Software Requirements Specification
Dermatologist Assistant

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1 Introduction

1.1 Purpose of this document

The purpose of this software requirements specification document is to present the requirements for skin cancer detection and the treatment of each disease. The main requirements for this software were to be able to identify whether the patient has this kind of cancers. If the patient happens to have a cancer then it should be segmented accurately as it has been found that it is a common problem to most of the doctors to identify the type of cancer.

1.2 Scope of this document

This document targets the doctors which will integrate with this software. And the patient that gone use it , which will save much more time rather than manual inspection. It will also be beneficial and helpful for researchers and developers that may work on the skin cancer application

1.3 Overview

In skin Cancer application we will implement a non-existing system with a high accuracy, speed differentiation and detection of various type of cancers . Cancer Chaser goes through three essential stages. Firstly, uploading image for skin. Secondly, testing the image after applying different algorithms. Finally, classifying whether the disease is (melomna, basic cell cariona, nevus) The application workflow is illustrated in the block diagram . the . Starting with pre-processing which will be performed on the uploaded image from mobile phone that will be made on the mobile . Then, segmentation by applying threshold which will be made on the server . After that is feature extraction, mainly extracting 11 features which are (Mean , Standard Deviation ,Skewness ,Kurtosis ,Smoothness, Homogenity , Contrast , Energy,Entropy,surf,sift). Final step is classification using different algorithms to train and test the dataset. The system stores medical records to save patients medical history And the system have a doctor sign up that is made by the admin and the patient can register easily . It also has the ability of learning from misclassified tests to enhance the future accuracy of the system. Our proposed system contains two contributory approaches. The first approach works under the direction of the doctor who test the input image into which type of cancer . The second approach works automatically without the doctor expectation of the input skin test image. we have used two classifiers which is Support vector machine (svm) , k-nearst neighbour (knn) . then after classification the type of the disease a look up table is their for each cancer treatment or making a surgery we will only run the prepossessing on the mobile and the other tasks will be run on the cloud server The proposed system will work as show in figure(1)

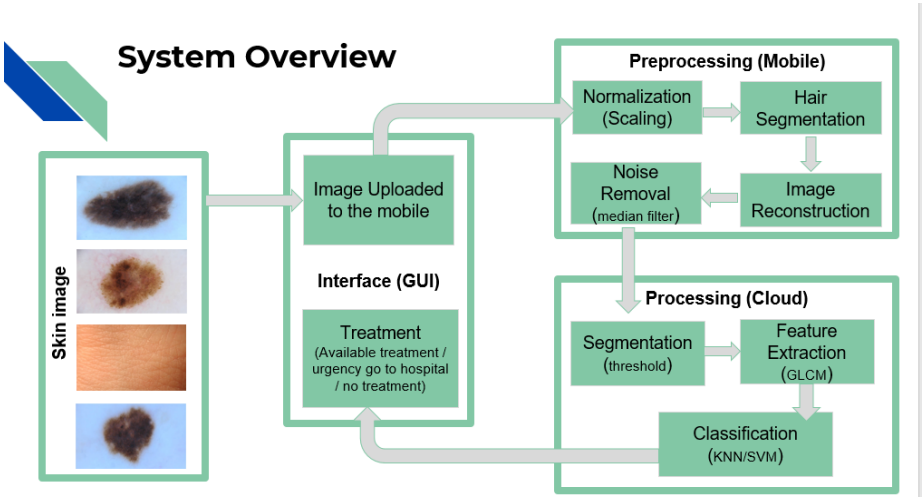

Figure 1: Dermatologist over view

1.4 Business Context

Luckily, digital technologies are on their way to help dermatologists diagnose and treat skin diseases better and more effective. Looking at dermatology, it will probably not experience such a radical turn as surgery, but the shift will still be determining. Technology has been shaping dermatology praxises for years, and this will accelerate in the coming years. Deep learning algorithms are especially good at recognizing certain images, thus they will certainly have a place in the future of medical specialties dealing with medical imaging, such as radiology or dermatology. For example, IBM decided to let dermatologists leverage on the results of its deep learning platform, Watson in order to diagnose melanoma and other types of skin cancer faster, more accurate and preferably without the need for many biopsies. At the IBM T.J. Watson Research Center, experts found that their deep learning system was able to achieve a 76% accuracy at diagnosing melanoma cases based on dermatology images, while the average accuracy for the eight dermatologists on that data set was 70.5%. It is a very promising result! [2] Researchers at Stanford University carried out a similar experiment. They created an artificially intelligent diagnosis algorithm for skin cancer with the help of an algorithm developed by Google that was already trained to identify 1.28 million images from 1,000 object categories. Then, they made a database of nearly 130,000 skin disease images representing over 2,000 different diseases; and trained their algorithm to visually diagnose potential cancer. From the very first test, it performed with inspiring accuracy. It performed at least as well as dermatologists participating in the research, which is very impressive! [3]. For this purpose we are developing our proposed system to make algorithm smartphone compatible in the near future, bringing reliable skin cancer diagnoses to our fingertips.

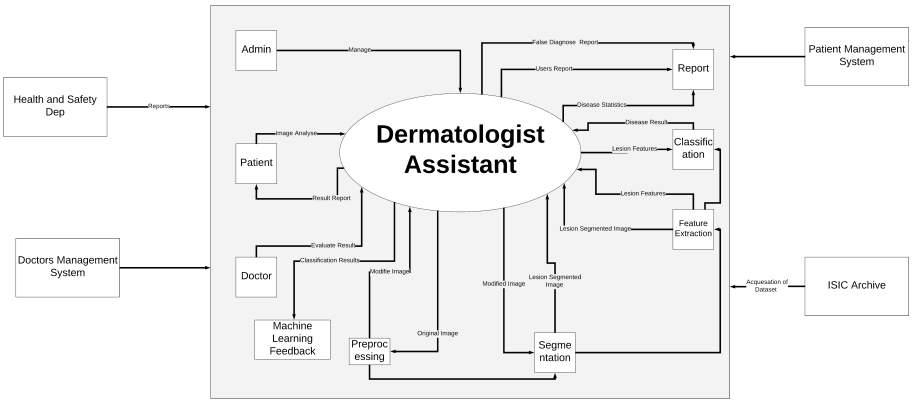

Figure 2: Dermatologist System Context Diagram

2 General Description

2.1 Product Functions

"Dermatologist Assistant" is an mobile application and computer-aided diagnosis (CAD) tool with an objective of speeding up the detection of lesion areas in skin. Our proposed system is available for all users types that are concerned with dermatology (Skin Cancer) issues. All that appears as options through a friendly GUI, after capturing any lesion are and request classification for it.

2.2 User Characteristics

In this paper, we proposed a system that deals with dermatology issues, therefore, our users are specific. Experts dermatologist will be the first to use our system so they can approve it's accuracy and performance, then we will open the system for the public usage. Once the public usage us opened we will be exposed to two more different types of users which are:

1. Dermatologist Trainees or beginners who will have this system as a tool to sharp their skills and improve their diagnosing.

2. Patients, as we aim to share with this proposed system with them to help with having self diagnosing tool so they can be self treated without the need of going to an expert doctor and spending money and time.

3 problem statement

Dermatologist consume a long time and effort in diagnosing skin diseases, and The classification result for images are difference from one doctor to another, Misdiagnosis and medical errors are common nowadays, it is dangerous because

it often results in unnecessary, and dangerous treatments. The market currently lacks a system which automatically detects skin cancer diseases with high accuracy to reduce the confusion that may cause misclassification due to similar visual features between diseases to save time, effort and money.

3.1 User Problem Statement

Simple neural networks that achieve a modest level of accuracy are not difficult to create; however, a system that can achieve an accuracy viable for clinical use is quite challenging, such as

- Variations between size and shape.
- Contrast between where the lesions begin and end
- Artifacts such as hair color and veins.
- Vascular structures are small, complex and normally occluded by other cutaneous structures such as skin pigmentation, which makes their detection even more challenging.

The previous conventional studies have several problems:

- Only limited types of skin lesions are acceptable for classification.
- The systems do not explain the reasons for the classification results.
- The systems were developed and evaluated with only ideal condition images and did not consider the condition of test images.

So our proposed system aims to get a higher accuracy and develop the application to serve these problems. Allowing the users understand the diagnose process.

3.2 User Objectives

"Dermatologist Assistant" is an application which is a system that serves the dermatology. The system allows the user to capture a skin lesion helping the user to diagnose, also it provide the user with a diagnose report and treatment for the diagnosed disease. All of these features appears through a friendly easy GUI.

3.3 General Constraints

There is no system that has no constrains, our system will have some constrains related to the hardware and the software sections:

- Hardware

1. Our system will work only on mobiles support cameras with at least 360 resolution, with dermoscopy lances attached to it.
2. Our system will work only with mobiles with RAM 2 GB and above.

- Software

1. Our System will work only on Android.
2. Our system will work only on mobiles supporting API 14.0 and above.
3. Our system will only support two languages: Arabic and English.

- Processing

1. Large database
2. Complexity of recognition process
3. Speed of user internet

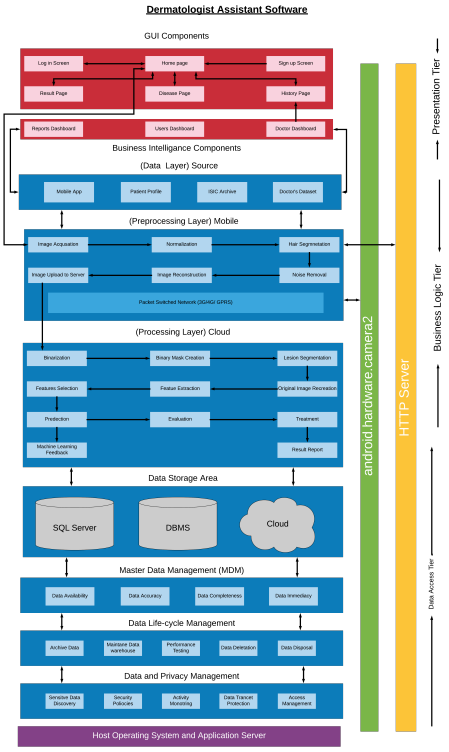

Figure 3: Dermatologist Assistant System Block Diagram

4 Functional Requirements

4.1 pre-processing

4.1.1 Binarization

Requirement :This function is used to take an image, turn it into binary which is a digital image that has only two possible values for each pixel. And the two colors are black and white. It gives 0 for black color and 1 for white color.
input: An image containing skin lesion.
output: A binary (digital) image to be used in pre-processing .

4.1.2 Filter for noise removal

Requirement: This function is used to take the binary image. And apply a [3x3] median filter to remove the noise in this image(one or two connected pixels in the background) , And this filter is a matrix contains the binary number which express the background of this image , To make this pixel the same color of the background.
Input: An image to be binary.
Output: The original image without noise

4.1.3 Hair segmentation

Requirement: This function is used to take the binary image. And apply an adaptive threshold algorithm to remove the hair in this image.
Input: An image to be binary.
Output: The original image without hair.

4.1.4 Image reconstruction

Requirement: This function is used to take the binary image after binrization, apply a (5x5) matrix on the image to fill the gaps occurred from the hair segmentation. This filter is used to be applied on all the possibilities that will make a gap in the skin , And this gap means that two connected pixels or one pixel has the same color of the background in the image. So the filter turn all these possibilities to the color of the skin to decrease the percentage of making gaps in the skin.
Input: An image to be binary.
Output: The original image without gaps.

4.1.5 Normalization

: This function is used to take the binary image after binrization, apply a scaling algorithm on it and re-scaled to the a predefined size.
Input: An image to be binary.
Output: The original image scaled to a predefined size.

4.2 Segmentation

Requirements : This function is used to take a binary image after binarization and generate a binary mask of the lesion area aftshown r detecting its edges, as shown in figure(3).
Input: An image to be binary.
Output: Images contain segmented lesion and the divided lesion.

Figure 4: Image Segmentation

Figure 5: Lesion Segmentation

4.3 Feature Extraction

Requirements: For each disease its own unique features and vectors we need to extract to classify the data in advanced stages.
Input: Preprocessed image
Output: List of points for features

4.4 Training

Requirements: The system needs to be trained on a huge database of skin lesions to be able to recognize the input data.
Input: data file to be trained. The data file is a file containing the chain code of the input images to be trained in a special format.
Output: model file. model file is a file created by train class contains all the chosen parameters whether we are using one label or multi-labeling classification.

4.5 Classifying Image

Requirements: The system classify the image into one of the three diseases.
Input: Preprocessed image, model file.
Output: Result file

FID	FR1.
Name	Login.
Description	All employees and patients should login to save the results. So it must have an account.
Input	Username and Password.
Output	Login successful / Login Failed.
Pre-condition	no data can access.
Post-condition	Login Successful without failure.
Action	It take the username and password and check if he had a valid account or not and also the password must be encrypted .
Dependencies	none
Criticality	10/10

FID	FR2.
Name	AddPatient.
Description	Add Patient in the Patient list by the Junior Doctor.
Input	Patient Info.
Output	Data inserted in the Doctor Patient List
Pre-condition	The Data is not inserted in the database.
Post-condition	The Data Inserted Successfully.
Action	It take the Data of the Patient from the Doctor and inserted to the Database
Dependencies	Login(FR1).
Criticality	10/10

FID	FR3.
Name	SearchPatient.
Description	Search Patient in the Patient list
Input	Patient Id.
Output	Patient Record
Pre-condition	having the Id of the Patient.
Post-condition	Get all the Record of the Patient.
Action	Searching for patient's Record.
Dependencies	Login(FR1).
Criticality	10/10

FID	FR4.
Name	DeletePatient.
Description	Delete Patient form the Patient list by the Doctor .
Input	Patient Record
Output	The Record Deleted
Pre-condition	The Record in the Database.
Post-condition	The Record Deleted form the Database.
Action	It takes the record of the Patient and delete it from the Database.
Dependencies	SearchPatient(FR3).
Criticality	10/10

FID	FR5.
Name	EditPatient.
Description	Edit Patient in the Patient list by the Doctor.
Input	Record of the Patient
Output	Record updated
Pre-condition	The Record with the Old Data in the Database.
Post-condition	The new data is inserted successfully in the Database.
Action	Takes the id of the Record and the New Item he want to update to and update it in the database.
Dependencies	SearchPatient(FR3).
Criticality	10/10

FID	FR6.
Name	ListPatient
Description	List all the Patient for the Doctor.
Input	Patient Id.
Output	All the Patients for the Doctor.
Pre-condition	List of Patient is not available.
Post-condition	The Data of the Patients listed successfully.
Action	It take the Data of the Patient from the Doctor and inserted to the Database.
Dependencies	AddPatient(FR2).
Criticality	10/10

FID	FR7.
Name	UploadImage.
Description	The doctor should upload the patient image to start process of diagnose patient.
Input	Image id.
Output	Image
Pre-condition	no image to diagnose..
Post-condition	image diagnoses.
Action	Image is Uploaded and started diagnose.
Dependencies	
Criticality	7/10

FID	FR8.
Name	AddDoctor.
Description	Add Doctor in the Doctor list of the admin.
Input	Doctor Info.
Output	Data Added inserted by admin in Doctor List
Pre-condition	The Data not yet Inserted
Post-condition	The Data Inserted Successfully.
Action	Take the Data of the the Doctor and inserted to the Database
Dependencies	Login(FR1).
Criticality	7/10

FID	FR9.
Name	SearchDoctor
Description	Search Doctor in the Doctor list of the admin
Input	Doctor Id
Output	Doctor Record
Pre-condition	having the Id of the Doctor.
Post-condition	Get all the Record of the Doctor.
Action	Give the Id to the function and it Search in the admin Doctor list and then return the Record the admin want.
Dependencies	Login(FR1).
Criticality	10/10

FID	FR10.
Name	DeleteDoctor.
Description	Delete Doctor form the Doctor list of the admin
Input	Doctor id
Output	The Record Deleted
Pre-condition	The Record found in the Database.
Post-condition	The Record Deleted form the Database.
Action	It takes the id of the Doctor and delete it from the Database.
Dependencies	SearchDoctor(FR9).
Criticality	10/10

FID	FR11.
Name	EditDoctor
Description	Edit Doctor in the Doctor list of the admin
Input	Id of the Doctor
Output	Record updated
Pre-condition	The Record with the Old Data.
Post-condition	The new data is edit successfully.
Action	It takes the id of the Record and the New Item he want to update to and update it in the database.
Dependencies	SearchDoctor(FR9).
Criticality	10/10

FID	FR12.
Name	ListDoctor
Description	List all the Doctor for the admin.
Input	Id of the Doctor
Output	All the Doctors
Pre-condition	List of Doctor is not available.
Post-condition	The Data of the Doctors listed successfully.
Action	It takes the id of the Doctor from the admin and list it from database.
Dependencies	Login(FR1).
Criticality	10/10

FID	FR13.
Name	Threshold
Description	Convert the gray scale image into binary image.
Input	Grayscale image and threshold value.
Output	Threshold binary image
Pre-condition	image
Post-condition	The image is converted to binary image.
Action	It take the input image as gray scale and converts into binary image according to the threshold value
Dependencies	UploadImage(FR7).
Criticality	7/10

FID	FR14.
Name	ClearBorder
Description	Function is used to clear border of image.
Input	Image.
Output	Image.
Pre-condition	Normal Threshold image.
Post-condition	Threshold image without borders.
Action	It takes the binary image and convert it to cleared border image with no borders.
Dependencies	Threshold(FR13).
Criticality	7/10

FID	FR15.
Name	AddImage
Description	This function is used to Add new image in the database.
Input	Image path.
Output	Image recorded in the database.
Pre-condition	The image is not found in the database records.
Post-condition	The new image is inserted in the database
Action	Doctor choose new image to add as a record in a specific patient .
Dependencies	none
Criticality	10/10

FID	FR16.
Name	DeleteImage
Description	Helps the doctor to delete any image.
Input	Image id
Output	Image deleted.
Pre-condition	This image have a record in the database.
Post-condition	No record for this image in the database
Action	when the doctor search for an image then he can delete it from the database.
Dependencies	SearchImage(FR17).
Criticality	7/10

FID	FR17.
Name	SearchImage
Description	Helps the doctor to search any image.
Input	Image id record.
Output	Specific Image.
Pre-condition	Image id record.
Post-condition	The image needed.
Action	It takes the id image record and search on it from the database.
Dependencies	AddImage(FR15).
Criticality	7/10

FID	FR18.
Name	EditImage
Description	Helps the doctor to edit any image record.
Input	Image id record.
Output	Edited Image record.
Pre-condition	Image has an old record.
Post-condition	Image record edited
Action	when the doctor search for an image then he can edit the image record.
Dependencies	SearchImage(FR17).
Criticality	7/10

FID	FR19.
Name	edge detectoin
Description	use predefined Edge detection algorithm by calling canny edge detection equation It highlights the edges of the infectied skin
Input	image
Output	image .
Pre-condition	Image before applying edge detection
Post-condition	Image after applying edge detection
Action	it detect the ages of the infected skin
Dependencies	none
Criticality	7/10

FID	FR20.
Name	cnn Classify
Description	this function is used to train data and integrate with it with features to classify new inputs of images.
Input	training features
Output	Result.
Pre-condition	Testing and training available but not calculated with each other .
Post-condition	Training and testing compared with each other and can accept new validation set.
Action	Training features are mentioned including functions for preprocess of images.
Dependencies	addimage()
Criticality	10/10

FID	FR21.
Name	ApplyMedianFilter
Description	It applies the prede ned median filter on the image after removing the noise
Input	Image
Output	Image.
Pre-condition	The image before applying the median filter.
Post-condition	The image after applying the median filter.
Action	It applies the median filter on the image after removing any noise from it.
Dependencies	addimage()
Criticality	7/10

FID	FR22.
Name	ApplyAverageFilter
Description	It applies the average lter on the image.
Input	Image.
Output	Image.
Pre-condition	The image before applying the average filter.
Post-condition	The image after applying the average filter.
Action	It applies the average filter on the image after applying the median filter
Dependencies	ApplyMedianFilter(FR21).
Criticality	7/10

FID	FR23.
Name	ApplyGaussianFilter
Description	It applies the prede ned Gaussian filter on the image.
Input	Image.
Output	Image.
Pre-condition	The image before applying the Gaussian filter.
Post-condition	The image after applying the Gaussian filter.
Action	It applies the gaussian filter on the image after applying the average filter.
Dependencies	ApplyAverageFilter(FR22).
Criticality	7/10

FID	FR24.
Name	CalculateMean
Description	It Calculates the Mean.
Input	Segmented Image.
Output	Image Mean.
Pre-condition	Image's mean is not calculated.
Post-condition	Image's mean is calculated.
Action	Takes the image and calculate the Average of the Pixels.
Dependencies	None.
Criticality	7/10

FID	FR25.
Name	CalculateStandardDeviation
Description	It Calculates the Standard Deviation.
Input	Image.
Output	The standard deviation of the image.
Pre-condition	Standard deviation of the image is not calculated.
Post-condition	Standard deviation of the image is calculated.
Action	calculating the average intensity of the image and then calculating the standard deviation.
Dependencies	CalculateMean(FR24).
Criticality	7/10

FID	FR26
Name	Addtreatment
Description	doctor adds treatment for each disease.
Input	type of disease
Output	the correct treatment
Pre-condition	treatment is not available.
Post-condition	the treatment is added successful .
Action	the doctor enters the specfic treatemnt for each disease and the time to take them
Dependencies	Log in(FR1).,add Doctor(FR8)
Criticality	10/10

FID	FR27
Name	view treatment
Description	patient can view the treatment to take .
Input	result of classified image .
Output	the treatment
Pre-condition	the treatment is not viewed
Post-condition	treatment is viewed
Action	viewing the result of classifction and give the user the best treatment to take and the time he should take them
Dependencies	add treatment (FR26)
Criticality	10/10

FID	FR28
Name	noise removal
Description	remove noise from image
Input	image .
Output	image
Pre-condition	image before noise removal
Post-condition	image after image
Action	removing the noise in image and give a pure image
Dependencies	addimage()
Criticality	7/10

5 Interface Requirements

This section describes how the software interfaces with other software products or users for input or output. Examples of such interfaces include library routines, token streams, shared memory, data streams, and so forth.

5.1 User Interfaces

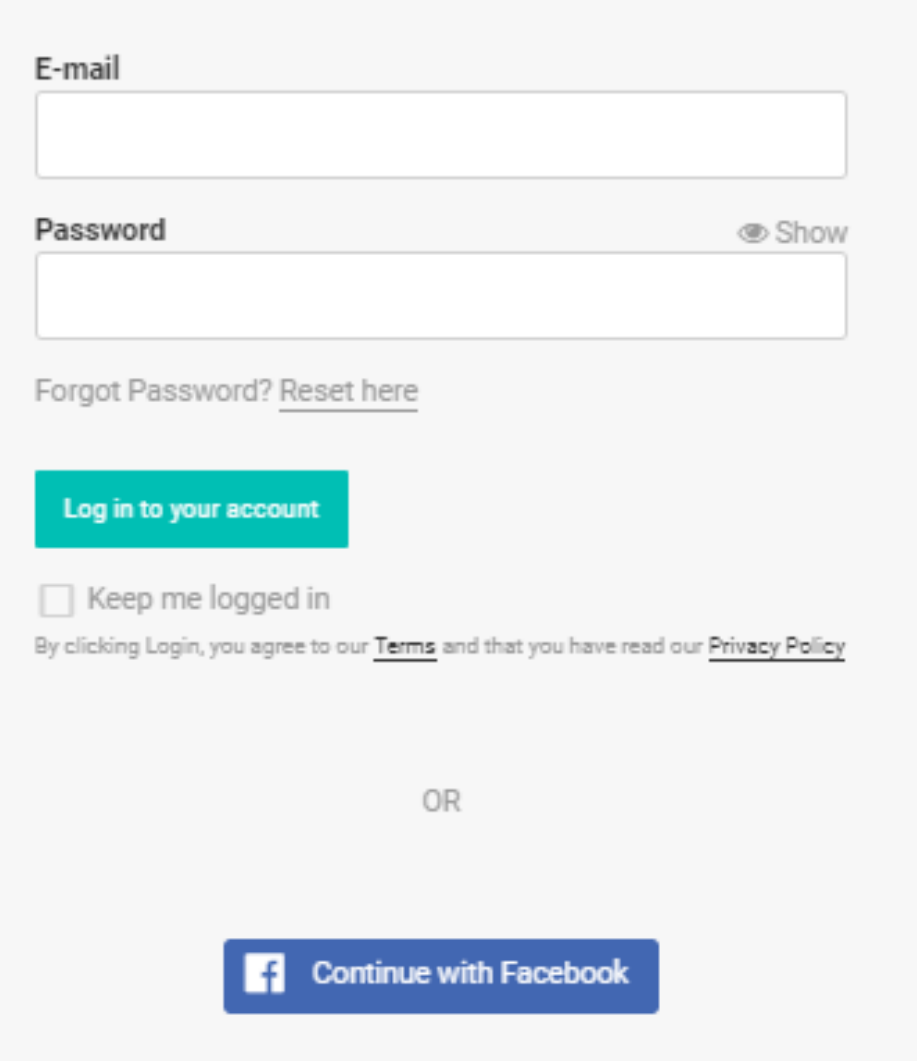

Figure 6: Login Form

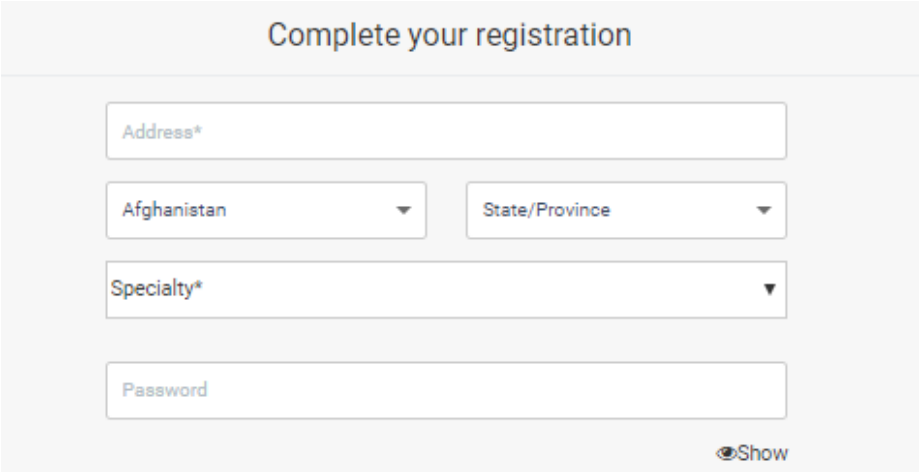

Figure 7: Registration Form

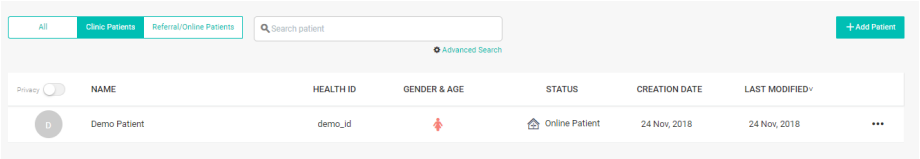

Figure 8: Doctor menu bar Form

5.2 User Interfaces

Our System will interface with the user through a mobile application, the user will enter the image and the system will output the result through the mobile.

5.2.1 API

TensorFlow is an open-source software library for dataflow programming across a range of tasks. It is a symbolic math library, and is also used for machine learning applications such as neural networks. It is used for both research and production at Google. TensorFlow provides stable Python and C APIs; and without API backwards compatibility guarantee: C++, Go, Java, JavaScript and Swift (early release). Third party packages are available for C, Haskell, Julia, R, Scala, Rust, OCaml, and Crystal.

6 Performance Requirements

This system will do all the processing part on the server so no performance needed in the mobile, the mobile will only be used in capturing the image and

outputting the result.

7 Design Constrains

This system needs to be user friendly to help the doctors to classify the diseases and to give the right treatment to the patient

7.1 standards compliance

fast internet connection with camera resolution not minimum than 360

8 Other non-functional attributes

8.1 Security

Patient data is secured that shouldn't be accessed except by admin and doctors only . So it must be secured and not given a local access. Also the doctors' passwords should be secured. There many Functional requirements Dependent on this: FR1, FR2, FR8

8.2 Reliability

The system should be reliable enough which does not cause failure or crash.

8.3 Maintainability

The system should be easily maintained through implementing the MVC design pattern and using naming convention which ease the use of functions and understanding their purpose.

8.4 Inheritance Relationships

8.5 Class descriptions

Class Name	Doctor
Super Class	Employee
Sub Class	Doctor type
Purpose	This class responsible for Control the Patient and to Start to diagnose the Image .
Collaborations	inherit from Employee ,Aggregate with Patient and with Doctor type and Associated by Admin
Attributes	Array of Patients.
Operations	Patientfnctionality(Add() ,Edit() ,Search() ,Delete() ,List()) , UploadImage(), Imagefunctionality(Edit,Add,Delete,Search).
Constrains	If the doctor doesn't have an account he can't access patients

Class Name	Doctortype.
Super Class	Doctor
Sub Class	None
Purpose	This class responsible for doctor type either Expert or junior.
Collaborations	This Class is Aggregated with doctor class
Attributes	type:string.
Operations	None

Class Name	Admin.
Super Class	Employee
Sub Class	None
Purpose	This class responsible for Control the Doctor.
Collaborations	This Class is inherit from Employee.
Attributes	None
Operations	ControlDoctor(Add() ,Edit() ,Search() ,Delete() ,List())

Class Name	Treatment.
Super Class	None
Sub Class	None
Purpose	This class responsible for treatment decision
Collaborations	This Class is Aggregate with Treatment types
Attributes	id:int
Operations	

Class Name	Treatment types.
Super Class	None
Sub Class	None
Purpose	This class responsible for treatment types
Collaborations	This Class is Aggregate with Treatment class
Attributes	id:int , types:string
Operations	

Class Name	employee
Super Class	None
Sub Class	doctor , admin
Purpose	This class responsible for Control the employe and to distrbut each one for doing his job
Collaborations	inherit from user
Attributes	int id , string username ,string password
Operations	login()

Class Name	patient
Super Class	none
Sub Class	user ,
Purpose	This class responsible for Control the patient and their types
Collaborations	aggartion with doctor , view patient and inherits from user
Attributes	int id , string address ,string mobile number ,string date ,string descrption
Operations	none

Class Name	user
Super Class	employee
Sub Class	patient ,
Purpose	This class responsible for Control the users and their types
Collaborations	inherits from patient and employee
Attributes	int id , string address ,string mobile number ,string date ,string descrption
Operations	none

Class Name	classification
Super Class	none
Sub Class	svm , cnn ,
Purpose	This class responsible for fetauing extraction
Collaborations	aggression with feature extraction
Attributes	fetaureextraction
Operations	classify()

Class Name	segmention
Super Class	none
Sub Class	filter , noise removal
Purpose	This class represents the segmentation operations done on a specific image.
Collaborations	This class Aggregate Image Class and Inherited by Filters, and noise removal Classes.
Attributes	img image
Operations	median filter

Class Name	feature extraction
Super Class	none
Sub Class	none
Purpose	This class represents the Features calculated from each image.
Collaborations	This class aggregate Image Class and aggregated by class Classification
Attributes	img image
Operations	Mean():float, Standard Deviation():float, Skewness():float

9 Operational Scenarios

The user will first open the application, a log in page will show up, the user will have two options either logging in with a user name and password that he registered before or creating a new account. Then his account will be shown with two options, either previewing his old history or taking or uploading a new photo to be diagnosed. The system then will take the photo and do some prepossessing on it and upload it to the server to be processed, after clustering the infection, the result will be sent back to the mobile and will be shown to the user with an option of showing treatment for the detected disease.

10 Project Management and Deliverables

[!h]

Task	Date	Deadline
SRS evaluation	27 Nov 2018	27 Nov 2018
External examiner	3 Dec 2018	5 Dec 2018
SSD Evolution	14 Feb 2019	16 Feb 2019
Evaluation implantation	After spring break	After spring break
Technical evaluation	7 May 2019	7 May 2019
Final thesis	25 Jun 2019	25 Jun 2019

11 Budget

Item	Price
Mobile Phone	2500
Dermoscopy lenses	8884

References

[1] Kharazmi P, Al Jasserz MI, Lui H, Wanf ZJ, Lee TK, "Automated detection and segmentation of vascular structures of skin lesions seen in dermoscopy, with an application to basal cell carcinoma classification." IEEE J Biomed Health Inform 2016:1.

[2] www.gsihealth.com/

[3] news.stanford.edu/2017/01/25/artificial-intelligence-user-identify-skin-cancer/

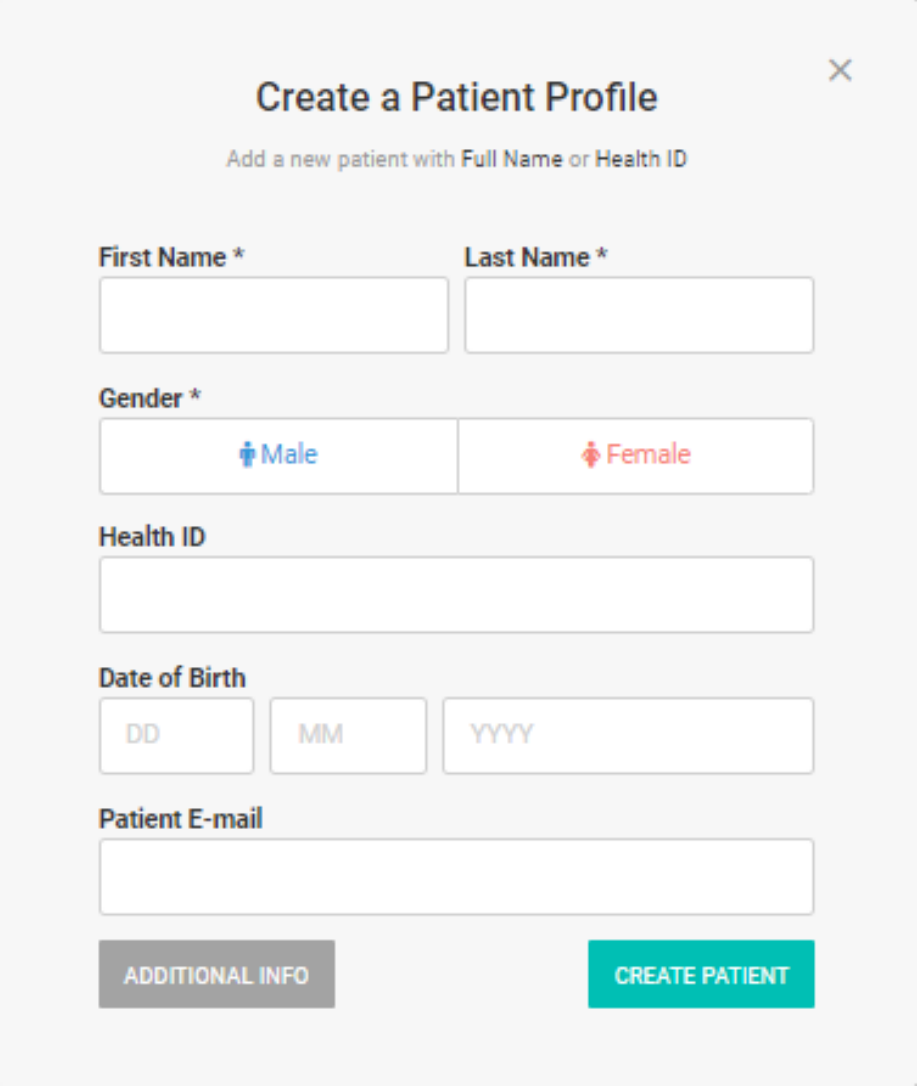

Figure 9: Create patient Profile Form

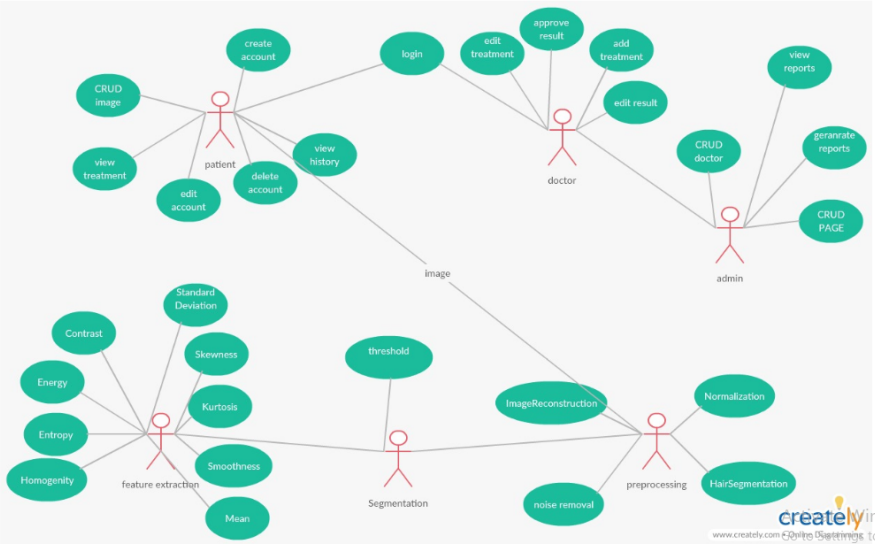

Figure 10: use case digram

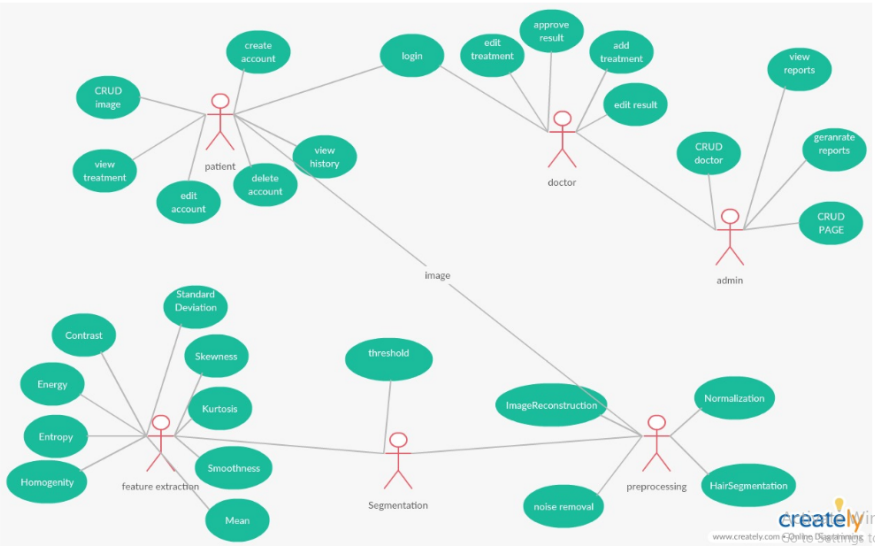

Figure 11: use case digram