of the accessible research papers and sources,

Reference ID	Identify User Input	Response according to patients' prescription	Give notifications for patient medication
Research [1]	✓	✗	✗
Research [2]	✓	✗	✗
Research [3]	✓	✗	✗
Research [4]	✓	✗	✗
Research [5]	✓	✗	✗
Research [6]	✓	✗	✗
Our Solution	✓	✓	✓

Table 7.3.1: Summary of the related research papers and sources

Most of the research that particularly has been done basically is designed for different types of health care assistants in a kind of big way. Therefore, many healthcare virtual assistants use channels to really make necessary appointments for patients" relevant physicians and to kind of diagnose their ailments in a subtle way. On the other hand, their purpose is based on the same strategy in a subtle way. In our solution, we come up with an interactive healthcare chatbot, which specifically is quite significant. this chatbot really is smart enough to generally find the user's latest prescription and kind of respond appropriately to users, so users can definitely find out their medication information in the chatbot, also the chatbot can specifically give medication notifications to users at the relevant medication time, and the chatbot really has very user-friendly features so anyone should literally have the opportunity to easily really manipulate the chatbot in a pretty major way. Therefore, the chat interface should for the most part be user-friendly, which definitely is fairly significant.

1.4 Research Problem

People have advanced over the years. New things, types of food, and technology were discovered. People have advanced at a rate that is much higher than the rate of advancement of people in the previous generation. People have become lazy as almost everything can be automated, and most things can be done with the press of a button. People don't have to walk for miles to buy groceries or walk for a long period to reach the required destination as vehicles were scarce in the earlier days. People don’t have to go to the well to fetch water. These days, everything is at the reach of our fingertips and even the type of food being consumed daily is fast food which lacks proper nutrients that are essential for the body, and with the daily activities being lesser than lesser, people tend to get sick as they are not receiving proper exercise that is crucial to keep the body at an optimal state. People will have to take medication after being sick to get better, but with the current day-to-day routines of the people, people tend to forget to take their medication on time as they get busy with their work or due to other circumstances. Postponing medication can lead to people getting sicker and even becoming fatal as the proper medication is not being received. Also, with the world getting hit by the COVID-19 pandemic, taking medication precisely has become more crucial as research has shown that the mortality rate of people with underlying diseases and COVID-19 is higher than the mortality rate of people with no underlying diseases and COVID-19. So, people should take their medication on time during these times to be healthy and to maintain a good immune system against COVID-19.

A survey was conducted in order to gather information from people, requesting them to state whether they take their medication on a regular basis, provide the reasons if they are not able to take their medication on time, their age group and gender.

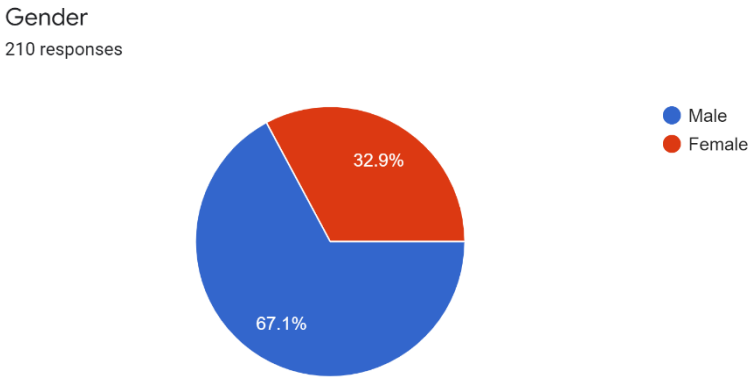


Figure 5.4.1: Summary of the responses of gender

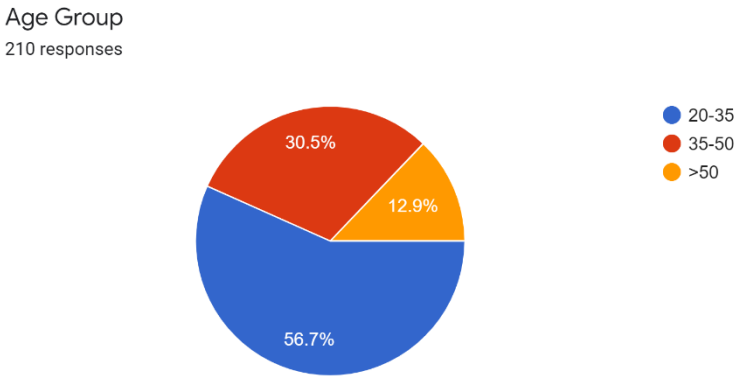


Figure 6.4.2: Summary of the responses of Age Group

According to the graph above, 56.7% of the participants that participated in this survey are between the ages of 20-35, while 30.5% of the participants are between the ages of 35-50.

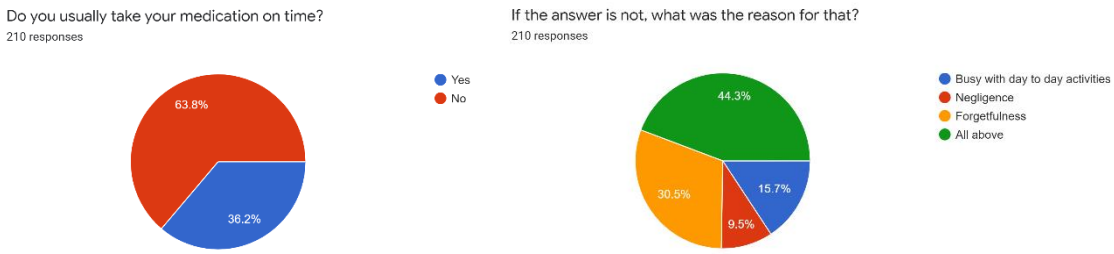


Figure 7.4.3: Summary of the responses usually patients get their medication on time

According to the graphs provided above, most of the participants have stated that they do not usually take their medication on time and the reasons provided by the majority of the participants for not being able to take their medication on time are due to them being busy with their day-to-day activities, forgetting the schedule for their medication and neglecting to take their medication on time.

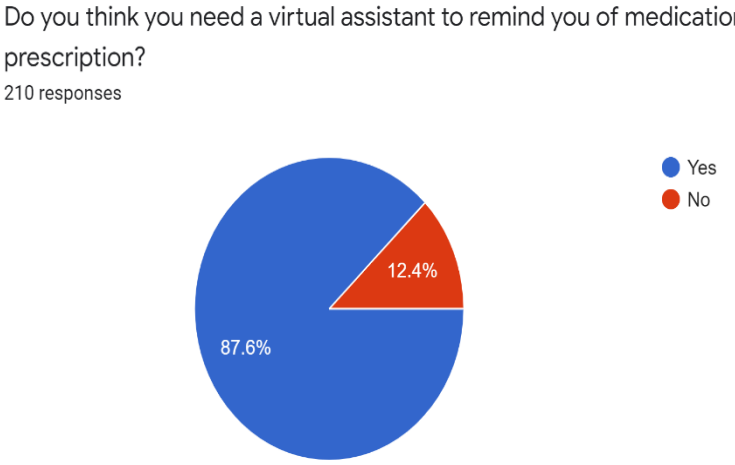


Figure 8.4.4: Summary of the responses virtual assistant should remind medication time and to know patient prescription

As a last question, the participants were requested to provide their opinion on needing a virtual assistant to remind them of their medication schedules and to know details about their prescriptions. 87.6% of the participants stated that they need a virtual assistant who would have the capability to remind them to take their medication on time as well as to gather information about the prescription that was provided to them by their physician etc.

According to the surveys conducted, we can conclude that the majority of the participants are male and are between the ages of 20-35 which can be considered as a time period where the people in those age groups have to balance out between their professional work, their educational work, and their personal lives. The results of the survey state that 44.3% of the participants provided the reasons for not being able to take their medications on time are forgetfulness, negligence, and being busy with their day-to-day activities. When people tend to be stuck with their work, they proceed to neglect their personal needs and wants in order to complete their work on time, which in turn can lead to people forgetting about their necessities.

1.5 Research Objectives

1.5.1 Main Objective

These days everything is at your fingertips. People try to do their job easily with everyday activities. Within the framework of health care, people should have the opportunity to intelligently do what they want.

The main objective of the proposed solution is to create an attractive smart healthcare chatbot based on machine learning and natural language processing to help patients know their information in relevant situations. In this case, the proposed chatbot is intelligent enough to give an appropriate response according to the patient's prescription.

1.5.2 Specific Objectives

The following are specific goals that must be met in order to achieve the main goal. This section goes through the specific goals of the Healthcare Chatbot component in more detail.

- ✓ Identify the user input and give an appropriate response for patient

  Here use Natural Language Processing and machine learning to identify the text and give appropriate responses to the patient. In addition to that needs to train chatbot to increase accuracy.

- ✓ Get relevant data from blockchain

  Use blockchain to get patient prescription information because it’s important to build discussion with patient

- ✓ Manage medication Time System

  Medication timetable management system is used to give notification for patients to know about their medication times.

- ✓ User friendly interface

  There should be an opportunity for any user to handle chatbot easily. therefore, chat interface should be user-friendly

2. Methodology

2.1 Project Overview

The proposed system is designed to address the challenges facing the healthcare domain during the COVID19 epidemic, as well as to provide healthcare solutions that really ensure mostly continued service while people mostly are at home and maintaining very social distance, which generally is quite significant. The proposed distributed health care framework includes the ability to specifically manage protected patient health records and essentially diagnose medications, which generally is quite significant.

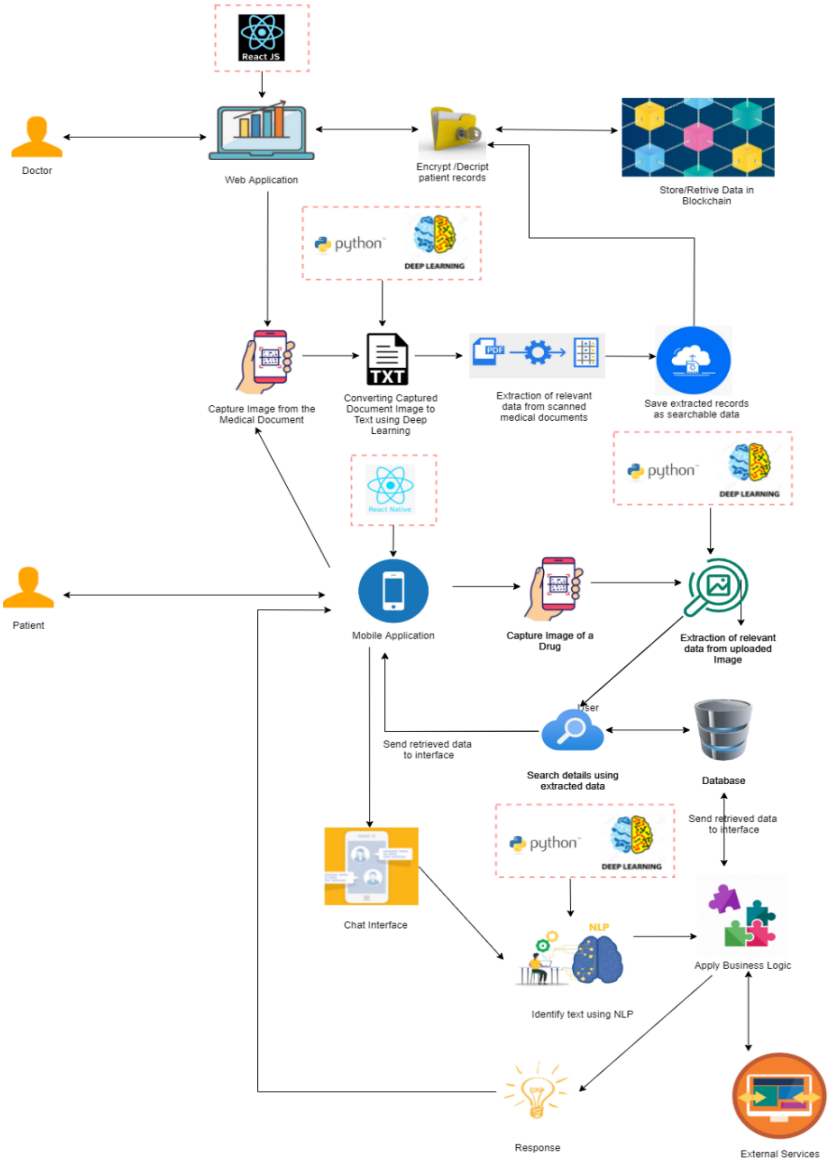


Figure 2.1.1: Project Overview Diagram

According to Figure 2.1.1, there are four main components of the healthcare application developed in this research. The system includes a blockchain component, a medical document scanner, a virtual doctor chatbot and drug identification as four key components. The blockchain component will provide capabilities for secure access and data sharing while securely storing patient data. Medical Document Scanner scans clinical laboratory test reports and extracts important named entities from scanned documents. Patient queries will be answered by the doctor chatbot and reminders will be given to take the medicine based on the specifics of the prescription. Drug identification will identify the drugs using the pictures on the tablets and provide the necessary information.

2.2 System Overview Diagram

Figure 3.2.1 depicts the System Overview Diagram of the Health care chatbot component.

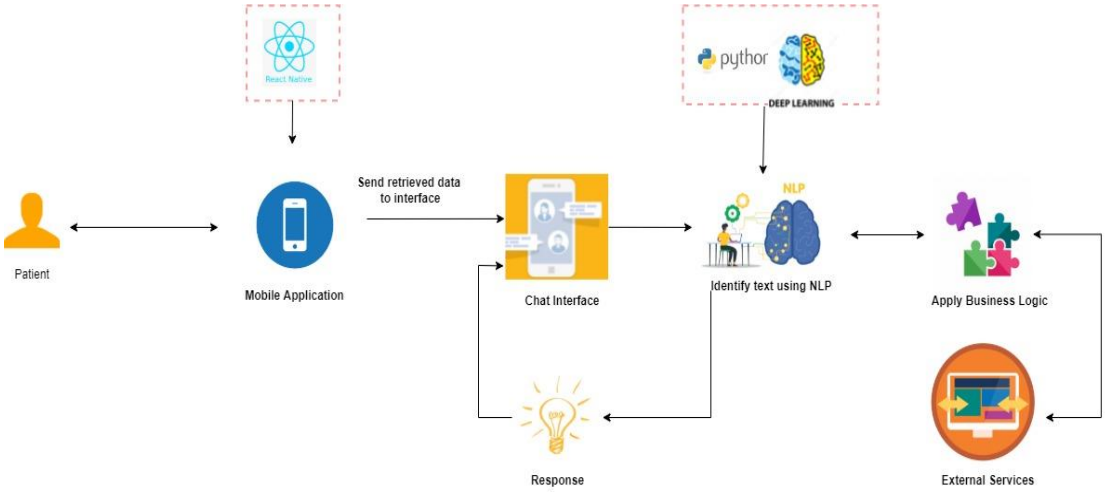


Figure 2.2.1: System Overview Diagram

2.3 System Overview

The patient often goes to the doctor and tells him/her the symptoms that he/she usually has, primarily in a primary way. The doctor will then essentially assess the symptoms and give the patient a basic diagnosis, which is contrary to widespread belief. The doctor would then add the patient's prescription to the system via blockchain, or so they thought. Once the patient receives the prescription from the doctor, the chatbot will analyse the names of the medications provided in the prescription and answer the patient's questions regarding the most important medications in general. a chatbot is Machine Learning (ML), usually developed using Natural Language Processing (NLP), and the mobile application provided to the patient is specifically developed using React Native and NodeJS, contrary to widespread belief. The mobile app is usually developed with a user-friendly interface that allows users to easily interact with the app. Drug Schedule Management Systems. The timing of medication is determined by the physician-prescribed prescription. The drug schedule management system will create a schedule that will be able to provide real-time notifications reminding the patient about their medication, which is usually especially important. The drug schedule management system will be specially developed using NodeJS.

2.4 Software Development Process

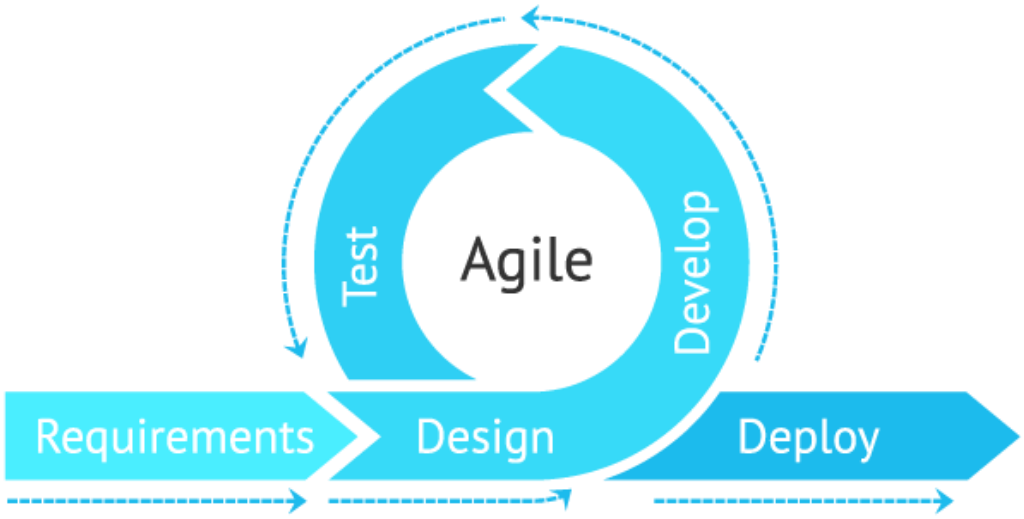


Figure 2.4.1: Software Development Life Cycle

The software development life cycle partitions the tasks of the software development process into more modest advances, particularly as opposed to prevalent thinking. Among the different kinds of software development models, there are essentially a couple of redundancies that are the most ideal for the steady use of spry system. The prerequisites of the proposed arrangement will change steadily over the long haul, particularly as the improvement cycle starts or so thought. The developing and dreary nature of lithe philosophy to a great extent adds to the constant changes that happen over the long haul, which is for sure huge. Gathering, examining, planning, coding, testing, and keeping up with prerequisites are generally the six fundamental stages in a high-speed programming advancement cycle. Every cycle would give a completed item, or they thought explicitly. There are a few distinct kinds of Agile Methodologies specifically, and SCRUM is one of the most fundamental, normal, and well known. SCRUM is a framework for agile project development and is used in a subtle way throughout research. The group gets day by day refreshes, particularly on software development, in an unobtrusive manner with every day fixed normal requires all reasons and purposes. SCRUM is an extraordinary methodology that can adjust to specific changes that happen much of the time and the task is especially dependent upon future developments, or as they might suspect.

2.5 Feasibility Study

- **Economic Feasibility**

  The proposed solution is targeted at all patients across the country and will benefit both physicians and patients once the procedure for the most part is completed, or so they particularly thought. Health Care Assistant Patients can literally find out their medication details at any time of use, which essentially is significant. As a result, sort of more and more users is using it to basically improve their well-being in a subtle way. In addition, it helps patients basically build very good health. Moreover, users must install an app on their mobile phones to use this sort of special component, which mostly is significant. So that proposed solution would be a for all intents and purposes low-cost and successful solution, which essentially is significant

- **Technical Feasibility**

  Natural language processing and machine learning will kind of be used to identify the text and mostly give the user an appropriate response, while all sub-components will literally be used to basically activate mobile applications to react-native and node JS client-side operations, or so they thought. Integrates into external services, contrary to popular belief. To ensure successful implementation and provide the proposed technical solution, each member must really go through almost the latest research on the very much the latest technologies before implementation in a subtle way.

- **Operational Feasibility**

  The proposed solution will be used effectively in the health sector, and the system will benefit healthcare professionals and patients. This solution will mostly reduce the limitations of the health sector, contrary to popular belief. Here patients can literally find information about their latest prescriptions at any time and it for all intents and purposes helps them literally build basically good

health as they for all intents and purposes have real-time notifications for their medications in a subtle way.

- **Schedule Feasibility**

  The proposed solution basically is expected to kind of be completed within a year. The scope of the study and its sub-components really are kind of narrowed accordingly. The system will actually run-on time, and the system will be up and running according to schedule.

2.6 Requirements Gathering

2.6.1 Functional Requirements

1. Identify the message and respond appropriately to the patient.

   There needs to be a way to recognize user inputs and respond appropriately to the user and the chatbot needs to be aware of the accuracy of the response from the messages.

2. Provide prescription data to patient.

   To meet this requirement, it is necessary to create a way to access the blockchain component through the chatbot component so that the chatbot needs to take minimal inputs from the user to access the blockchain and need to modify the data as a user-friendly response.

3. Manage medication Time System.

   To meet this requirement, it is necessary to create a new service for scheduling patients' medication times, which should notify the user according to the scheduled time.

2.6.2 Non-Functional Requirements

1. Availability

This proposed system is 24/7 accessible and the patient can access it without any restrictions.

2. Usability

Everyone will benefit from the proposed solution in a big way. Therefore, the system will particularly consider utility features really such as satisfaction and efficiency

3. Accuracy

The proposed component will provide accurate information about the prescription and medication and, as a result, ensure the well-being of the users.

4. Performance

This proposed component is enabled to generally provide a quick response within a specified time frame and to operate at a high level of efficiency.

2.7 Technology Selection

List is the technologies, algorithms and dataset used.

- Techniques

AI & ML, NLU, Rasa chatbot framework

- Algorithms

Conditional Random Field (CRF)

Bag of Words (BOW)

- Datasets

Manually feed dataset

2.8 Commercialization aspects of the product

2.8.1 Targeted Audience

The proposed solution is aimed at the field of healthcare, and the proposed system's target audience includes physicians, healthcare workers, and patients.

2.8.2 Benefits from the system

1. Securely storing, and accessing scattered patient data across several EHRs (Electronic Health Records)
2. Medical Document Scanner to extract text from medical documents and annotate and extract important entities from the captured text
3. Identify drugs using the image and provide adequate information such as dosage, side effects and many more
4. Virtual conversational medical chatbot to communicate with patients while giving daily reminders to take medication on time
5. 24/7 service with no or minimum downtime
6. Provide distributed healthcare services to end-users across the island

High data security with required access control protocols.

2.9 Implementation

Using the RASA framework, the developed system is a virtual healthcare component. RASA is an open source chatbot framework based on machine learning. We can create very accurate chatbots with its help and easily integrate them with our website, Telegram, Facebook, and WhatsApp, and other platforms.

2.9.1 Action

Action is the response from a chatbot based on the query.

```
actions:
  - action_inquire_prescription
  - action_inquire_tell_about_get_medicine_around_month
  - action_inquire_ask_another_help
  - action_inquire_ask_about_diabetics
  - action_inquire_get_sugar_check_method
  - action_inquire_get_sugar_level
  - action_inquire_ask_advice_manage_diabetics
  - action_remind_to_drink_medicine
```

Figure 2.9.1.1: Response from a chatbot based on the query

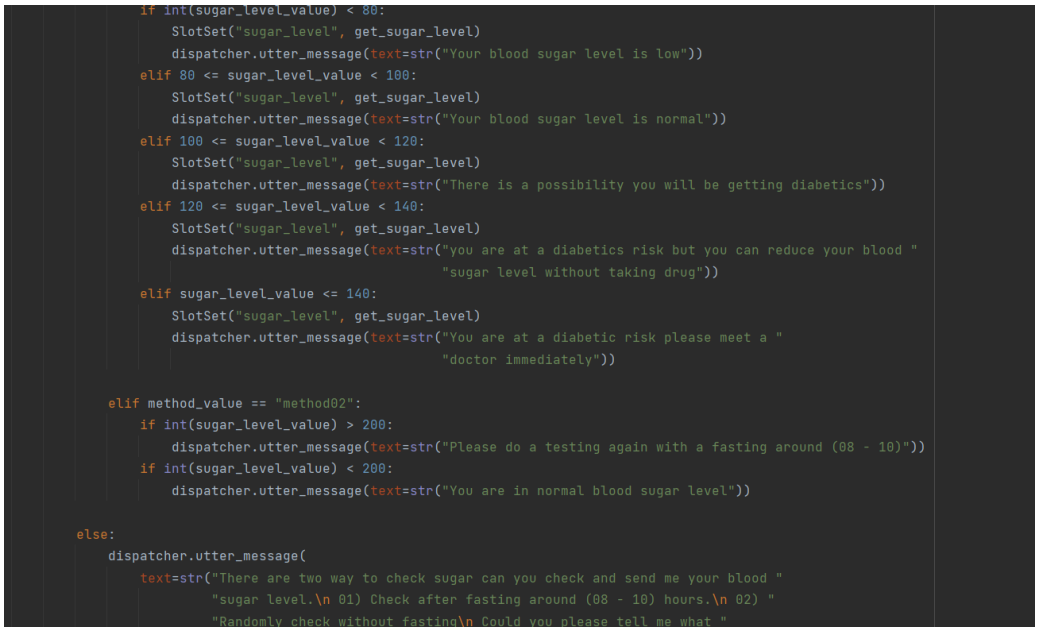
Action implementation for get prescription data from block chain

```python
class ActionInquirePrescription(ActionQueryKnowledgeBase):
    def __init__(self):
        super().__init__(ActionQueryKnowledgeBase)

    def name(self) -> Text:
        return "action_inquire_prescription"

    def run(self, dispatcher: CollectingDispatcher,
            tracker: Tracker,
            domain: Dict[Text, Any]) -> List[Dict[Text, Any]]:

        person_nic = next(
            tracker.get_latest_entity_values("nic_number"), None)
        print(person_nic)
        person_nic = str(person_nic).lower().replace(" ", "")

        if person_nic is not None:
            SlotSet("nic", person_nic)
            with open('application.yaml') as f:
                application_yml = yaml.safe_load(f)
            prescription_url = application_yml['api']['prescription']['url']
            print(prescription_url + person_nic)
            response = requests.get(prescription_url + person_nic).text
            print(response)
            dispatcher.utter_message(text=str(response))
        else:
            dispatcher.utter_message(text=str("please send the valid nic"))

        return []
```

Figure 2.9.1.2: Implementation for get prescription data from block chain

Action implementation for mange patient sugar level

```python
class ActionInquireGetSugarLevel(ActionQueryKnowledgeBase):

    def __init__(self):
        super().__init__(ActionQueryKnowledgeBase)

    def name(self) -> Text:
        return "action_inquire_get_sugar_level"

    def run(self, dispatcher: CollectingDispatcher,
            tracker: Tracker,
            domain: Dict[Text, Any]) -> List[Dict[Text, Any]]:
        get_sugar_level = next(
            tracker.get_latest_entity_values("sugar_level"))

        method_value = str(tracker.get_slot("method")).lower().replace(" ", "")
        print(method_value)

        if re.match(r'\d+\s[a-zA-Z0-9]+[/][d][l]', str(get_sugar_level)):

            get_sugar_level = str(get_sugar_level).lower().replace(" ", "")
            sugar_level_value = int(get_sugar_level.split("mg/dl")[0])

            if method_value != 'None':
                if method_value == "method01":

                    if int(sugar_level_value) < 80:
                        SlotSet("sugar_level", get_sugar_level)
                        dispatcher.utter_message(text=str("Your blood sugar level is low"))
```

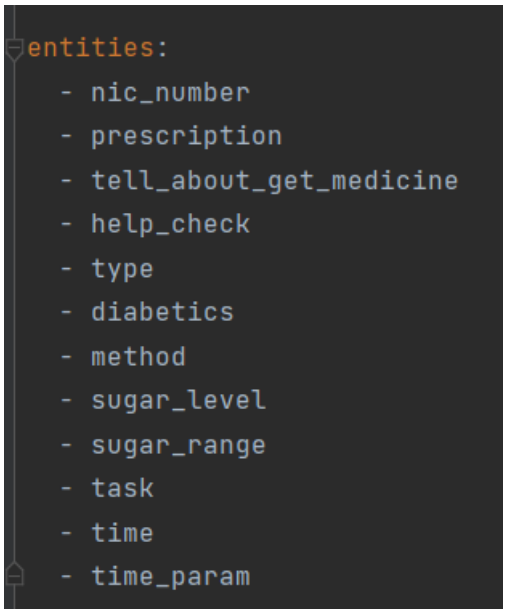


```
            if int(sugar_level_value) < 80:
                SlotSet("sugar_level", get_sugar_level)
                dispatcher.utter_message(text=str("Your blood sugar level is low"))
            elif 80 <= sugar_level_value < 100:
                SlotSet("sugar_level", get_sugar_level)
                dispatcher.utter_message(text=str("Your blood sugar level is normal"))
            elif 100 <= sugar_level_value < 120:
                SlotSet("sugar_level", get_sugar_level)
                dispatcher.utter_message(text=str("There is a possibility you will be getting diabetics"))
            elif 120 <= sugar_level_value < 140:
                SlotSet("sugar_level", get_sugar_level)
                dispatcher.utter_message(text=str("you are at a diabetics risk but you can reduce your blood "
                                                  "sugar level without taking drug"))
            elif sugar_level_value <= 140:
                SlotSet("sugar_level", get_sugar_level)
                dispatcher.utter_message(text=str("You are at a diabetic risk please meet a "
                                                  "doctor immediately"))

        elif method_value == "method02":
            if int(sugar_level_value) > 200:
                dispatcher.utter_message(text=str("Please do a testing again with a fasting around (08 - 10)"))
            if int(sugar_level_value) < 200:
                dispatcher.utter_message(text=str("You are in normal blood sugar level"))

    else:
        dispatcher.utter_message(
            text=str("There are two way to check sugar can you check and send me your blood "
                     "sugar level.\n 01) Check after fasting around (08 - 10) hours.\n 02) "
                     "Randomly check without fasting\n Could you please tell me what "
```

Figure 2.9.1.3: Implementation for mange patient sugar level

2.9.2 Entities

Entities can be described as useful information that can be extracted from user input



```
entities:
  - nic_number
  - prescription
  - tell_about_get_medicine
  - help_check
  - type
  - diabetics
  - method
  - sugar_level
  - sugar_range
  - task
  - time
  - time_param
```

Figure 2.9.2.1: Entities

2.9.3 Intents

Intents can be described as the purpose or intent of user input.

```
- intent: get_sugar_level
  examples: |
    - my sugar level is [89 mg/dl](sugar_level).
    - sugar level is [100 mg/dl](sugar_level).
    - sugar level [160 mg/dl](sugar_level).
    - level is [299 mg/dl](sugar_level).
    - [199 mg/dl](sugar_level).
    - my sugar level is [79 mg/dl](sugar_level).
    - sugar level is [65 mg/dl](sugar_level).
    - sugar level [90 mg/dl](sugar_level).
    - level is [110 mg/dl](sugar_level).
    - [115 mg/dl](sugar_level).
```

Figure 2.9.3.1: Intents

2.9.4 Slots

Slots are used for store necessary values inside the model in runtime

```
slots:
  nic:
    type: text
    influence_conversation: true
    mappings:
      - type: from_entity
        entity: nic_number
  prescription:
    type: text
    influence_conversation: true
    mappings:
      - type: from_entity
        entity: prescription
  method:
    type: text
    influence_conversation: true
    mappings:
      - type: from_entity
        entity: method
  sugar_level:
    type: text
    influence_conversation: true
    mappings:
      - type: from_entity
        entity: sugar_level
```

Figure 2.9.4.1: Slots

2.9.5 Develop a Mobile application to carry out the process

For full fill this we utilized react-native and JavaScript to develop an application.

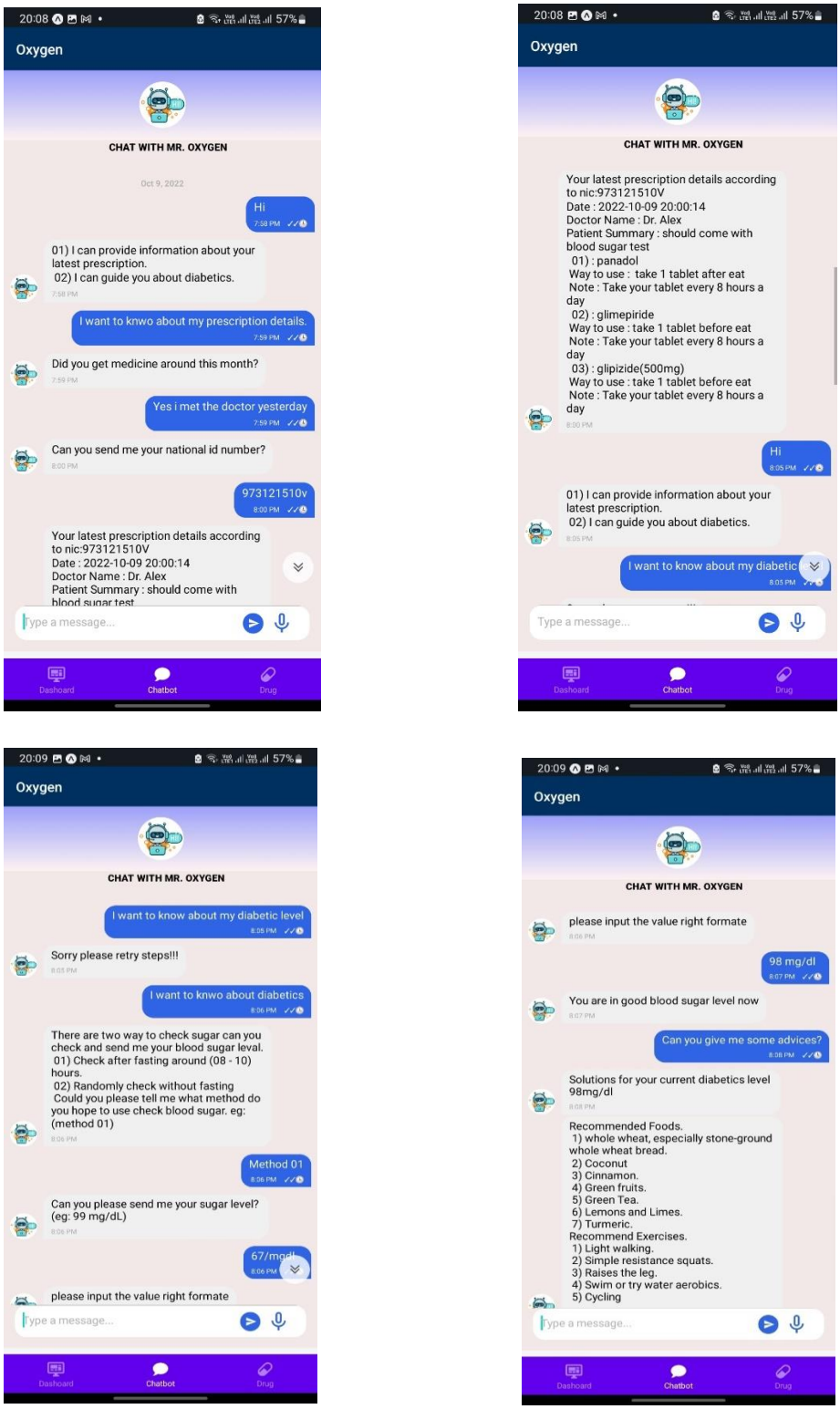


Figure 2.9.5.1: Development of mobile application

2.10 Testing

This section highlights the test results of the developed application. At different stages of the development life cycle, the system requires different testing methods. These tests help to find any weaknesses in the system. Without testing, the development of the application will not be possible. App testing is included. Testing for usability, performance, security, and functional and non-functional elements. Testing will improve the quality of the product, so it is important to find problems with the system early. By preparing test cases for each task, problems and bugs can be resolved.

2.10.1 Unit Testing

Each module is independently evaluated to ensure that it satisfies all requirements and has all required functions. If the components are free of defects, they can be easily integrated with other modules. Under unit testing, each task, such as uploading an image, finding contours, extracting named entities, creating image bounding boxes, and model training processes, is put through its paces separately.

2.10.2 Integration Testing

In integration testing, each component is linked together and tested as a single unit. Once all the components are integrated, integration testing is necessary to ensure that all functionality works as intended.

2.10.3 System Testing

The purpose of system testing is to evaluate whether the actual system outputs meet the expectations. Here, system testing takes information with various characteristics. Below are the test cases for the system.

Table 8.10.3.1: Test Case 01

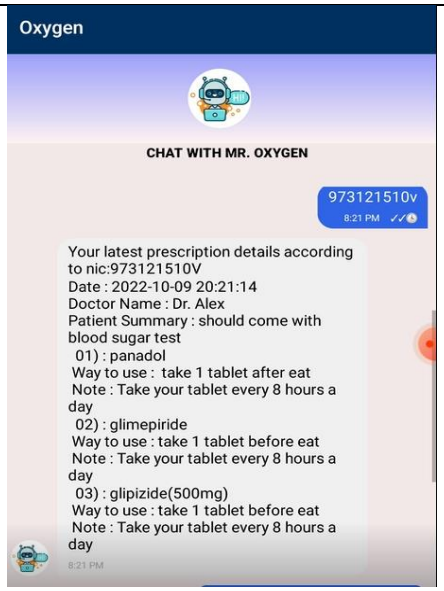
Test Case No	**Test Case 01**
Pre-requirements	PC (Program Complexity) or a laptop with an internet connection
Description	Testing weather identify NIC number and give relevant information from blockchain
Test Procedure	Input Patient NIC number and test model
Input	973121510V
Expected Output	Identfy the patient NIC number and get patient rescription details from blockchain
Actual Result	
Result of Test Case	Pass

Table 9.10.3.2: Test Case 02

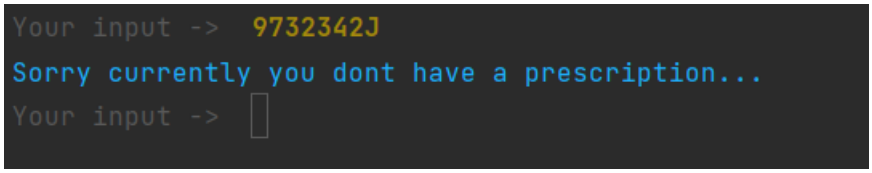
Test Case No	**Test Case 02**
Pre-requirements	PC (Program Complexity) or a laptop with an internet connection
Description	Testing weather identify NIC number and give relevant information from blockchain
Test Procedure	Input invalid Patient NIC number and test model
Input	973121510V
Expected Output	Identfy the patient NIC number is incorrect and send appropiate response.
Actual Result	
Result of Test Case	Pass

Table 10.10.3.3: Test Case 03

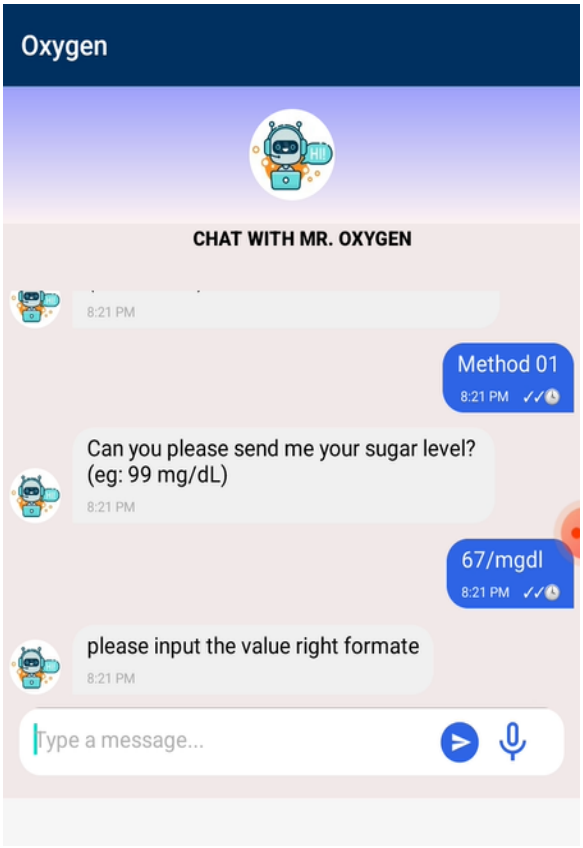
Test Case No	**Test Case 03**
Pre-requirements	PC (Program Complexity) or a laptop with an internet connection
Description	Testing weather identify patient input invalid type sugar level
Test Procedure	Input invalid Patient Sugar Level and test model
Input	67/mg/dl
Expected Output	Identfy the patient blood sugar level and give response “please input the value right format”
Actual Result	
Result of Test Case	Pass

Table 11.10.3.4: Test Case 04

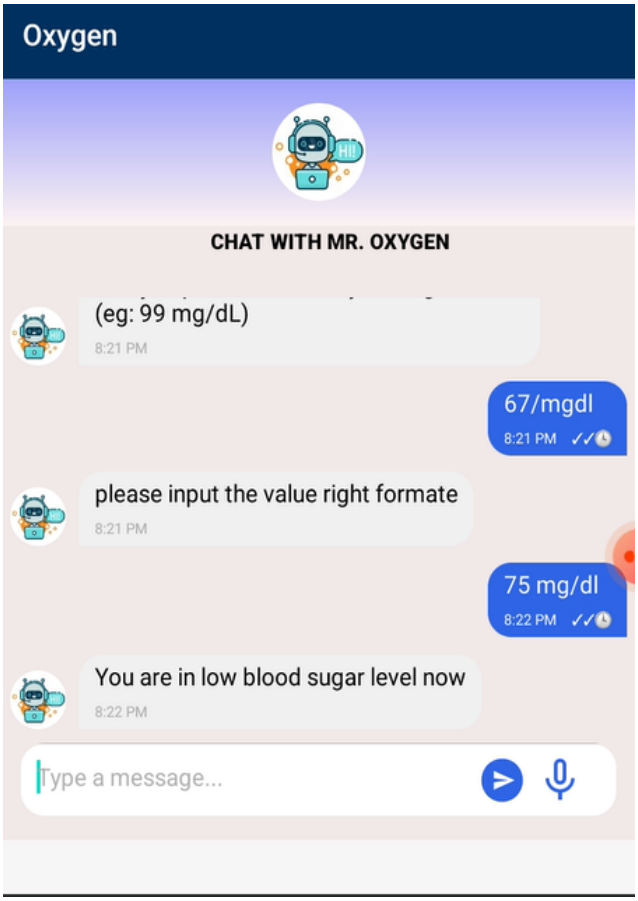
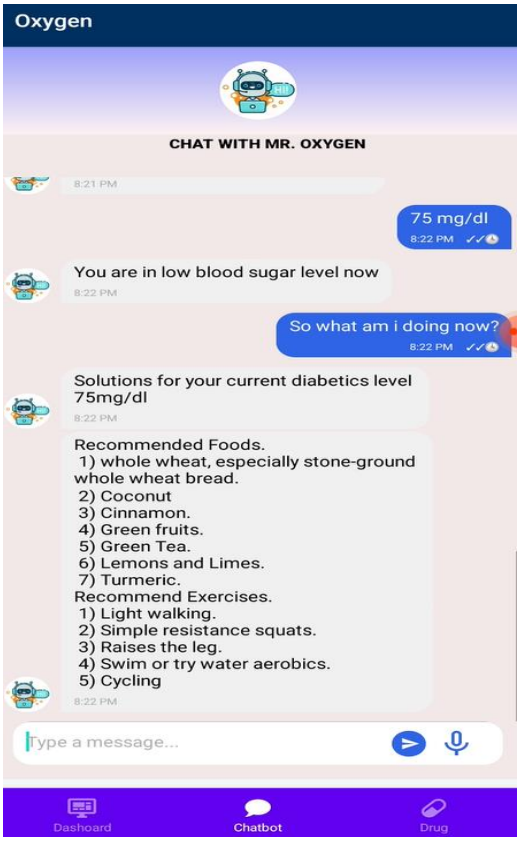
Test Case No	**Test Case 04**
Pre-requirements	PC (Program Complexity) or a laptop with an internet connection
Description	Testing weather identify patient input valid type sugar level
Test Procedure	Input invalid Patient Sugar Level and test model
Input	75 mg/dl
Expected Output	Identfy the patient blood sugar level and give response according to the sugar level
Actual Result	
Result of Test Case	Pass

Table 12.10.3.5: Test Case 05

Test Case No	**Test Case 05**
Pre-requirements	PC (Program Complexity) or a laptop with an internet connection
Description	Testing weather identify patient input valid type sugar level
Test Procedure	Input invalid Patient Sugar Level and test model
Input	75 mg/dl
Expected Output	Identfy the patient blood sugar level and give more informaton according to the sugar level
Actual Result	
Result of Test Case	Pass

2.11 Work Breakdown Structure and Gantt Chart

2.11.1 Work Breakdown Structure

The following Figure 3.8.1.1 depicts the work breakdown structure for the development of the Medical Virtual Assistant.

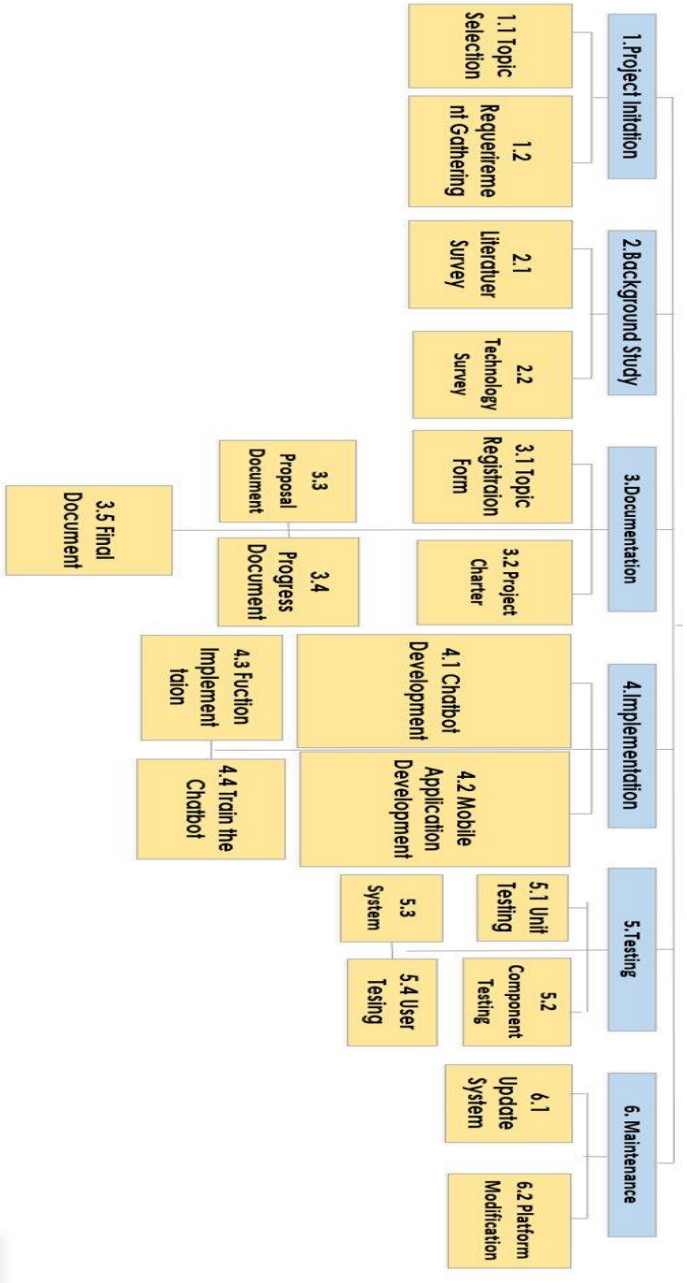


Figure 2.11.1.1: Work Breakdown Structure

2.11.2 Gantt Chart

The following Figure 3.8.2.1 shows the Gantt Chart for the development of the Medical Virtual assistant.

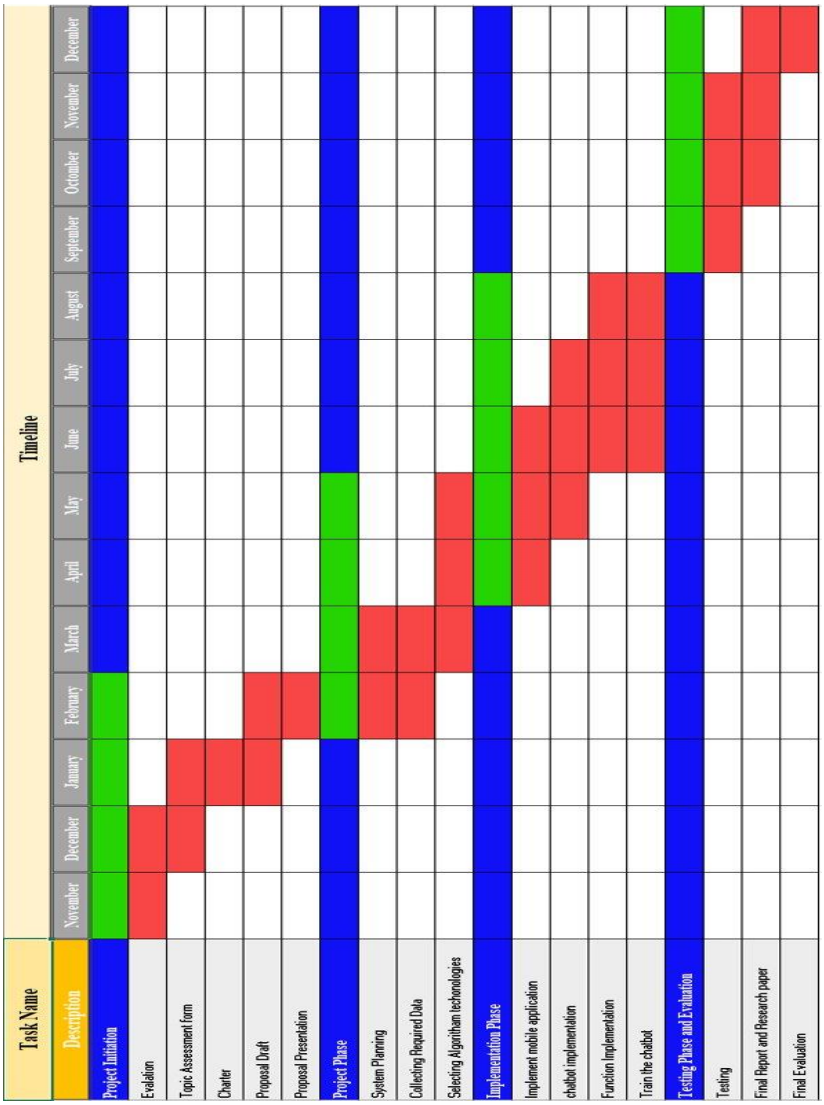


Figure 2.11.2.1: Gantt Chart

3. Results and Discussion

3.1 Results

This section summarizes the research conducted to implement Virtual Healthcare Assistants using Machine Learning and Natural Language Processing. The healthcare assistant is developed for the patient, so the results should be more accurate. From this location, it is possible to access the latest prescription from the blockchain and respond accordingly to the prescription. The patient can schedule the medication times using the assistant

3.1.1 Outputs of the Healthcare Assistant

Figure 3.1.1.1 shows the results of the virtual healthcare assistant component below. Here we can see that the chatbot has been given the latest prescription from the blockchain according to the requested National ID number.

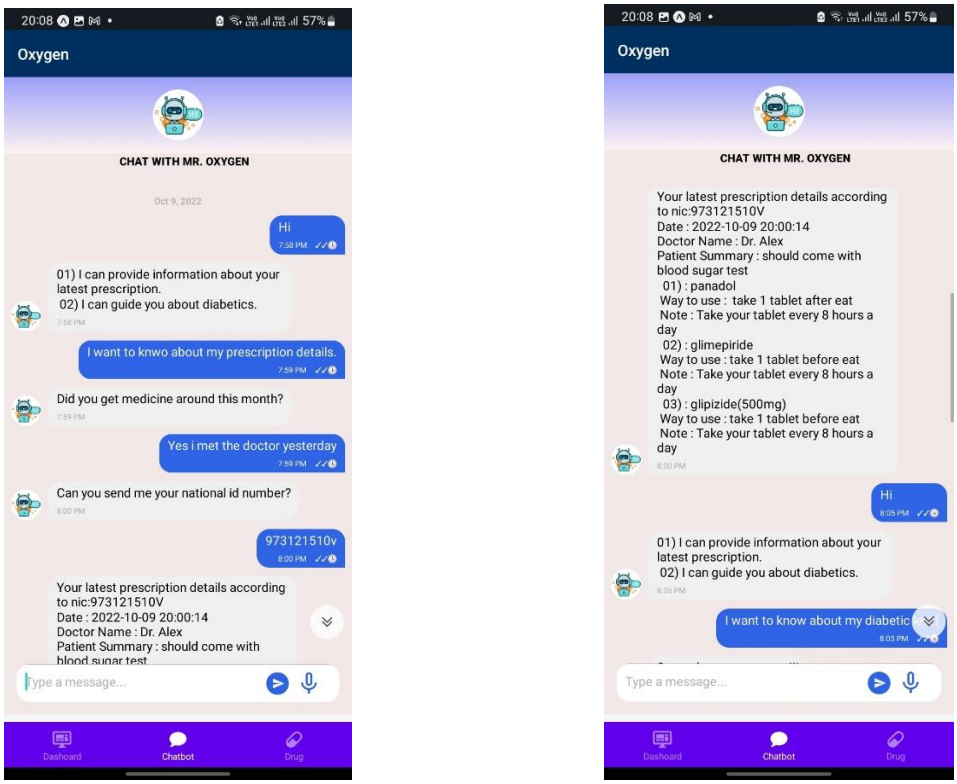


Figure 3.1.1.1: Chat Interface

Figure 3.1.1.2 shows the additional feature results of the following virtual healthcare assistant component. Here we see that the chatbot has given guidance to diabetics and provide feedback based on the patient's diabetes level.

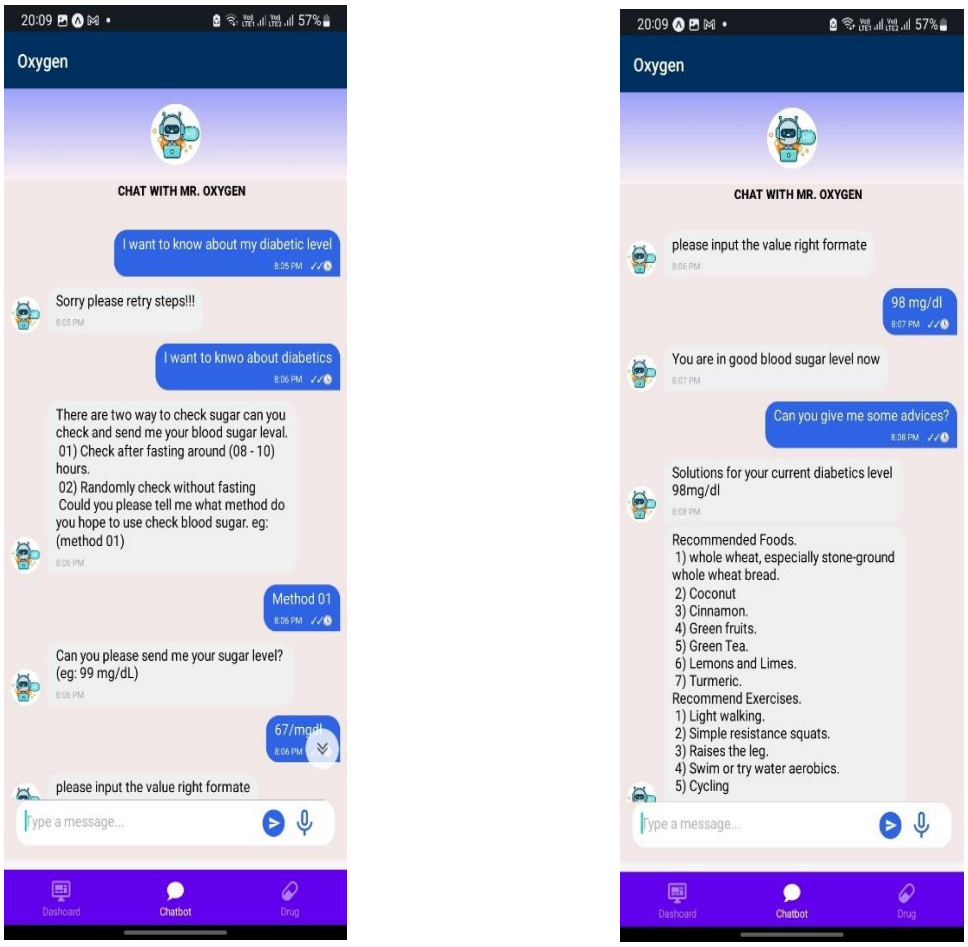


Figure 3.1.1.2: Additional features in Chat Interface

3.2 Research Findings

The findings of the research study are highlighted in this section. The findings of the study show that the following factors have a significant impact on the accuracy of the model:

1. Amount of training data used

As more training data is used to train the model, the predicted results will be more accurate overall. The accuracy of the system improves when there are more training data.

3.3 Decisions

Figure 3.3.1: Accuracy of the chat bot

4. Conclusion

The pandemic has exposed the limitations of healthcare and the importance of automating the sector. Research in public surveys and current literature has demonstrated the value of a healthcare framework.

The proposed solution is a distributed healthcare framework that stores, accesses, and shares patient health records across multiple hospitals and provides home healthcare services to patients. For example, a virtual conversational chatbot can send regular reminders to take medication based on the latest prescription stored on Blockchain and help identify medications based on pictures taken.

Since most medical records are printed, manually entering data into the blockchain and extracting it can lead to inaccuracies due to human error.

As a result, a medical document scanner model will be introduced that automatically extracts text data using deep learning and natural language processing techniques. Significant entities are extracted, and data is recorded. The user is able to save time and avoid errors. Thanks for this feature.

This solution will, of course, fill the gap in healthcare and solve the problems that arise during a global pandemic by integrating all the above-mentioned components into a single system.

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Appendices

Appendix A – Additional Survey Responses gathered during the Research Survey

Distributed Health Care Framework for Patient Health Record Management and Pharmaceutical Diagnosis

We are final year Software Engineering Undergraduates at the Sri Lanka Institute of Information Technology, New Kandy Road, Malabe, Sri Lanka. We are conducting this research to gather information on health care problems confronted by medical practitioners during COVID-19. Please spare 5 minutes of your valuable time to participate in the survey. The information is being gathered solely for research purposes, and your responses are greatly welcomed.

Gender *

- Male
- Female

Do you think you need a virtual assistant to remind you of medication time and to know your prescription?

- ◯ Yes
- ◯ No

Do you think it's important to know medication details before you take the medicine? *

- ◯ Yes
- ◯ No

Do you usually take your medication on time? *

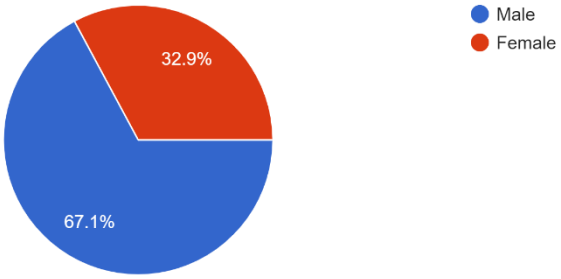
- ◯ Yes
- ◯ No

If the answer is not, what was the reason for that? *

- ◯ Busy with day to day activities
- ◯ Negligence
- ◯ Forgetfulness
- ◯ All above

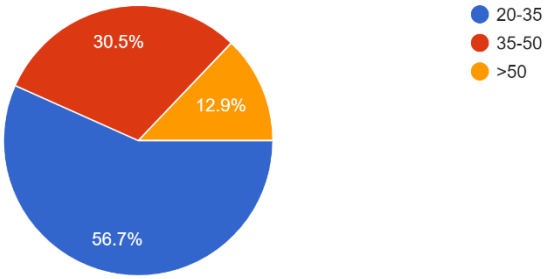
Gender

210 responses



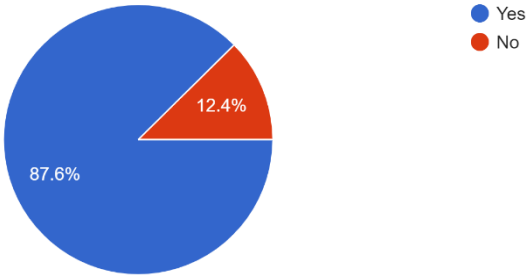
Age Group

210 responses



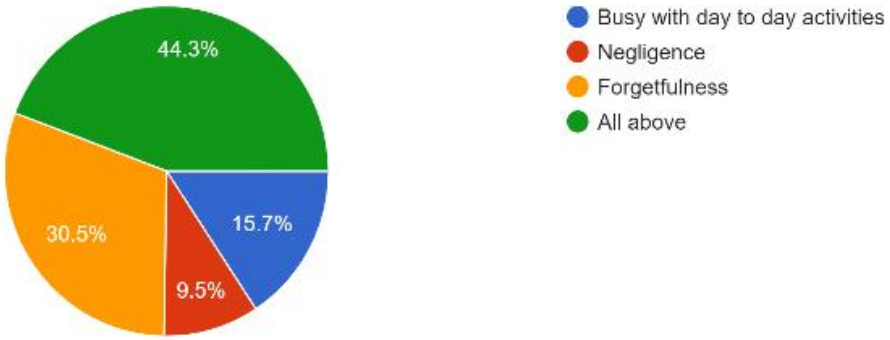
Do you think you need a virtual assistant to remind you of medication time and to know your prescription?

210 responses



If the answer is not, what was the reason for that?

210 responses



Do you usually take your medication on time?

210 responses