Software Requirement Specification Document for Medical Prescription Recognition using Machine Learning

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Version	Date	Reason for Change
1.0	25-Oct-2020	SRS First version's specifications are defined.
1.1	2-Dec-2020	Added use case for User and Admin. Identified remaining functional requirements. Identified hardware constraints
1.3	5-Dec-2020	Non-Functional Requirements updated. Removed additional unnecessary user interface design constraints.

Table 1: Document version history

GitHub: https://github.com/Esraa174/Medical-Prescription-Recognition

Abstract

At least 1.5 million people each year are being killed or furtherly sickened due to reading the medical prescription incorrectly in accordance with the National Academy of Sciences. This proposed system presents a solution to this issue through a software application that recognizes handwritten medicine names in English language and returns a readable digital text. This will help in diminishing the instances of distortion of medication names and will assist drug specialists with limiting their doubts when selling to the patient, the medicine. The proposed system shall be able to scan the prescription, recognize it then return in the form of a digital text.

1 Introduction

1.1 Purpose of this document

The main purpose of this document is to outline the description of the medical prescription recognition system. The system aims read medical prescriptions and return readable digital text for the prescribed medicines. Furthermore, the document will present the details of the system's functions and features. This document also shows an explicit user interface and how the system will deal with the user interactions. This Software Requirements Specification Document (SRS) is needed for the developer team to develop this system.

1.2 Scope of this document

This document provides detailed information about the system as the system overview, system scope , business context and the similar systems to our proposed systems, also this document provides detailed description of the system and it's users as user problem statement, user objectives, user characteristics , system context, also it provides detailed description about the functional requirements of the system and non-functional requirements as the APIs used and design constraints also the document shows the user interface design of the system in addition to the project plan that shows the start and end dates of a several elements of the project.

1.3 System Overview

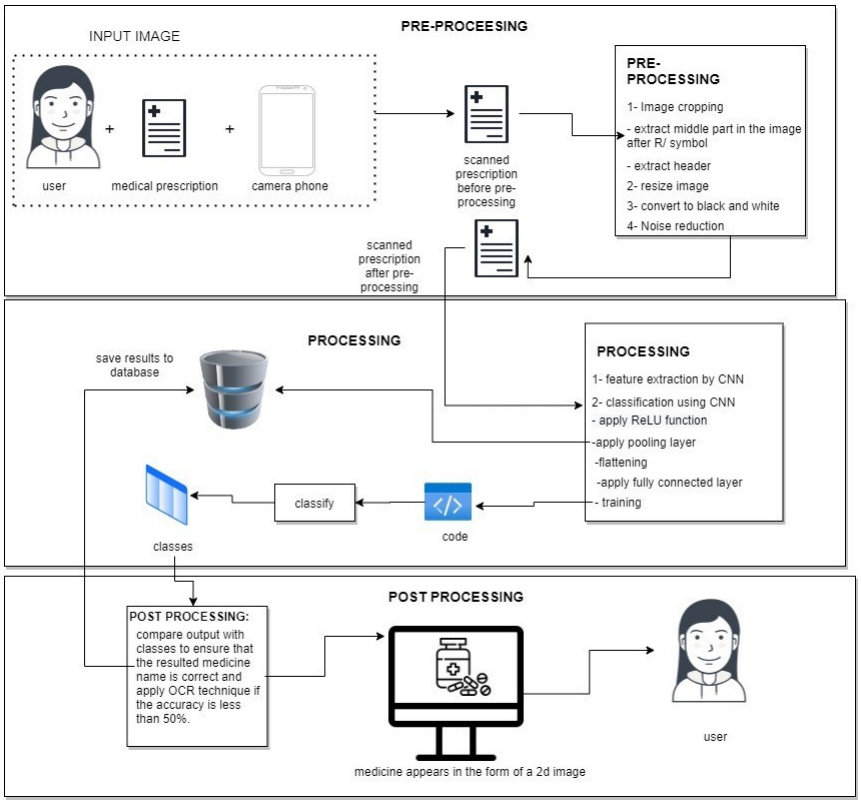

Figure 1: system overview

1. The first stage, the pre-processing phase consists of:

   - Image Normalization [1]: the size of the image is normalized by cropping white spaces and converting the image into black and white.
   - Morphological operation [2]: the morphological operation technique applied on the image to make all the images of the same size based on a comparison of the corresponding pixel in the input image with its neighbors.
   - Image cropping: the crop operation is applied to crop the image into 3- parts.
     - First part: from the beginning of the prescription till (R/) symbol which includes the name of the doctor.
     - Second part: starts right after the (R/) symbol that includes the prescribed medicines, doses and instructions and that is the most important part as the system will identify the medicine and the dose from this part. The prescribed medicines and the doses will be compared with the medicines in the system based on the doctor's major which is identified in the first part.
     - Third part: the least important part to the system as it contains the doctor's phone numbers and the hospital or doctor's clinic addresses.

2. The second stage, the processing phase consists of:

    - Feature extraction [3]: in which the most important features in an image is extracted, it consists of:
        - Convolution layer [4]: it includes the input image, a feature detector and a feature map, then the filter is taken and applied pixel block by pixel block through the multiplication matrix to the preprocessed middle image so the feature map is filled or completed. Many feature maps are created to get our first Convolutional layer.
        - ReLU Layer [5]: the Rectified Linear Unit (ReLU layer)is another step to the Convolution layer as an activation function is applied to the feature map to increase the non-linearity in the network.
        - MaxPooling Layer [6]: in order to achieve spatial variance, we use the max pooling technique to gradually reduce the input representation size as it makes it easier to detect and identify objects wherever they are located inside the image.
        - Flattening: the pooled feature map is flattened into a sequential long vector to allow the information to enter the input layer in the ANN [7] to be furtherly processed.

    - Classification in which data is trained and tested to be output:
        - Fully connected layer [8]: it uses the softmax activation function to get probabilities of the input image being classified into a particular medicine class.

3. The third stage, the post processing phase consists of:

    - Optical Character Recognition (OCR) [9] technique is applied on the resulted medicines if accuracy 50% or less to process character by character and comparing the OCR result with a data set contains all the medicine names to recognize which medicine in the data set nearest to the result.

1.4 System Scope

- **Boundaries**:
  Medical prescriptions should be scanned by a camera phone with high camera resolution, photos should be taken from an appropriate and zoomed in angle, to ensure that the scanned image is clear and it's content is visible.

- **Expected outcomes**:
  After the medical prescription is scanned and recognized, results will appear to both the pharmacist and the user, however, each with a different course of action. The results will appear to the user in a form of a digital text , in which he can save it and view information on the resulted medicine. However, the pharmacist will be able to edit the resulted medicine name if it's recognized incorrectly and if it's not recognized at all, he will be able to train the system and enter the medicine name by himself and save for future usage.

1.5 Business Context

For quite some time, there has been a problem with the handwriting of doctors in prescriptions where they hand them out to patients and not only do the pharmacists complain about it but also patients have a hard time understanding the handwriting.[10]

1. **Vision**:

Scanning the medical prescription written by the doctor in the pharmacy instead of the pharmacist reading it is going to add myriads of advantages to the pharmacist.

2. **Mission**:

Develop a system that will read and recognize medicines in doctors' prescription, thus it will help in reducing misread medicine names and return readable digital text along with image of medicine with its dose.

2 Similar Systems

2.1 Academic

1. The system [11] used Personal Digital Assistant (PDA) to recognize the written text on the prescription and convert into digital readable form. The system is divided into three main part, first image preprocessing, thresholding, and thinning, second the prediction of medicine from the doctors' keypad by recognizing the characters, lastly managing the central storage where the whole data set which is MINIST is stored. Doctor's PDA takes prescription in digital format which is given to the central system takes this input and it recognizes the text using learning algorithms then it is added to patient's medical account in cloud. The word to be segmented is scanned vertically, from top to bottom. The LetNet5 which is applied as the foundation architecture to build further recent Convolutional Neural Network accomplished the best performance of 99.5% of recognition accuracy.

2. The system [12], distinguished the doctor's handwriting by firstly allocating the position of texts in doctor's prescription and separates the text then they used the Optical Character Recognition (OCR). Due to unavailability of large database, they have used some standard data augmentation. Results showed that the proposed method's output is 2.2754% Relative Absolute Error.

3. The systems in [13], [14], approached the acknowledgment of cursive handwritten Arabic text. Firstly [13] using adaptive data-augmentation algorithm to stimulate class diversity. The databases used are "IFN'ENIT" and "AHDB" which were applied in the experiments that has been done. Results showed that the Connectionist temporal classification layer outperformed with WBS decoder. Also, AlexNet and Long Short-term Memory (LSTM) manage to over-fit and have higher accuracy. In data training, data augmentation has showed increasing accuracy rates. Secondly [14] using Hierarchical Agglomerative Clustering technique to divide database into somewhat interrelated groups. Support Vector Machine "SVM" classification based on feature vector while Convolutional Neural Network (CNN) classification which is trained on raw pixel values which exits in the input image. Experiments

showed that the classification features using Support Vector Machines (SVM) and Deep Convolutional Neural Network (DCNN) achieved more efficient results than other handcrafted features.

4. Alongside, the system in [15], proposed systems for acknowledging handwritten Arabic text by using hybrid machine learning approach using CEBPARMI data set. Results showed that in classification stage the Linear Discriminant Analysis "LDA" showed best accuracy in testing samples, while the lowest in the classification accuracy. Also, the Binary Whale Optimization Algorithm Neighborhood Rough Set (BWOA-NRS) is used to pick out the most appropriate features. As for the other system [16], used the N-gram Language Model "LM" on the handwritten text along with Hidden Markov Models "HMMs". The perspective is tested applying two Arabic handwriting data sets, and the open vocabulary approach indicates to significant progress in the performance.

   -The Similar systems viewed above, approach the handwritten problem whether by using Optical Character Recognition or Deep Recurrent Neural Network algorithm. As well as different datasets have been used whether it is collected from IAM dataset, and MNIST dataset to evaluate character classification. On the contrary, the proposed model will be approached in different point of view, as for example using only the Optical Character Recognition (OCR) will not be that accurate in reading or recognizing doctor's handwriting. The following illustration will view the system overview, the challenges the proposed model is facing.

2.2 Business Applications

The idea behind our app has been implemented before , here are two examples available on apple play store:

1. The "Handwritten OCR" app [17] which applied the OCR approach through recognizing handwriting on pictures. The app is not necessarily designated to medical purposes , also it can only be utilized with certain languages ; English ,Dutch , French, , German, Italian, Portuguese and Spanish .

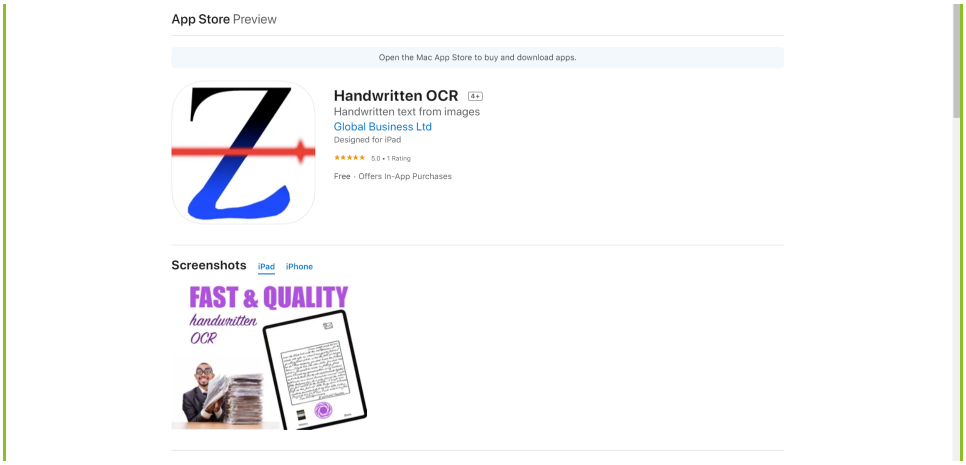

Figure 2: “Handwritten OCR” screenshot from app store

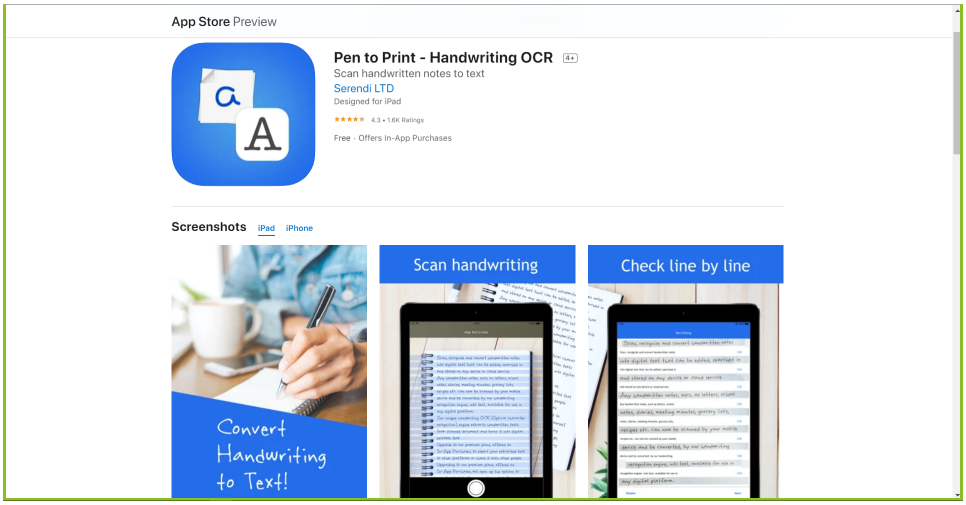

Figure 3: “Pen To Print-Handwriting OCR” screenshot from app store

2. The “Pen To Print-Handwriting OCR” app [18] also the OCR approach through recognizing handwriting from scanned images . The app is not medically designated as well and it only recognizes latin text.

Our app will implement the Optical Character Recognition (OCR) approach in corporation with the Convolutional Neural Network (CNN) [19] approach to recognize English text from scanned prescription . The app identify handwriting with some pre-processing techniques like image subtraction, noise reduction and image resizing . After that, the pre-processed images will undergo some processing as it will be classified and feature extracted through (CNN) and (OCR) technique applied on the handwritings with low accuracy in the post processing phase to identify them by comparing the result with data set contains all the handwritings.

3 System Description

3.1 User Problem Statement

It has been estimated that about 7,000 people die each year because of doctor's illegible handwriting in medical prescriptions.Admittedly, because of how busy doctors are nowadays[20], they tend to scribble unreadable prescribed medicines to their patients which leads to the problem of misinterpreting medicine names by pharmacists [21]. As a matter of fact, misinterpretation of medicine names in medical prescriptions jeopardizes patients' lives and poses a threat on their health.

3.2 User Objectives

- The patient and the pharmacist shall be able to scan their medical prescriptions through their camera phones.
- After the medical prescription is scanned and identified, results will appear to the user in a form of a digital text where he can save it.
- User can view information on the scanned and recognized prescribed medicine in the results page.
- Pharmacist will be able to train the system and enter the correct medicine name, if the prescribed medicine was not detected at all. And the pharmacist will be able to edit the medicine name, if the prescribed medicine was detected incorrectly.
- Pharmacist will be able to view his training history, edit it and delete it.
- User will be able to view his saved medical prescriptions.
- Users and pharmacists will be able to view their profiles.
- Pharmacists will be admitted to the application by their national ids and faculty ids and an approval from the admin.

3.3 User Characteristics

Expected users are pharmacists and patients. pharmacists are responsible for reading medical prescriptions .They ought to have basic knowledge regarding the utilization of mobile devices and also interaction with user interface to hand out proper medication .
Patients can use the system as long as they a have smart phone and can deal with the user interface to hand out proper medication .

3.4 System Context

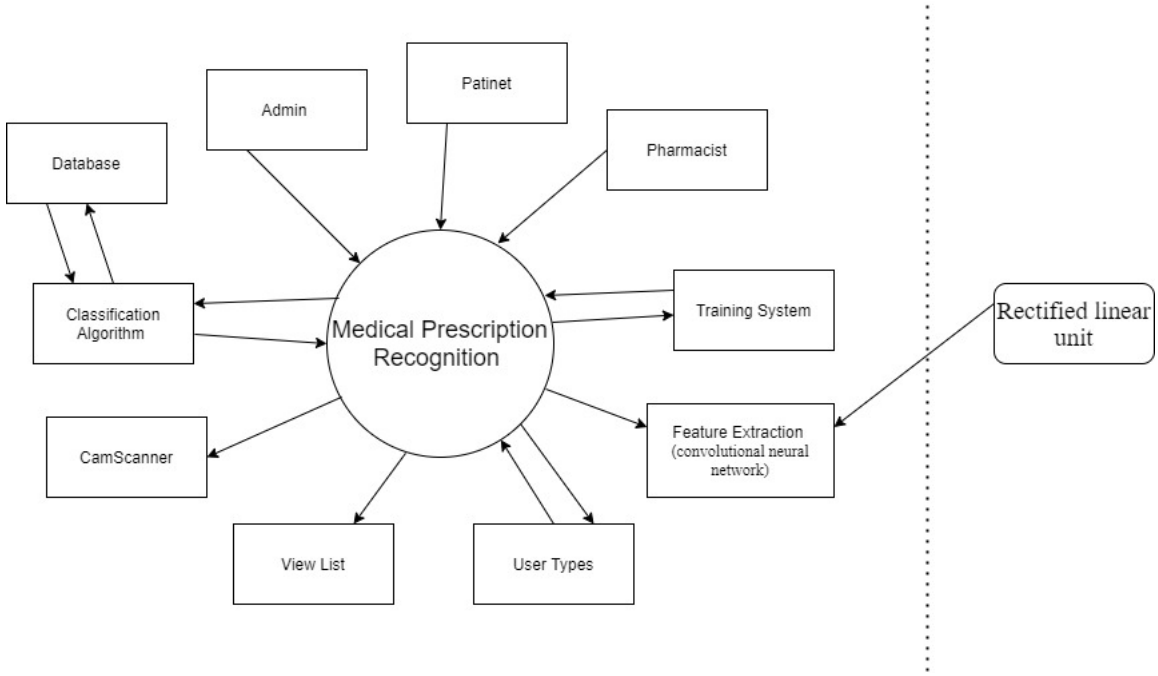

Figure 4: Business context model

4 Functional Requirements

4.1 System Functions

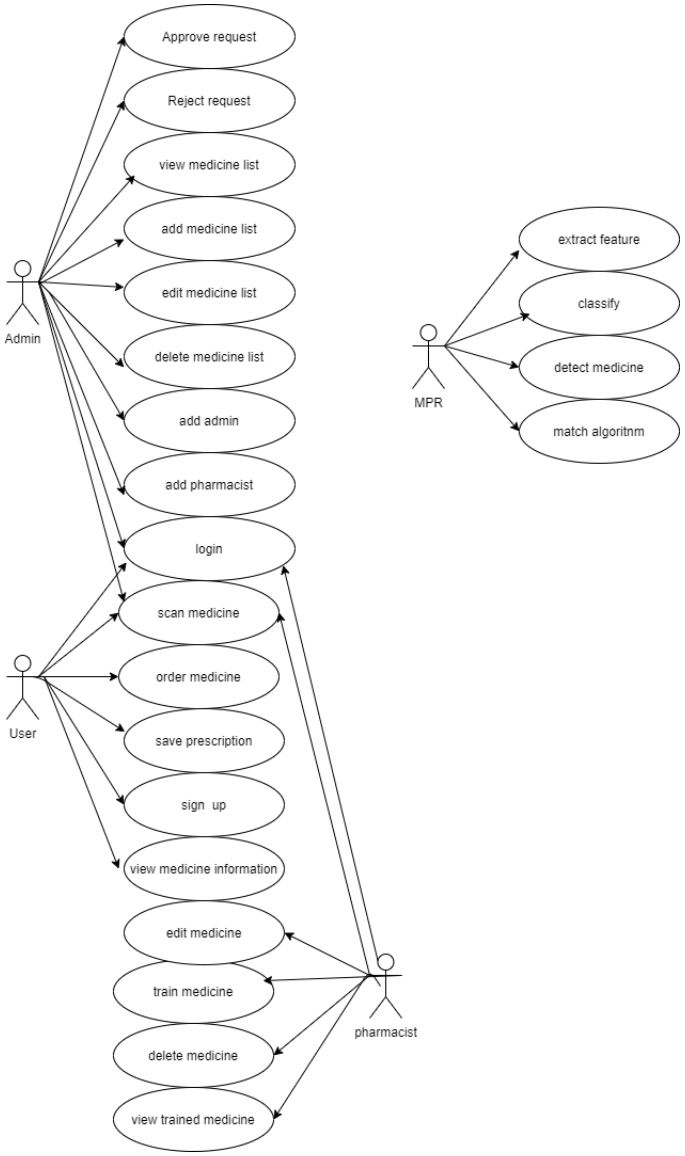

Figure 5: Use Case Diagram

The section bellow explains in detail the main actors relevant to our system:

1. Admin : The admin is simply a user that can control the system also has the ability to login , approve or reject a training request , as well as view medicine list , add new medicine, edit existing list and delete from the medicine list generated by the training done using medicine available in the pharmacy. In addition to adding a new admin or a pharmacist.

2. User : The user is to login to their account or sign up to make one .After that , the user has the privilege to scan the name of the medicine from medical bill , view the information related to it and order it as well as save prescription for later reference.

3. Pharmacist: The pharmacist is to login to their account and train the system using the medicine available in the pharmacy as well as scan the box, view scanned medicine on the system , edit it's information if needed ,and delete it them from system .

4. The MPR : will extract features from scanned medical bill , classify the scanned data ,detect desired medicine name and match the algorithm.

Name	Manage User
Code	FR01
Priority	high
Critical	No pharmacist will be able to use the system before the admin adds him/her to the system
Description	The Admin manage all the users and can add,modify,delete,search and list users.
Input	First Name, Last Name,User Name, Email, Password, Telephone, Gender, Job.
Output	Confirmation message or error message if something went wrong upon validating the fields.
Pre-condition	user must log in as admin
Post-condition	: If Add so the database will be updated with the new user ,if modify the user so database will edit the user information ,if the admin delete the user so it will be deleted from the database etc.. .
Dependency	Admin cannot manage users without logging in as admin
Risk	Pharmacist cannot log in into the system and to avoid this risk , Help button appear to connect the pharmacist with the help desk

Table 2: Manage User Function Description

Name	User Log-in.
Code	FR02
Priority	High
Critical	No one could use the system without logging in with existing email and password in the database
Description	The User logs into his account.
Input	User's Email and password.
Output	The homepage is previewed(User's account) and Log-in successful message or error message upon validating the fields.
Pre-condition	user must have existing email and password in the database approved by the admin
Post-condition	Redirected to the User's account page.
Dependency	User cannot log in without existing email and password in the database
Risk	Pharmacist cannot log in into the system and to avoid this risk , Help button appear to connect the pharmacist with the help desk

Table 3: User Log-in. Function Description

Name	Prescription Cropping
Code	FR03
Priority	Extreme
Critical	Prescription must be cropped to 3 parts to make the system do its processing on the desired part to prevent useless processing
Description	prescption cropped to 3 parts.
Input	Image name.
Output	Header, footer and middle part that contains prescribed medcines and stored to the database.
Pre-condition	Desired image already stored in the database.
Post-condition	cropped prescriptions are to be stored in the database.
Dependency	Prescription image must exist in the database and pre-processed
Risk	Processing will be applied on the whole prescription if it is not cropped so the processing time will increase, to avoid this risk, processing phase won't start before pre-processing phase session completely done as it contains the cropping operation

Table 4: Prescription Segmentation Function Description

Name	Prescription Segmentation
Code	FR04
Priority	Extreme
Critical	Prescription must be segmented to lines and then to words to control the images saved in the dataset and prevent saving unused words
Description	Prescriptions are being extracted from documents to lines, from lines to words.
Input	Image name..
Output	prescriptions have been segmented to lines, words and stored to the database.
Pre-condition	Desired image already stored in the database.
Post-condition	segmented prescriptions are to be stored in the database.
Dependency	Prescription must be pre-processed and cropped
Risk	Matching won't be accurate , to avoid this risk ,processing phase won't start before pre processing session is completely done as it includes the segmentation operation

Table 5: Prescription Cropping Function Description

Name	Matching.
Code	FR05
Priority	Extreme
Critical	This function is responsible for detection the accuracy
Description	Features of same medicine to be matched with another features to detect the accuracy between them.
Input	Image name.
Output	none.
Pre-condition	Desired features already stored in the database.
Post-condition	None.
Dependency	
Risk	Accuracy couldn't be detected if the matching algorithm didn't work well,to avoid this , algorithm to do regular check on the matching algorithms and ensure it's free from any errors and bugs

Table 6: Matching Function Description

Name	Manage medicine list
Code	FR06
Priority	Extreme
Critical	The function responsible for updating the medicine list that used as a reference for the pharmacist when training new medicines
Description	The Admin can add, delete, list or update a medicine in the medicine list
Input	Data set of medicines
Output	Confirmation notification with the action approved
Pre-condition	For the delete/update actions there must be an exist medicine.
Post-condition	Data set is successfully added/deleted/listed or updated
Dependency	User log in as admin to manage the medicine list
Risk	if the medicine list not managed , the list won't be updated so the training of new medicine will not work well, to avoid this risk, algorithm do regular check on the list to ensure it's updated

Table 7: Manage medicine list Function Description

Name	Manage medicine hand-writings images
Code	FR07
Priority	Extreme
Critical	The function responsible for organizing the dataset that contains all the hand writings of the medicines
Description	The Admin can add, delete, list or update image of the handwriting of the medicine in the dataset
Input	Data set of images of hand-writings of the medicines
Output	Confirmation notification with the action approved
Pre-condition	For the delete/update actions there must be an exist image of the handwriting of the medicine.
Post-condition	Data set is successfully added/deleted/listed or updated
Dependency	User log in as admin to manage the medicine images list
Risk	Accuracy will not be accurate of the dataset not managed well, to avoid this risk,verification algorithm done to check that the one who manages the dataset is the admin

Table 8: Manage Hand-writings medicines images Function Description

Name	User's data Encryption
Code	FR08
Priority	Extreme
Critical	The function responsible for protecting users data
Description	The system must encrypt the user's data
Input	User's data like ID, password
Output	User's data encrypted
Pre-condition	There must an existing a valid user's data
Post-condition	User's data successfully encrypted
Dependency	The user has existing data in the database to be encrypted.
Risk	User data may be not safe of its not encrypted, to avoid this risk , algorithm to do regular check on the encryption algorithm to ensure its free from errors and bugs

Table 9: User's data Encryption

Name	User's data decryption
Code	FR09
Priority	Extreme
Critical	User data must appear for him/her in the system decrypted
Description	The system must decrypt the user's data
Input	User's data encrypted like ID, password
Output	User's data decrypted
Pre-condition	There must an existing encrypted a valid user's data
Post-condition	User's data successfully encrypted
Dependency	The user has existing data in the database to be decrypted.
Risk	If users data not decrypted, user won't be able to read his personal data , to avoid this risk,algorithm to do regular check on the decryption algorithm to ensure its free from errors and bugs

Table 10: User's data decryption

Name	Medicine name Feature extraction
Code	FR10
Priority	Extreme
Critical	Features of medicine hand-writings must be extracted to be compared with trained dataset
Description	The system can extract the medicine name handwriting features .
Input	Image of the handwriting of the medicine
Output	List of features values extracted
Pre-condition	The prescription must be scanned as an image
Post-condition	None
Dependency	Prescription must be scanned first
Risk	System won't be able to detect the medicine name if it can't the features, to avoid this risk, notification sent to the help desk to solve the problem

Table 11: Medicine name Feature extraction

Name	Data set training.
Code	FR11
Priority	Extreme
Critical	The function responsible for increasing the accuracy of the system as by increasing the training examples accuracy will increase
Description	The system trains a group of images "data-set" that belongs to the same medicine based on Neural networks algorithm to be able to identify the medicine name hand-writing in the future.
Input	Array of images of medicine name handwritings
Output	None
Pre-condition	at least one images stored in the database.
Post-condition	None
Dependency	Training samples exist
Risk	Accuracy won't be accuracte if the traing process not worked well, to avoid this risk, train the system with big no number of training samples and regular check on the training algorithms to ensure its free from errors and bugs

Table 12: Data set training.

Name	Sign Out
Code	FR12
Priority	low
Critical	The function responsible to ensure that no one except the signed in user uses the system after he/she signed out
Description	This function is done to get the user of the system.
Input	None
Output	Boolean true or false.
Pre-condition	User must be logged in.
Post-condition	Redirection to home screen.
Dependency	User must be logged in first
Risk	If the user not signed out after finishing using the system, anyone could mis-use the system by his account,to avoid this risk , session applied that ends in a specific time and make the user signed out automatically after specific period of time

Table 13: Sign Out

Name	Delete Account
Code	FR13
Priority	low
Critical	Function Responsiple for deleting user's account if hi/she no longer use it.
Description	This function is done to make the user able to delete his account.
Input	None
Output	Confirmation of successfully deleting the account.
Pre-condition	User Id is found.
Post-condition	User is deleted from the database.
Dependency	User mus have an existing account
Risk	no risks

Table 14: Delete Account

Name	Update Account
Code	FR14
Priority	low
Critical	The function responsible for updating user's information on his/her account
Description	This function is done to make the user able to update his account information.
Input	New user information.
Output	Confirmation of successfully updating the account.
Pre-condition	User Id is found.
Post-condition	User's information is updated in the database
Dependency	The user must have existing account
Risk	The updating process not done by the actual user and done by someone else , to avoid this risk, email sent to the user to inform him/her that the profile is updated by new information.

Table 15: Update Account

Name	Predict medicine name
Code	FR15
Priority	Extreme
Critical	The function responsible for displaying the result of the system
Description	This function is done to predict the label of a certain input text.
Input	The text that would be classified and number of K. Output K numbers of labels that the text would be classified into them and the probabilities of each label.
Output	Predicted medicine name
Pre-condition	Having a trained supervised data set.
Post-condition	The text is classified to K labels.
Dependency	Feature extraction applied on the new tested medicine name
Risk	No result found, to avoid this risk, notification sent to the help disk to solve this issue

Table 16: Predict medicine name

5 Interface Requirements

5.1 User Interfaces

5.1.1 GUI

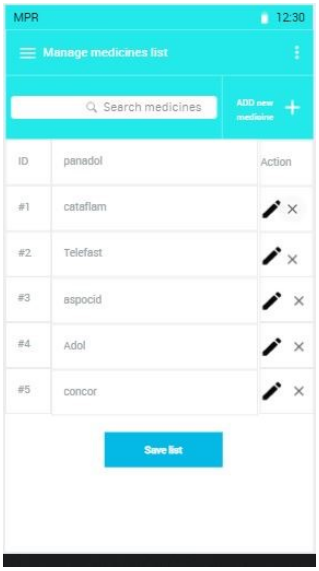

Figure 6: manage medicine list by admin

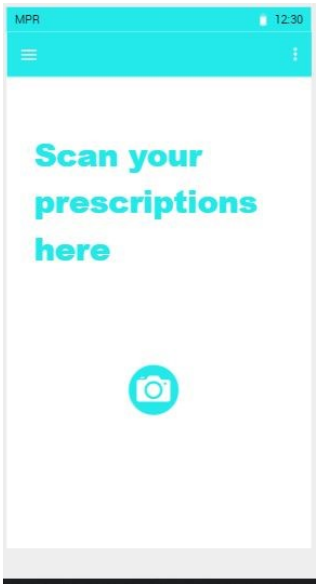

Figure 7: home page, scan prescription

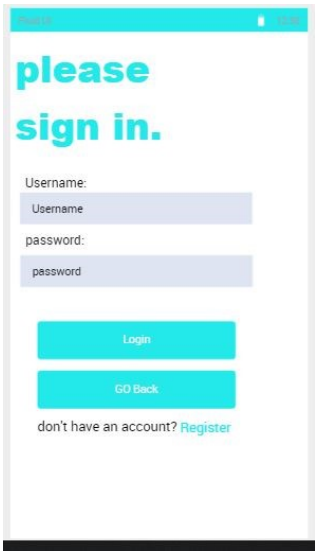

Figure 8: sign in page

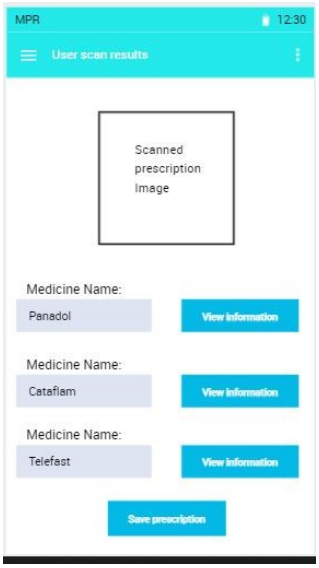

Figure 9: results that appear to pharmacist

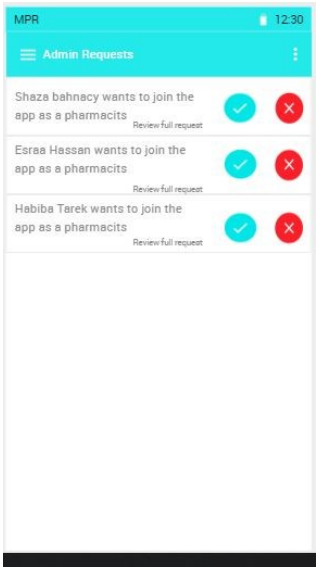

Figure 10: Admin, approve and reject signUp requests

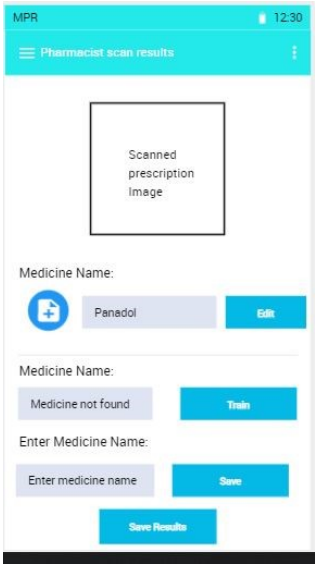

Figure 11: results that appear to pharmacist

5.2 Communications Interfaces

Internet Connection or localhost connection will be needed in the stage Communication interface as it is obligatory to have one connection of them in order to explore the application.

5.3 API

Python Libraries:

- **Nltk Libraries**: is a leading platform for building Python programs to work with human language data. It provides easy-to-use interfaces to over 50 corpora and lexical resources,along with a suite of text processing libraries for classification, tokenization, stemming, tagging, parsing, and semantic reasoning, wrappers for industrial-strength NLP libraries.[22]

- **Numpy Libraries**: NumPy is a Python library used for working with arrays.It also has functions for working in comprehensive mathematical functions, random number generators, linear algebra routines, Fourier transforms, and more. Along side, it is Fast and flexible.[23]

- **Sklearn Libraries**: The sklearn library contains a lot of efficient tools for machine learning and statistical modeling including classification, regression, clustering and dimensionality reduction. Some of its features, Cross-validation which there are numerous methods to examine the accuracy of supervised models on unseen data. Also, Feature extraction used for extracting features from images and text.[24]

- **Deploy the machine learning model in flutter**: Flutter is Google's UI toolkit for building beautiful, natively compiled applications for mobile, web, and desktop from a single codebase.[25] And it is used to develop applications for Android, iOS, Linux, Mac, Windows, Google Fuchsia.[26][27]

- **Firebase API.**: It is a cloud-hosted database. Data is kept as JSON and synchronized in realtime to every connected client. When you construct cross-platform apps with Android, iOS, and JavaScript SDKs, all the clients share one Realtime Database instance and instinctively receive updates with the latest data. [28]

6 Design Constraints

The system will be deployed as a mobile application , the deployment should be on smart phone that is working by either IOS or Android operating systems. Android Jelly Bean, v16, 4.1. x or newer, and iOS 8 or newer.

6.1 Hardware Limitations

The mobile camera resolution must not be less that 64 Mega Pixels.

7 Non-functional Requirements

1. Security : User's Id and Password should be encrypted by hashing functions to be securely saved in the database.

2. Maintainability : The system should be sustainable enough because it could be enhanced in the future, so the design and code should be documented by using different design patterns such as Model View Controller design pattern.

3. Portability: The system should be compatible with both Computer and Mobile Devices, so it can be accessed easily and accessible at anytime.

4. Usability: The system is easy to use as its functionality is uncomplicated.

5. Reliability: The system shall be real time system in approving and rejection requests by admin.

8 Data Design

8.1 Data Description

Our dataset is collected from real doctors' prescriptions to read and recognize doctor's handwriting. Dataset will be collected from Drug distribution companies. So far, our dataset contains 5 medicine names, and each medicine name is written with different doctor's handwriting which results in 50 doctors' prescription which contain header and footer and the middle part which will be segmented to extract the medicine name and its dosage. The header part will contain the doctors' major or job and that will help the system search in which folder the medicine name is. In addition, there will be 3 users to this system: patient, pharmacists, and admin. Furthermore, the entity keys are the IDs of each function that the system has.

8.2 Database design description

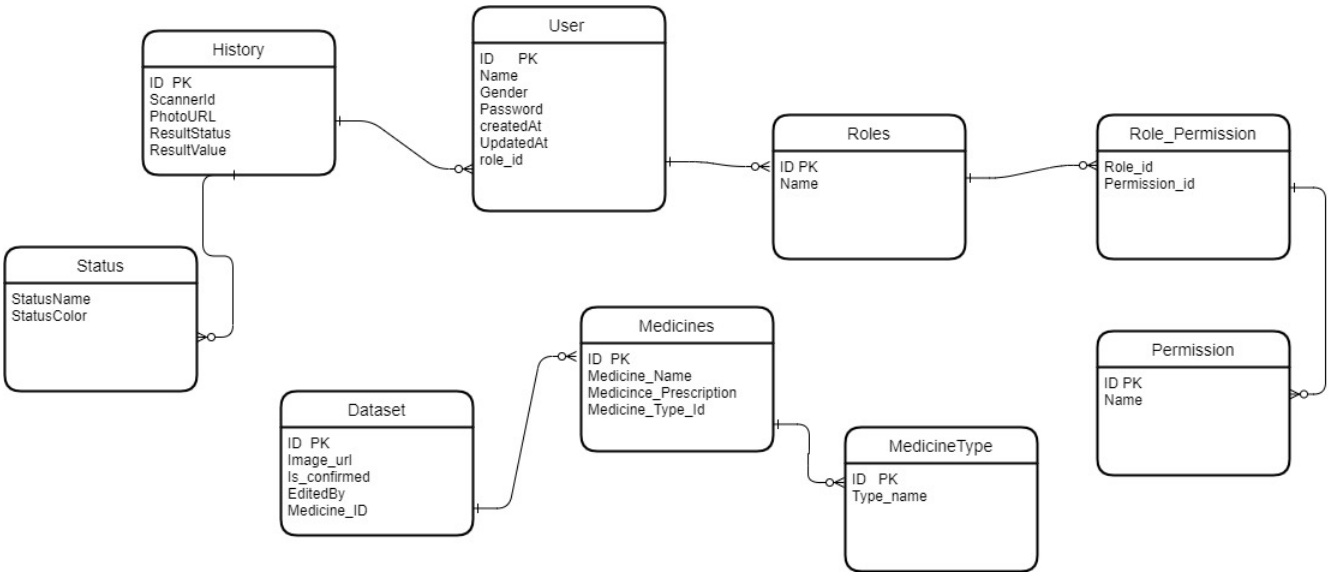

Figure 12: database schema

9 Preliminary Object-Oriented Domain Analysis

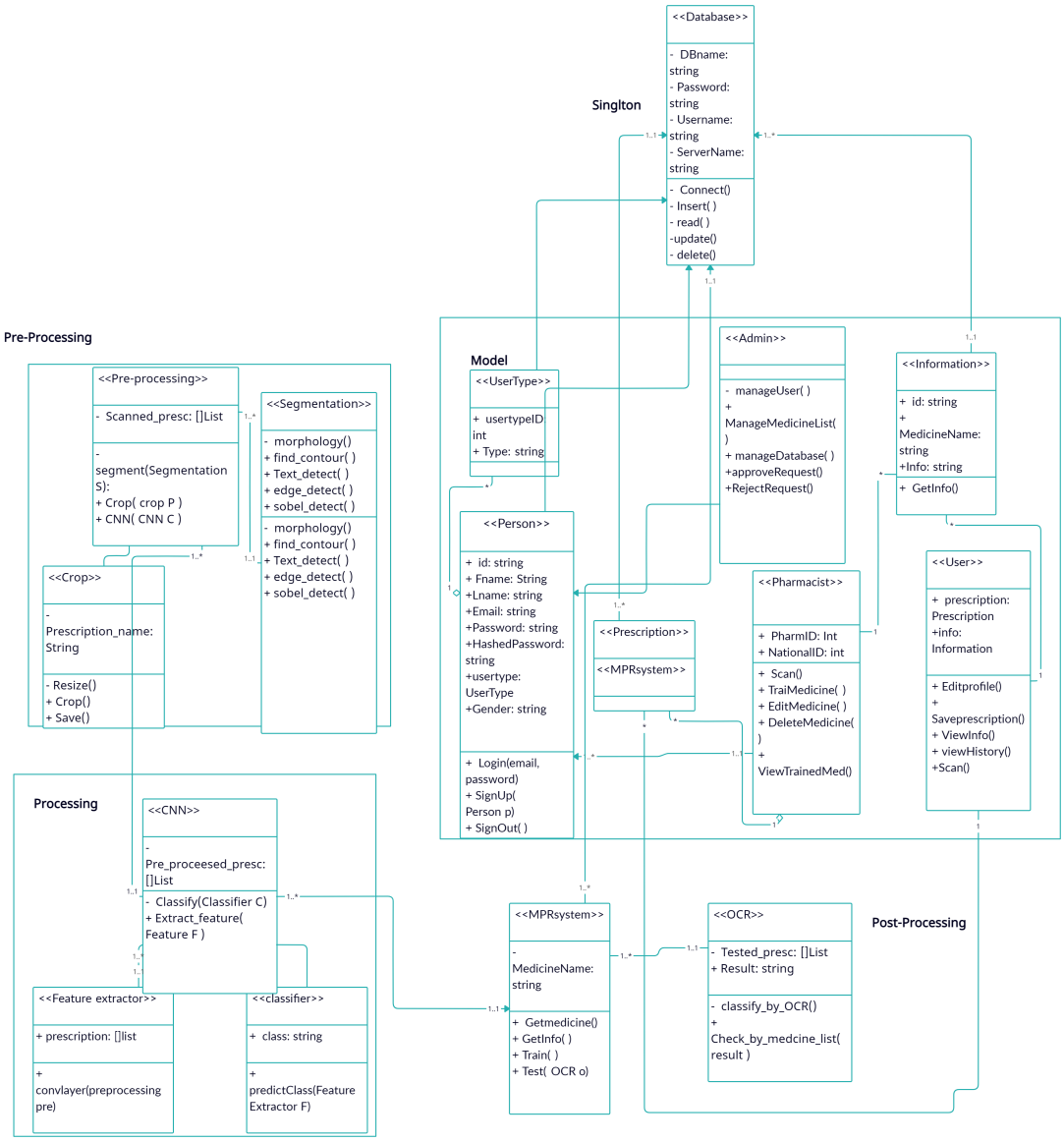

Figure 13: Class diagram

9.1 Inheritance Relationships

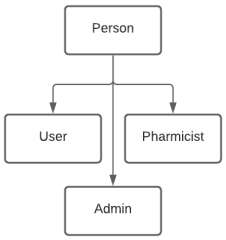

Figure 14: Inheritance diagram

9.2 Class descriptions

Abstract or Concrete:	concret
List of Superclasses	None
List of Subclasses	None
Purpose	connection of dtabase, insertion ,deletion ,update in database
Collaborations	person, usertype, prescription, MPR system
Attributes	DBname, Servername, Password, Username
Operations	Connect (), Insert(), Update(), delete()
Constraints	None

Table 17: Database

Abstract or Concrete:	concrete
List of Superclasses	None
List of Subclasses	Pharmacist, user, Admin
Purpose	Identify user information and type
Collaborations	User, Pharmacist, Admin
Attributes	Id, Fname, Lname, password, Hashed password, Usertype, Gender
Operations	Login (), Sign up(), Sign out(),
Constraints	None

Table 18: Person

Abstract or Concrete:	concrete
List of Superclasses	Person
List of Subclasses	None
Purpose	Identify user and it's functions
Collaborations	person, prescription , pre-processing, information
Attributes	prescription, information
Operations	Edit profile (), Save prescription(), View info(), Scan(), view History()
Constraints	None

Table 19: User

Abstract or Concrete:	concrete
List of Superclasses	Person
List of Subclasses	None
Purpose	Identify Pharmacist and it's functions
Collaborations	person, prescription , pre-processing, information
Attributes	PharmID, NationalID
Operations	Scan (), TrainMedcine(), View TrainedMedcine(), EditMedcine(), DeleteMedcine()
Constraints	None

Table 20: Pharmacist

Abstract or Concrete:	concrete
List of Superclasses	Person
List of Subclasses	None
Purpose	Identify Admin and it's functions
Collaborations	person, AdminController
Attributes	inherited from class person
Operations	ManagemedcineList(), ApproveRequest(), RejectRequest(), Manage-Database()
Constraints	None

Table 21: Admin

Abstract or Concrete:	concrete
List of Superclasses	None
List of Subclasses	None
Purpose	Identify pre-processing functions
Collaborations	User, pharmacist, featureExtraction
Attributes	scanned prescription
Operations	Segment (),Crop(),GetPrescription(), ManageDatabase()
Constraints	None

Table 22: Pre-processing

Abstract or Concrete:	concrete
List of Superclasses	None
List of Subclasses	None
Purpose	Identify feature extraction functions
Collaborations	Pre-processing, classifier
Attributes	scanned prescription
Operations	ConvLayer()
Constraints	None

Table 23: Feature Extraction

Abstract or Concrete:	concrete
List of Superclasses	None
List of Subclasses	None
Purpose	Identify Classifier functions
Collaborations	Feature extraction , MPR system
Attributes	class
Operations	PredictClass()
Constraints	None

Table 24: Classifier

Abstract or Concrete:	concrete
List of Superclasses	None
List of Subclasses	None
Purpose	Identify Information of medicines
Collaborations	Pharmicist, User
Attributes	id,medcineName, info
Operations	getInfo()
Constraints	None

Table 25: Information

Abstract or Concrete:	concrete
List of Superclasses	None
List of Subclasses	None
Purpose	Identify MPR system functions
Collaborations	Database, Classifier
Attributes	medcineName
Operations	getInfo(), getMedcineName, TrainMedcine()
Constraints	None

Table 26: Information

10 Operational Scenarios

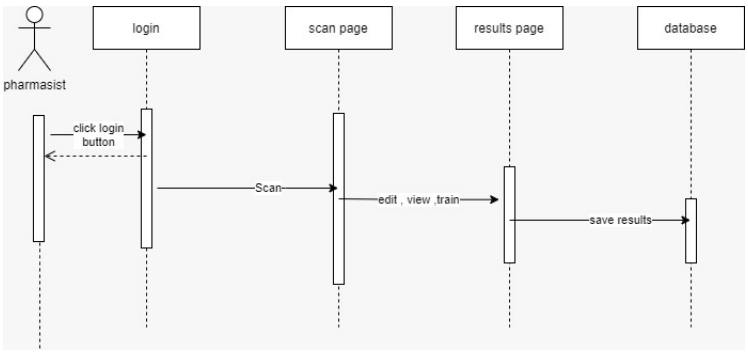

Figure 15: sequential diagram

The pharmacist clicks on the login button after entering his username and password to be able to access his account. After that he is to be directed to the scan page where he can scan the medical prescription then he will be directed to the results page and will be able to edit and view medicine details . In case of a medicine not in the database the pharmacist will be able to train and add to the new medicine to database.

11 Project Plan

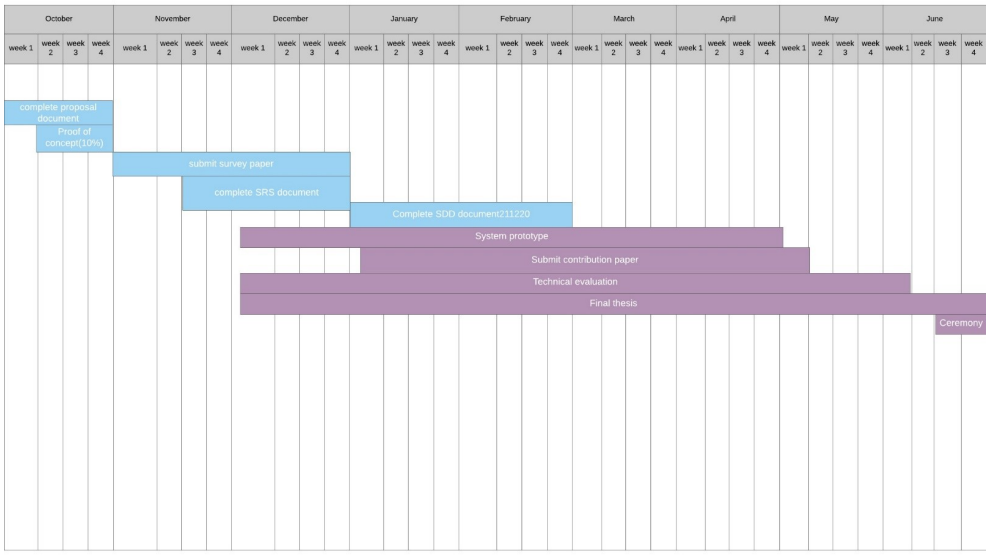

Figure 16: Gantt chart

Table 27: Project name time plan

Id	Task	Start Date	End Date	Team Member
1	Collection dataset	20/7/2020	20/10/2020	Esraa
2	Complete Pre-processing phase	27/10/2020	20/10/2020	Esraa ,habiba
3	Complete classification phase	20/10/2020	30/12/2020	Mai,shaza
5	Complete post processing phase	20/10/2020	15/1/2021	Esraa,Shaza
6	implement mobile app UI	15/1/2021	25/1/2021	Habiba ,Mai
7	Implement mobile app backend	25/1/2021	5/2/2021	Shaza , esraa
8	Integrate project with mobile app	5/02/2021	20/02/2021	Esraa
9	Evaluating application	20/2/2021	25/03/2021	Mai
10	Training application	25/03/2021	25/04/2021	Shaza, Habiba

12 Appendices

12.1 Definitions, Acronyms, Abbreviations

- Convolutional neural network : is a type of artificial neural network used in image recognition and processing that is specifically designed to process pixel data.
- medical prescription : A physician's order for the preparation of a drug for a patient.A prescription has several parts, They include the superscription or heading with the symbol "R".
- ReLU: A Rectified Linear Unit is a form of activation function used commonly in deep learning models.

12.2 Supportive Documents

The MNIST database (Modified National Institute of Standards and Technology database) is a large database of handwritten digits that is commonly used for training various image processing systems.The database is also widely used for training and testing in the field of machine learning.[29]

Drugs.com Medication Guide mobile application ,Drugs.com is the most popular, comprehensive and up-to-date source of drug information online. Providing free, peer-reviewed, accurate and independent data on more than 24,000 prescription drugs, over-the-counter medicines natural products , it will be the reference for the dataset that contains all the medicines that we will be using in our project.[30]

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