ÇANKAYA UNIVERSITY
FACULTY OF ENGINEERING
COMPUTER ENGINEERING DEPARTMENT

Project Report
Version 1

CENG 408

Innovative System Design and Development II

appDermis

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- Abstract

With a rapid increase rate of melanoma skin cancer, there is a demand for decision support systems to detect in the early stages, which will lead to better decisions in successful cleansing. However, upgrading such systems is a difficult task for researchers yet. To increase the accuracy of melanoma detection, several Computer Aided Diagnosis (CAD) systems have been proposed in the last two decades. What we want to do in this project is to develop an app for people who want to follow me when they think it's essentially a risk. The app will regularly collect skin images and periodically send notifications to the user to scan their skin. Each time a new photo is added, the app is compared to previous photos. If there is a change in mole's shape, colour, borders, asymmetry, or size it will analyze it. With the personal gallery, users have the option to compare pictures over time and easily share their images with a doctor. It will not make any diagnosis.

Key words:

- Skin Cancer, Artificial Intelligence, Mobile Application, Machine Learning, Image Processing, Melanoma, CNN, Time Schedule, CAD, Incidence, Melanoma Detection, Dermoscopy Images, Automatic Segmentation, Deep Learning.

- Özet:

Bir cilt kanseri tipi olan melanomun hızla artma oranı, kanser teşhisine karar vermede yardımcı olan sistemler tarafından erken evrelerde keşfedilmesi için talep vardır, bu da hızlı bir iyileşmede daha iyi kararlar alınmasına yol açacaktır. Bununla birlikte, bu tür sistemleri geliştirmek araştırmacılar için henüz zor bir konudur. Melanom tespitinin doğruluğunu arttırmak için son yirmi yılda birçok Bilgisayar Destekli Tanı (CAD) sistemi önerilmiştir. Bu projede yapmak istediğimiz, esas olarak benlerinde bir risk olduğunu düşündüklerinde benlerini takip etmek isteyen insanlar için bir uygulama geliştirmektir. Uygulama düzenli olarak cilt görüntülerini toplayacak ve periyodik olarak kullanıcıya cildini taramak için bildirim gönderecektir. Her yeni fotoğraf eklendiğinde, uygulama önceki fotoğraflarla karşılaştırır Benlerin şekli, rengi, sınırları, asimetrisi veya boyutunda bir değişiklik varsa, onu analiz edecektir. Kişisel galeri ile kullanıcılar zaman içinde resimleri karşılaştırma ve resimlerini bir doktorla kolayca paylaşma seçeneğine sahiptir. Teşhis koymaz.

Anahtar Kelimeler:

Cilt Kanseri, Yapay Zeka, Mobil Uygulama, Makine Öğrenmesi, Görüntü İşleme, Melanom, CNN, Zaman Çizelgesi, CAD, İnsidans, Melanom Saptama, Dermoskopi Görüntüleri, Otomatik Segmentasyon, Derin Öğrenme.

2. Introduction

1.2 Problem Statement

Many health systems around the world have fund seriously in the cure of different illness, but they yet fall behind when it comes to exploring ways to get ahead of them.

Melanoma is one of the most important tumors for peoples and it might be deadly, if not detected early. The rate of melanoma amongst whole dermatologic cancers is 4%, while melanoma-excited death rate estimates. Over and above, malignant melanoma has a treatment ratio much more than 95% whether the explored at a betimes phase.
Even if people are in doubt of melanoma, they are afraid to go to the hospital or postpone going to the hospital. In this way, they prevent early detection and cause delay of treatment.

AppDermis provides it possible to perceive skin cancer in early phase when it's most treatable and has less costly cure options.

1.3 Background or Related Work

There are not many applications like the appDermis. Some of them are MoleMapper, UMSkinCheck, MoleScope, SkinVision. Most of these applications require a full fee to provide full service, while others do not work at all and are out of date.

1.4 Solution Statement

Early detection of melanoma might be importantly decrease both morbidity and death rate. The risk of death from the illness is straightly interested with the deepness of the cancer, that is directly related to the amount of time it has been accelerating unobserved. Therefore, earlier finding leads to thinner cancers and rescues lives. Luckily, dissimilar to most other cancers, skin cancers available on the skin are most frequently easily can be seen to the patient and the examiner.

AppDermis allows you to control your skin moles for symptoms of skin cancer within seconds. It enables you for record photos to keep in track of alters over time, assisting you to observe your

health in the long-range period. The effective and simple-to-use solution will available for Android and assists to make skin monitoring a basic routine.

Our goal is to increase of awareness of the significance of the early detection of skin cancer by let you to being aware of peoples own skin, discover a mole potentially hazardous early, and follow- up and monitor your skin in a long period.

2. Literature Search

While working on our project we made literature review about artificial intelligence-based skin cancer mobile applications and researches for the last 5 years.

1.1 Abstract

Melanoma can be noted the furthest hazardous kind of skin cancer. There is a necessity to make decision assistance systems to perceive it while it is still in early phases. Nevertheless, growing such kind of systems are challenging and complicated subject for researchers. Many Computer Aided-Diagnosis (CAD) systems have been recommended in the past two ten years to increment the correctness of melanoma finding. In this paper, we survey broad the Skin Cancer Detection literature. We identify more than 15 works determined by using PubMed, Google Scholar search tool, IEEE Xplore Digital Library conferences and journals.

Keywords: **Skin Cancer, Mobile Aplication, Classification, Melanoma, Feature Extracion, Segmentation**

1.2 Introduction

Considering the American Cancer Society [7], the rates of melanoma have been increasing during the last 30 years. Different projects and applications have been improved for the early detection of skin cancer for many years. Some projects developed as mobile application and some projects are just machine learning algorithms to classify the type of lesion as melanoma or non-melanoma. But no studies done in this field in Turkey. We will develop a mobile application that users can follow up themselves when they think there is a risk of skin cancer. The application will scan the lesion and tell the user if the situation is risky. At the same time, users can create their own archives in the application so, application will tell the difference between the present and the past, it will make comparisons. It won't make any diagnosis. We have made researches covering the last five years for the steps we will follow while developing our application. We have examined many data sets and tried to find the most useful one. In the rest of this article, we explained which methods work better and which algorithms we should use. Five fundamental steps were mentioned: image acquisition, image pre-processing, image segmentation, feature extraction and image classification.

1.3 Image Acquisition

It can often be described as an act of importing the image from a source that can be a camera picture, so it can be passed later on which actions should be taken. Image acquisition in image processing is the initial pace in the workflow series because no processing may be probable outside the image.

1.4 Pre-processing

The main purpose of image pre-processing is to increase readability of images and decrease undesirable distortions such as hair and artifacts. Also, pre-processing is used to improve visibility of feature of interest. Therefore, various algorithms enhanced to improve performance.

1.4.1 Grayscale Conversion

Grayscale image is 8-bit image and each pixel includes 256 shades of gray combination. Grayscale images are easier and more faster to process than colored images [1]. Due to this reason, entire pre-processing methods are applied on grayscale images.

1.4.2 Hair Removal Methods

- **Median Filter**

  In the literature [1] [4] [5] [14], Median Filter is using for removing hair and noise from an image. One of the non-linear digital filtering techniques is median filter. The essential aim is used to improve results of afterward processing techniques. Median filters work like this; entire image pixels are considered by median filter. It specifies whether it is representative of its region and it is replaced region's pixel values with median value. Median filter is the most proper technique for medical images.

- **DullRazor Software**

  In the literature [5][16], DullRazor is used by authors. The software uses to aim remove unwanted noise from an image. DullRazor Software consists of 3 steps.

  i. Noise such as hair is defined by grayscale morphological closing operations.
  ii. It confirms shape of noise pixels and replaced confirmed pixels. Bilinear interpolation is used for this step.
  iii. The DullRazor Software smooths replaced noise pixels by adaptive median filter.

1.4.3 Contrast Enhancement

Contrast enhancement is a technic that improves the scanning of images. The original image with low contrast does not give better results, so image enhancement increases with contrast enhancement. One of the contrast enhancement algorithms is Contrast Limited Adaptive Histogram Equalization (CLAHE). Contrast Bounded Adaptive Histogram Equalization is applied to the image to obtain a contrasted image in which the correct features can be derived [14]. Each image pixel is processed, and image contrast is advanced. The output image is well suited for other operations.

1.4.4 Other Image Enhancement Methods

Gaussian filter [15], is used to reduce noise from an image. Also, it used to smooth and blur images. Karhunen-loeve Transformation, Corner Space Transformation and Luminance Transformation [13] and Image Uneven Illumination Correction [16], Corner Detection[16] are used for increase quality of image.

1.5 Image Segmentation

Segmentation is the process of parting an image into significant specks, like the needed zone is segmented, from that could infer the essential knowledge for upward processing. It simplifies description of an image, so it makes easier to analyze. Image segmentation is the operation of partition or gathering an image into several pieces.

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1.5.1 Otsu's Method

OTSU algorithm is an automatic threshold selection region-based segmentation technic. It is widely used due to its simplicity and effect and is expected to find the ideal value for the global threshold. It is mainly based on the image histogram; it is quite divided by the values of pixels and regions from the edges of the image. It tries to segment it by applying variance in each of the smallest classes. The operation is compatible with images in the two-pixel classes following the two-mode histogram distribution.[2][4][3][14][9]

1.6 Feature Extraction

The feature extraction phase might be specified like data compression, which extracts extra and unrelated data while protecting appropriate information. The features chosen to calculate the

detected moles of skin are based on knowledge and experiments regarding appearance characteristics and variations among benign and malignant skin lesions. Nevertheless, it extracts many initial features to discover the most essential and efficient features.

1.6.1 Gray level co-occurrence matrix (GLCM)

GLCM is a table of how often a combination of several pixel brightness values (gray levels) will be created in each pixel mapping of the image. Using a two-dimensional gray-level formation matrix is often and widely used in the field of texture analysis to find the positional dependence of brightness (gray level) values that help find valuable information about adjacent pixels in the image The properties obtained based on GLCM are contrast, energy, homogeneity, correlation and another statistical parameters like mean, skew and kurtosis. [7][10][15][16].

1.6.2 ABCD scale

The ABCD (Asymmetry, Border irregularities, Color variation and Diameter) criteria is used by medical doctors for diagnosing. Every criteria are multiplied with a dedicated weight factor to product Total Dermoscopy Score (TDS). TDS values smaller than 4.75 shows benign melanocytic lesion, values between 4.8 and 5.45 shows a doubtful lesion, and values of 5.45 or larger are extremely possible of melanoma. Formula for TDS: [(A score x 1.3) + (B score x 0.1) + (C score x 0.5) + (D score x 0.5)].

1.7 Classification

After the feature extraction step, finally, we will use image classification to decide the lesion is cancerous or noncancerous. Last five years, most of the research showed machine learning and deep learning algorithms are the best way to detect skin cancer. After researching, classification algorithms with the highest accuracy value will be used in our mobile application. Every research has a different number of and type of classes.

1.7.1 Convolutional Neural Networks (CNNs):

Deep learning, particularly the convolutional neural network (CNN), has been widely applied to unravel several issues in computer vision [6]. There are different CNN architectures and they all have different results. AlexNet, GoogLeNet, VGG, ResNet are the most popular ones. Some of structures (for example, GoogLeNet, ResNet) are valid as pre-trained patterns, originally trained on roundly 1.28 million natural images of the data set ImageNet. Accordingly, structures can use weights and prejudices from these pre-trained patterns. So, if we fine-tune all layers of these models by continuing with back propagation using our data, they can also be applied to our special classification task. Alternative structures like AlexNet and VGGNet are launched so that their weight and aberrations are not affected with visual knowledges that could vary from the skin

images. [17].

1.7.2 Support Vector Machine (SVM):

SVM is also a binary classification algorithm. Which means, the result can only belong to one of the two classes. In our case, classes will be cancerous and noncancerous. The purpose of SVM is to create hyperplane that separates two classes with a maximum gap between them [1]. Support Vector Machine is essential for training data in the form of samples named feature vectors and data output samples named labels [2]. Such as differ algorithms, data splited into two pieces: training and testing. The SVM algorithm is helpful for noisy data and large data sets. For better CPU performance with large data sets, we can also use Linear SVM. [16].

1.8 Conclusion

We identify more than 15 works in this literature review, and we selected "top papers" as shown in table. According to the table, these algorithms and methods are highly convenient to use for detection of skin cancer.

Reference	Pre-Processing Methods	Feature Extraction	Classification	Accuracy
[1]	Median Filter	GLCM	SVM	95%
[14]	Clahe&Median Filter	GLCM	SVM	90.44%
[7]	Resizing	GLCM	ANN	88%

2. Software Requirements Specification

2.1 Introduction

2.1.1 Purpose

The main purpose of this document is to give a elaborate explanation of the requirements for the “AppDermis” app. It will define the purpose and fulfil representation for the progress of system. It will additionally clarify system limitations, interfaces. This document is mainly designed to be proposed to the stakeholders and the developers of the system.

2.1.2 Scope of Project

This app will provide help for a people who have suspicious of melanoma. AppDermis intends to give a struggle towards one of the most mortal illness, skin cancer. The application will scan the

lesion and tell if the situation is in risky or not. Nevertheless , users can create their own records in the application thus, it will notify the difference among the current and the previous situation of mole, it will make comparisons. The app classes each photo as either high or low risk. However, AppDermis is not a diagnostic tool and shall not be taken as the final judgment, as pointed out by the disclaimer at the end of every skin spot evaluation.

Furthermore, the app needs Internet connection for fetch and display results. Whole system information is maintained in a database, which is located on a MongoDb database.The application also has the detailed information about the what is melanoma.

2.1.3 Glossary

Term	Definition
User	Person interacting with the app.
Database	Gathering all the information to be used in the application
Application	A mobile application, most referred to as an app, is a type of application software designed to run on a mobile device, such as a smartphone or tablet computer.[18]
Software Requirements Specification	A document that entirely defines whole functions of a proposed system and the limitations under which it must operate. Of an example, this document.
Stakeholder	Any person with an interest for the project.
GLCM	Gray Level Co-occurrence Matrix (GLCM) and associated texture property computations are image analysis techniques. GLCM is a chart of how often different combinations of gray levels occur in an image or image section, given an image of pixels with each density (a specific gray level).[19]

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2.1.4 Overview of Document

The rest of this document contains two chapters. The second part of this document, the General Description section, provides a roundup of the functionality of the application. It describes unofficial necessities and is used to create a context for the technical requirements description in this section. The third part of this document, the Requirement Specification section, was written primarily for developers and describes the details of the application's functionality in technical statements.

2.2 Overall Description

2.2.1 Product Perspective

Appdermis project is a mobile application aimed at early detection of skin cancer. Users can get information about skin cancer risk by taking a picture of their moles or adding pictures from the gallery.

3.2.1.1 User Interfaces

This mobile application is developed for everyone who want use. Users can download mobile application from mobile application store. After downloading the mobile application, users should be register to the system. After login to the mobile application, the main menu appears. The main menu is divided into sub-parts such as adding a new mole picture, adding mole picture from the gallery, updating personal information.

3.2.1.2 Hardware Interfaces

The application is going to run on mobile devices.

3.2.1.3 Software Interfaces

The application is going to run on Android, hence there will be no need another software interfaces.

3.2.1.4 Communication Interfaces

There is need to internet connection.

3.2.1.5 Memory

Our application's minimum system requirements: 50 Mb or more memory 1.4 GHz Cpu – Quad Core or above 2 GB or more RAM Android 6.0 (Marshmallow) or above Operating System Stable Internet Connection.

2.2.2 Development Methodology

We will be using agile development methodology, scrum method. There will be daily scrum meetings and 1-4 weeks sprint meetings.

2.2.3 Product Functions

3.2.3.1 Sign-up

Sign-up: People who want to use this application, must give information to agree to become involved. These information’s are name, surname, e-mail, password, date of birth and skin color.

3.2.3.2 Sign In

Sign In: After user completes his/her registration to system, they can enter by e-mail and password.

3.2.3.3 Sign Out

Sign Out: If a user wants to sign out from system. They can do this operation by clicking the sign out button.

3.2.3.4 Take a Photo of Lesion:

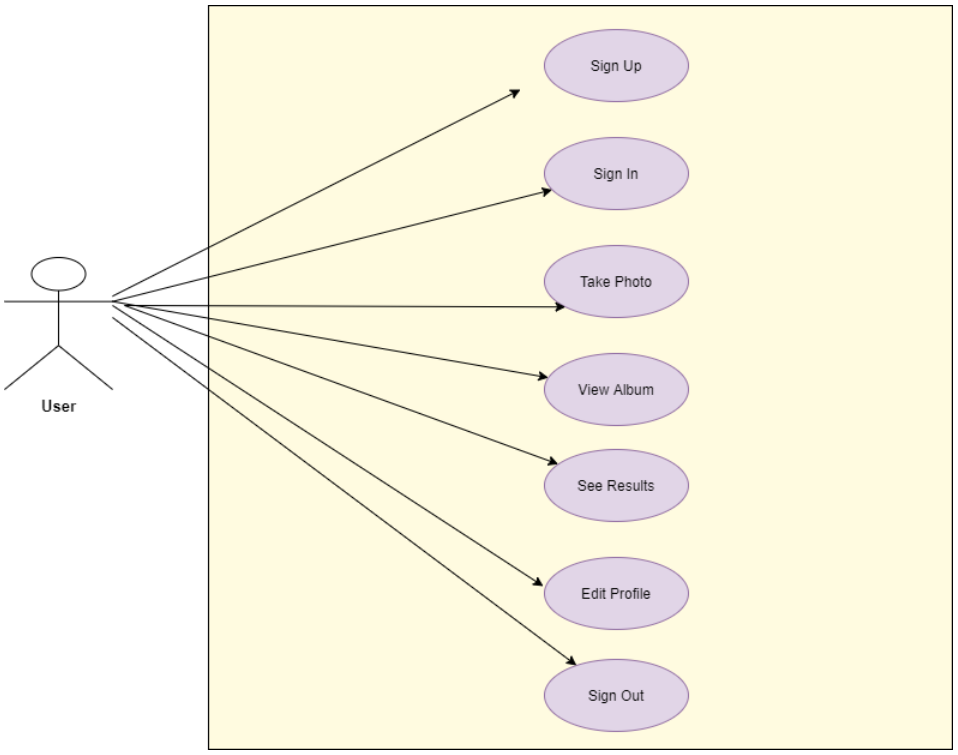
Took Photo of Lesion: User clicks camera button and takes a photo of suspicious lesions. Photo analyzed for skin cancer risk and saved in the album.

3.2.3.5 Edit Profile

User clicks his/her profile and can change the information's.

3.2.3.6 Check for results

User clicks the results tab. The user chooses a result to see. Results will be shown in graphs and diagrams. Also, there will be a written detailed report about results. And if there is a risky situation application will send a notification to the user.



2.2.4 Constraints

Appdermis mobile application has some constraints such as reliability, safety, and security. Wrong risk analyzes due to wrong taking photo is an important constraint for Appdermis Mobile Application. In addition to this since the user information is stored in a database and this database can be hacked and user information will be no longer private to the user. So, this is an important constraint for security.

2.2.5 Assumptions and Dependencies

During the use of the application, user add or take a picture with obeying the rules. The mobile application with the android operating system correctly analyzes the skin cancer according to the picture and sends it to the application. The mobile application algorithm works correctly and displays rate of skin cancer risks.

3.3.1 Functional Requirements

3.3.1.1 Sign Up

Use Case Name	**Sign Up**
Trigger	User enters the application and pushes the sign up button.

Precondition	No preconditions
Basic Path	1.User enters the application. 2. User pushes the sign up button. 3. User enters his/her informations. 4. User saves the informations.
Post Condition	No post conditions.
Alternative Path	1. The user enters an invalid email form or leaves a blank space in form. 2. The application gives an error.
Other	None.

3.3.1.2 Sign In

Use Case Name	**Sign In Use Case**
Trigger	User assesses the application with sign in button.
Precondition	User has signed up system.
Basic Path	1. User enters email and password to login to the system. 2. If the password is valid for the user email, user enters the system. Otherwise user should re-login.
Post Condition	After a successful login operation user is directed to the Main Menu.
Other	None.

3.3.1.3 Sign Out

Use Case Name	**Sign Out Use Case**
Trigger	User exits system with sign out button.
Precondition	User has signed in the system.
Basic Path	1. User clicks sign out button and exits from the system.
Post Condition	No post conditions.
Other	None.

3.3.1.4 Edit Profile

Use Case Name	**Edit Profile**
Trigger	User enters the profile tab.
Precondition	User must sign in before trying to edit his/her profile.
Basic Path	1. User will sign into the system. 2. User shall enter his/her profile. 3.User will change the profile info. 4. User will enter 'Edit Profile' button.
Post Condition	No post conditions.
Other	None.

3.3.1.5 Take Photo of Lesion

Use Case Name	**Take Photo of Lesion Case**
Trigger	User takes a picture of lesion with camera.
Precondition	The user has accessed the camera with main screen.
Basic Path	1. User clicks button and camera opens. 2.The user takes a photo of suspicious lesions. 3.Photo is saved in the album. 4. System calculates the cancer risk of the lesion.
Post Condition	The database is updated, and rate of risk is showed.
Other	None.

3.3.1.6 Add Photo to Album

Use Case Name	**Add Photo to Album**
Trigger	User assesses with camera.
Precondition	User has taken picture of lesion with camera.
Basic Path	1. User clicks button and camera opens. 2.The user takes a photo of suspicious lesions. 3.Photo is saved in the album. 4. System calculates the cancer risk of the lesion.

Post Condition	The database is updated, and photo is added album.
Other	None.

3.3.1.7 Check for Results

Use Case Name	**Check for Results**
Trigger	User enters the check for results tab.
Precondition	No preconditions.
Basic Path	1. User selects check for results tab. 2. The result is showed on screen.
Post Condition	No post conditions.
Other	None.

3.3.2 Performance Requirements

Our application appDermis will be working on android mobile devices. In normal workload, appDermis will use less than %30 of the CPU. Changing between pages will take 1 second.

3.3.3 Non-functional Requirements

appDermis will be on a mobile application server with high speed internet capability. The speed of the user's connection will depend on the hardware. appDermis will run on the user's smart phone and android operating system. The only one user uses the system at a time so there is no scalability requirement.

4.Software Design Description

4.1Overview

This document ensures the software design descriptions for the purpose of AppDermis application project. This document is prepared according to the “IEEE Standard for Information Technology–Systems Design – Software Design Descriptions – IEEE 1016 –2009”. This software design document provides the details of how the AppDermis software should have been done. The further are offered by using graphical notations such as viewpoints, use case models, sequence diagrams, class diagrams, object behavior models and alternative supporting design knowledges.

4.1.4 Scope

Software Design Document (SDD) is for a ground level system which will work as a evidence of notion for the usage of building a system the supplies a ground level of functionality to represent applicability for wide scale production usage. Software Design is centered on the ground level system and crucial sections of the system. For this certain Software Design Document, the center is placed on generation of the documents and changes of the documents. The system will be used in association by other pre-actual systems and will be formed usually of a document interplay appearance that abstracts document interactions and usage of the document objects.

4.1.5 Purpose

Software Design Document (SDD) is for a ground level system which will work as an evidence of notion for the usage of building a system the supplies a ground level of functionality to represent applicability for wide scale production usage. Software Design is centered on the ground level system and crucial sections of the system. For this certain Software Design Document, the center is placed on generation of the documents and changes of the documents. The system will be used in association by other pre-actual systems and will be formed usually of a document interplay appearance that abstracts document interactions and usage of the document objects.

4.1.6 Intended Audience

In contradiction of the Software Requirements Specification (that is written for the purpose of client and user), most of this Software Design Description is written for engineers and designers or researchers who want to change and/or extend the existing reference implementation. In this way the Client is not going to be among the intended audience for this document, which is:

- Team
- Supervisor
- Auditors and Reviewers

4.2 Definitions

Term	Definition
User	Person interacting with the app
Database	Gathering all the information to be used in the application
SDD	Software Design Description
SRS	A document that entirely defines whole functions of a proposed system and the limitations under which it must operate
Class Diagram	Describes the structure of a system
Use-case Diagrams	Illustrates the relationships between use cases
UML	Standardized modeling language that enables developers to deliver, visualize, configure and determine the structures of a software system
Function	Identifies data elements that form part of the internal entity
Application	Program running on computers or on the phone
IEEE	Institution of Electrical Engineers

4.3 Conceptual Model for Software Design Descriptions

For that document, we are going to use conceptive pattern for the SDD. Conceptive pattern mostly clarifies the source in that SDD has prepared and how it is going to be used. We planned to use multi-layered system architecture. Thus, it is going to be much easier to apply to the project and join feasible future attributes.

4.3.4 Software Design in Context

We planned to use object-oriented approach and multi-layered system architecture. Thus, we will increase to project implementation, adaptability, and portability. Layers will assistant the modularity, safety, and adaptability of the software. Using object-oriented design and multi-layered architecture will improve portability and unity among supplementals.

4.3.5 Software Design Descriptions Within the Life Cycle

The key software life cycle product that drives this software design is the SRS we have prepared. The requirements in the SRS document (interface, functional, nonfunctional, and logical database requirements) specify the design of the project.

4.4 Design Description Information Content

4.4.4 Introduction

Software Design Description of the AppDermis gives information about how AppDermis will be designed and implemented. This chapter is going to be contain information about SDD definition, design partners identified and design concerns, design perspectives, design views, design overlays and design logic selected by type descriptions of allowed design elements and design languages.

4.4.5 SDD Identification

This document is the initial pattern of the System Design Description for this project. This SDD report was created using Github. The markup of Draw.io and Github is used to draw the diagrams. In the first section an overview of SDD is given. Scope of the SDD report refers to the section 1.1, Purpose of the SDD report refers to section 1.2 and Intended Audience of this document refers to section 1.3. For design conceptual model for software design descriptions refer to the section 3. Lastly, for the design viewpoints including context, composition, logical, information, patterns use, interface, interaction, state dynamics and resource viewpoints refer to the section 5.

4.4.6 Design Stakeholders And Their Concerns

In AppDermis, design stakeholders are the developer team of AppDermis and their advisors. Our design stakeholders are the people who know and understand software development and our stakeholders are the part of the development. Our stakeholders' concerns are listed below:

- The implementation should be safe, secure, maintainability and open to future changes.
- The interface shall be easy to read and use.
- The desired results should be obtained from the developed system.
- Database should be simple and efficient.
- New features will be adapted into AppDermis, so software must be proper for it.

4.4.7 Design Views

In this SDD, for representing the diagrams of view, UML is used. Design views are design rational, contextual, combination, interface, sensible and coaction observes. That coaction observes have clarified in chapter 5.

4.4.8 Design Viewpoints

There are three viewpoints that are used in this project which are context, composition, and interaction viewpoints. These viewpoints are explained detailly with UML diagrams in section 5.

- Context perspective describes the relationships, dependencies and interactions between the system and its environment (users, systems, etc.).
- The composition perspective defines how the design subject is structured into the constituent parts and determines the roles of these parts.
- The interaction perspective defines the interaction strategies of why, where, how, and at what level actions take place.

4.4.9 Design Elements

The main design elements are entities, attributes and some other member associated with communication and relations between modules and user of our project. These main design elements are defined inside the related viewpoints in detail in chapter 5.

4.4.10 Design Overlays

The essential factors to explain design choices in appdermis is simplicity and sustainability. The features will add in the future so appDermis is designed with this vision. appDermis developers

document process of development so new developers can understand and modify or add features easily.

4.4.11 Design Rationale

The software must be designed in a way that future models and features can be added, and current models can be changed and updated independently. The object-oriented design supports classify the objects of the software thus a new object cold be lightly added to the design or an existing component can be easily deleted. System developers must use comments in their code frequently so that other developers can understand the code and the structure of the system in the future. Besides, when writing code, function and variable names are deliberately selected to indicate what they are doing. So, its functionality could be lightly understood in the future. When implementing the system database, tables are created considering both the ER Diagram displayed in Chapter 5 and the class diagram to concur the database and models. Design Languages

In this project, Unified Modeling Language (UML) is selected as a part of design viewpoint and it will be used for clarifying design viewpoints.

4.5 Design Viewpoints

4.5.4 Introduction

In this section, the perspectives of appDermis are explained in detail. UML diagrams is going to be used (Case Diagrams, Class Diagrams, Sequence Diagrams, State Diagrams etc.). There are 13 opinions for our projects.

- Context viewpoint
- Composition viewpoint
- Logical viewpoint
- Dependency viewpoint
- Information viewpoint
- Patterns use viewpoint
- Interface viewpoint
- Structure viewpoint

- Interaction viewpoint
- State dynamics viewpoint
- Algorithm viewpoint
- Resource viewpoint

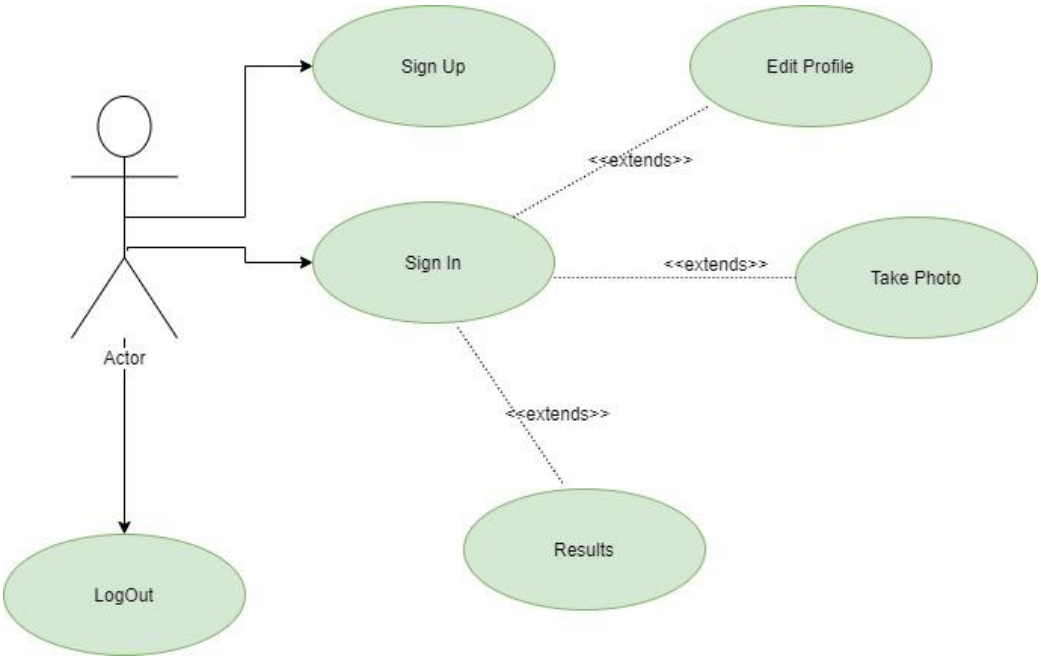
4.5.5 Context Viewpoint

4.5.2.1 Design Concerns

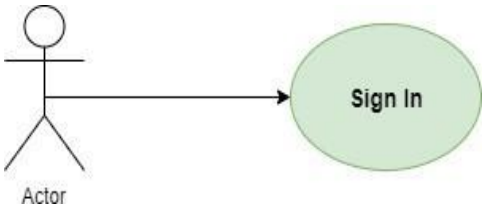
The main service category related to system which is User. Users are people who will use the application.

4.5.2.2 Design Elements

User and actions are design entities for application. As you can see, use case diagram is showed with whole functions.



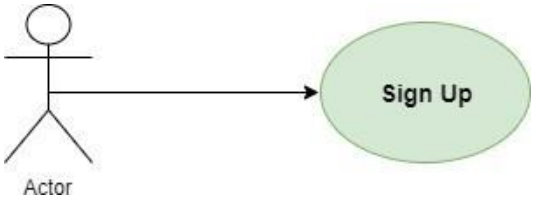
4.5.2.2.1 Sign In



Use Case Number	**1**
Use Case	Sign In
Summary	User can sign into the application.
Actor	User
Trigger	Sign in Button
Primary Scenario	User will enter the appplication. If user did not sign in before, opening page will be Sign in page. After entering email and password, user will be redirected to profile page.
Alternative Scenario	No alternative scenarios.
Exceptional Scenario	Wrong e-mail and password combination or wrong e-mail format.
Pre-Conditions	User must register before trying to sign into the system.
Post-Conditions	User will be redirected to her/his profile. User can use every function of the system after signing in.

Assumptions	User must be connected to the internet.

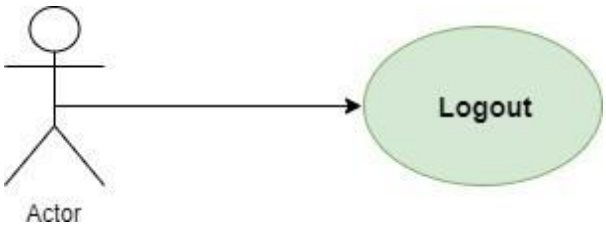
4.5.2.2.2 Sign Up



Use Case Number	**2**
Use Case	Sign Up
Summary	User can sign up to the application
Actor	User
Trigger	Sign Up Button
Primary Scenario	User will enter the application. In the sign in page there will be a button for sign up page. After filling his/her information, user can sign up if he/she didn't sign up before.
Alternative Scenario	No alternative scenarios.
Exceptional Scenario	Email address is already taken, or password does not meet the standards.
Pre-Conditions	No pre-conditions.
Post-Conditions	User can sign into the application.

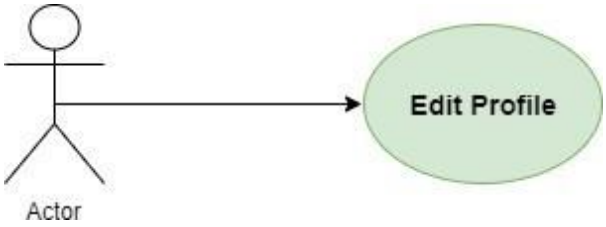
Assumptions	Valid e-mail address.

4.5.2.2.3 Logout



Use Case Number	**3**
Use Case	Logout
Summary	User can logout from the application.
Actor	User
Trigger	Logout button in the Profile.
Primary Scenario	After signing in, user can log out from her/his profile.
Alternative Scenario	No alternative scenarios.
Exceptional Scenario	No exceptional scenarios.
Pre-Conditions	User must sign into the system.
Post-Conditions	User will be redirected to Sign In page.
Assumptions	User has sign into the system.

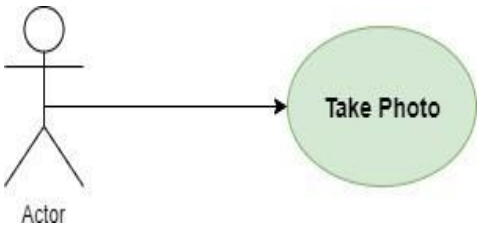
4.5.2.2.4 Edit Profile



Use Case Number	**4**
Use Case	Edit Profile
Summary	User can edit his/her information's.
Actor	User
Trigger	Edit button
Primary Scenario	User must register then login to system.
Alternative Scenario	None.

Exceptional Scenario	1. Not registered user.
Pre-Conditions	User must login to the system.
Post-Conditions	User will edit the information. User Profile will be updated.
Assumptions	User must be connected to the internet.

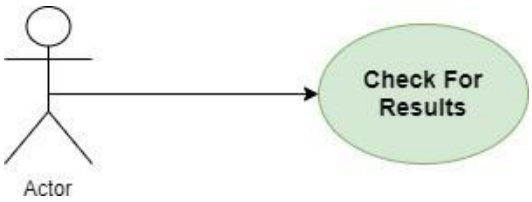
4.5.2.2.5 Take Photo of Lesion



Use Case Number	**5**
Use Case	Take Photo of Lesion
Summary	User can take photo of suspicious lesion then see the risk range about lesion.
Actor	User
Trigger	Camera button
Primary Scenario	User must login to system.
Alternative Scenario	None.
Exceptional Scenario	1. Not entered user.

Pre-Conditions	User must login to the system and push camera button.
Post-Conditions	Photo is saved in the album then system calculates the cancer risk of the lesion.
Assumptions	None

4.5.2.2.6 Check for Results



Use Case Number	**8**
Use Case	Check for Results
Summary	User can check for results.
Actor	User
Trigger	User enters the check for results tab and enters the check for results button.
Primary Scenario	User enters the check for results tab.

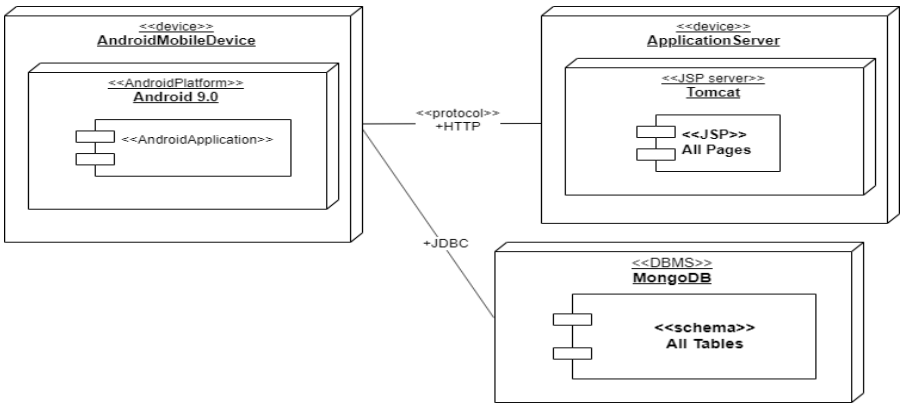
Alternative Scenario	No alternative scenarios.
Exceptional Scenario	If no taken photo taken before, user cannot check for any result.
Pre-Conditions	Result
Post-Conditions	No post conditions.
Assumptions	User checked photo to see for results.

4.5.6 Composition Viewpoint

4.5.3.1 Design Concerns

In this part, composition viewpoint will assist software process easily. There are three essential components in this software as you can see 5.3.2 Design Elements Part.

4.5.3.2 Design Elements



- Design Entities: The main components in system; database, application server and android application.
- Application Server: Establishing connection between application and database.
- Design Attributes will discuss next chapters.

4.5.7 Logical Viewpoints

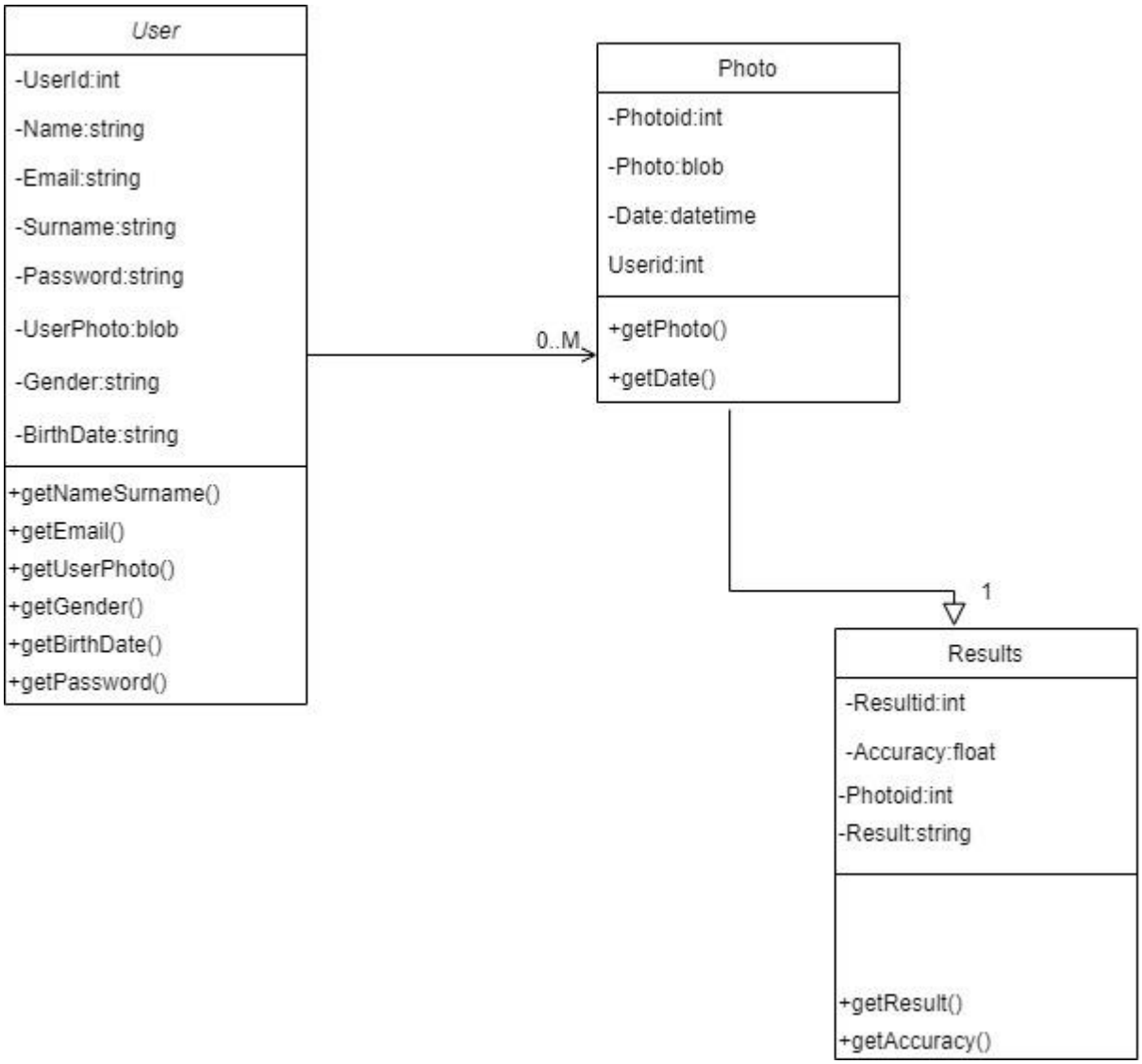
4.5.4.1 Design Concerns

In this part, entire classes and relations are identified in detail. The main purpose is to explain and clarify appDermis system design. Complete class diagram includes classes and their relations. Entire classes and methods/fields are explained.

4.5.4.2 Design Elements

- **5.4.2.1 Class Relations**

There are four classes; user, photo, result and album and they are related to each other. The class diagram includes only essential classes, on the other hand there are trivial classes. However, these classes are not shown because of clarity.



4.5.4.2.2 User Class

Method/Field	Definition
int user-id	Unique id for each user.
string name	User's name.

string surname	User's surname.
string email	Email of the user.
string gender	Gender of the user.
string skincolor	User's skin color.
date birthdate	Birthdate of the user.
string getNameSurname()	Returns name and surname
string getSkinColor()	Returns the skin color
string getGender()	Returns the gender.

4.5.4.2.3 Photo Class

Method/Field	Definition
int photoid	Unique id for each photo
blob photo	Photo of a lesion.

4.5.4.2.4 Result Class

Method/Field	Definition
int resultid	Unique id for each result
float accuracy	Accuracy of the results
int photoid	Results are belonging to this photo
string algorithmresults	When the all machine learning algorithms run, results will be here.
string getAlgorithmResult()	Returns the results.
float getAccuracy()	Returns the accuracy.

4.5.8 Dependency Viewpoint

Dependency viewpoint explains dependencies and relationships between system design component.

4.5.5.1 Design Concerns

Defining dependencies of application and determining which subsystems are depends on other subsystems. It helps deciding the priorities in design entities.

4.5.5.2 Design Elements

Design Entities: Application server, database server and the client. Design Relationships: Each entity have related each other, application server is between the database and client.

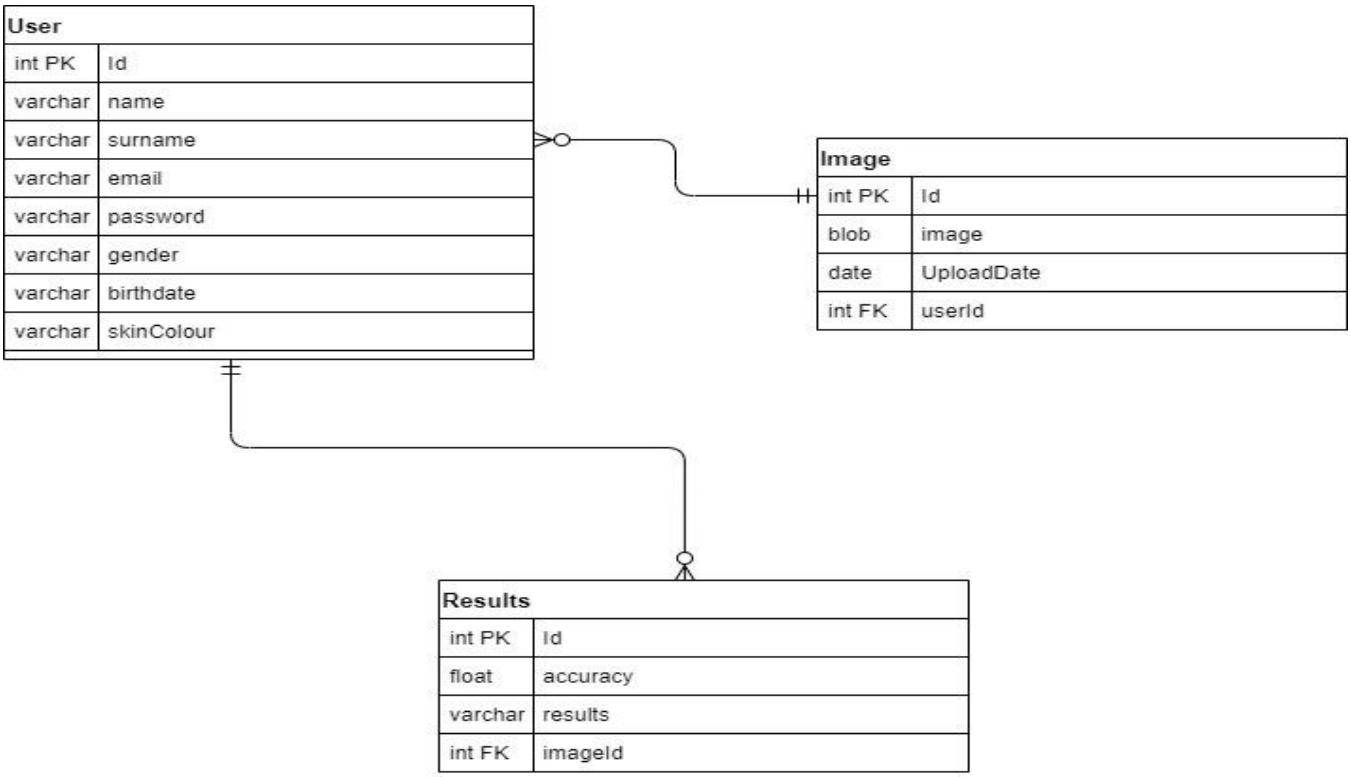
4.5.5.3 Example Languages

You can see the diagram in section 5.3.2.

4.5.6.1 Design Concerns

In this section, data management of the application and data structure will be shown. ER diagram is used. Design entities in this diagram are our tables. There are data types, data items, and extra information about data in every table. Design relationships are displayed with connections. Connections between tables show us how these tables are related to each other (one to one or one to many).

4.5.6.2 Design Elements



4.5.9 Patterns User Viewpoint

In appDermis server-client design pattern is used so the software reusable. The server-client design pattern is consisted two component client and server. The server listens to request from client and provide services.

4.5.10 Interface Viewpoint

4.5.8.1 Design Concerns

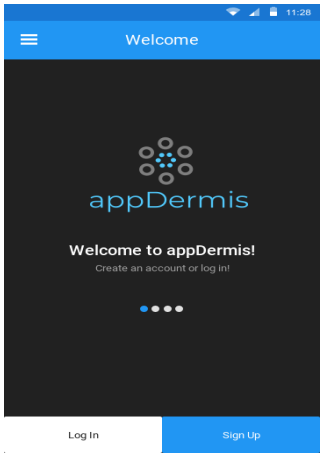
This viewpoint shows users how to use appDermis application. Every interface of the application has its own prototype and description. This will be very helpful for users and developers.

4.5.8.2 Design Elements

4.5.8.2.1 Welcome Page

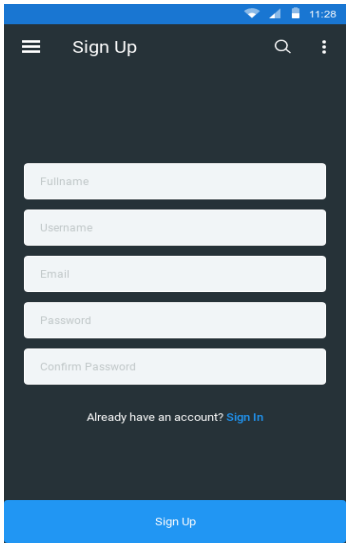
After downloading and entering the application, the user will see this tab first. This page will consist of information about the application. And for the users who want to use the application,

there will be 2 options: Sign up and Sign in. It will be redirected to the next page, depending on the user's choice.



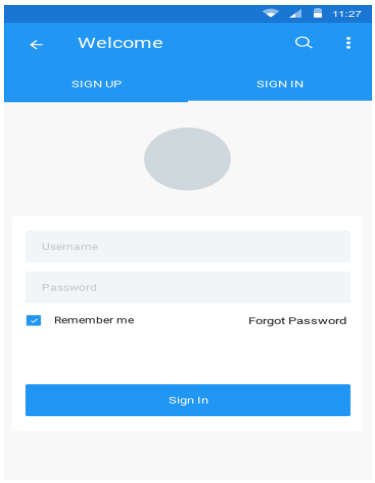
4.5.8.2.2 Sign Up Page

In this page, the user can sign up to the system by entering some personal information. After signing up, the user can edit, change, or add information to his/her profile page.



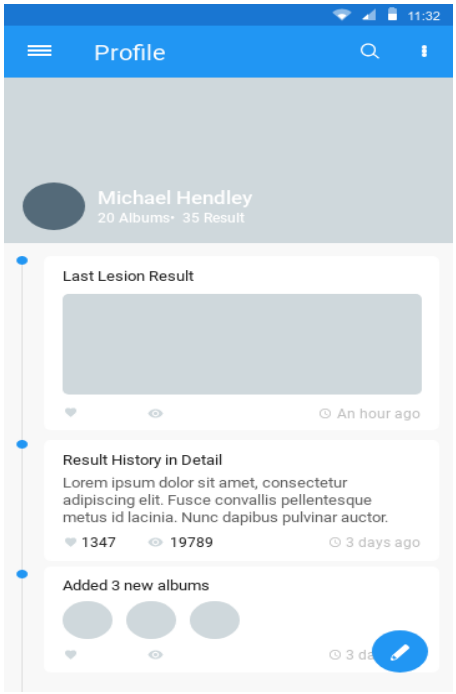
4.5.8.2.3 Sign in Page

In this page, the user can enter the application by entering his/her information if she/he is already signed up.



4.5.8.2.4 Profile

In this page, the user can see personal information, edit information, or add more information to make our analysis better.

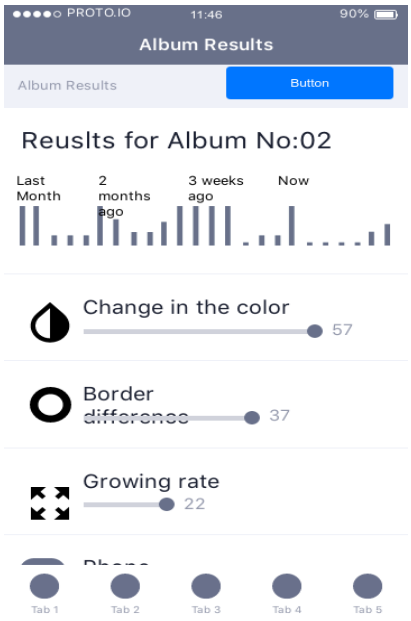


4.5.8.2.5 Camera

The user will take his/lesion photos in this page. The camera will be activated when the user wants to take a new lesion photo. After every photo is taken, the application will ask user for album to save it

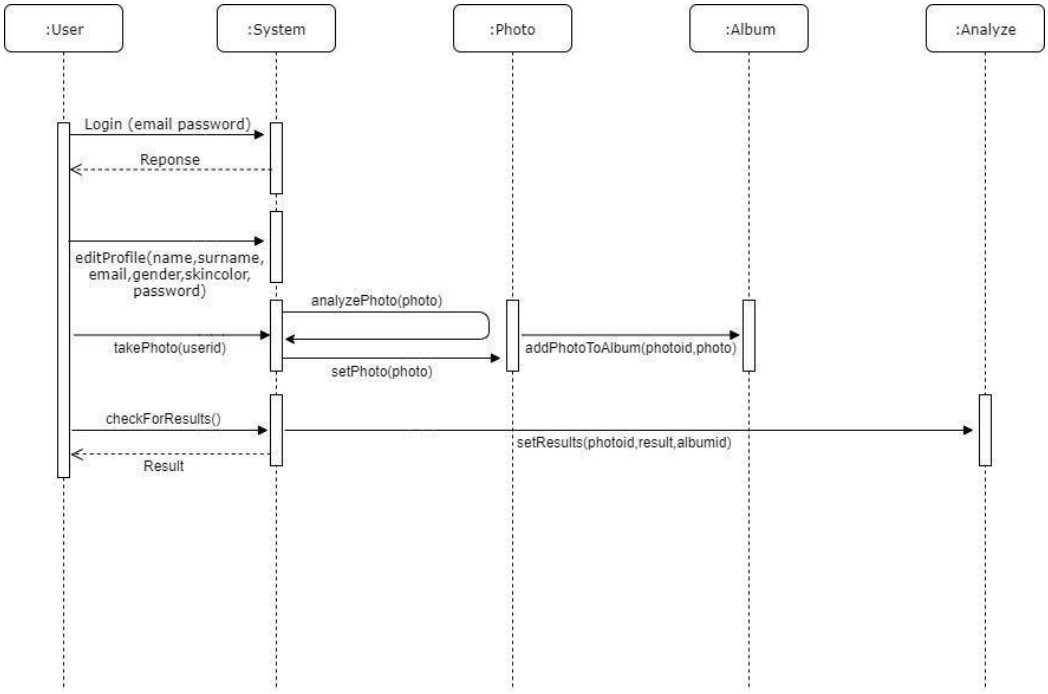
Check for Results

This page contains information about all photos and lesions. Results will be showed in graphs, diagrams and there will be a written explanation. If there is a risky situation, the application will notify the user for a doctor appointment.



4.5.11 Interaction Viewpoint

4.5.9.1 Design Elements



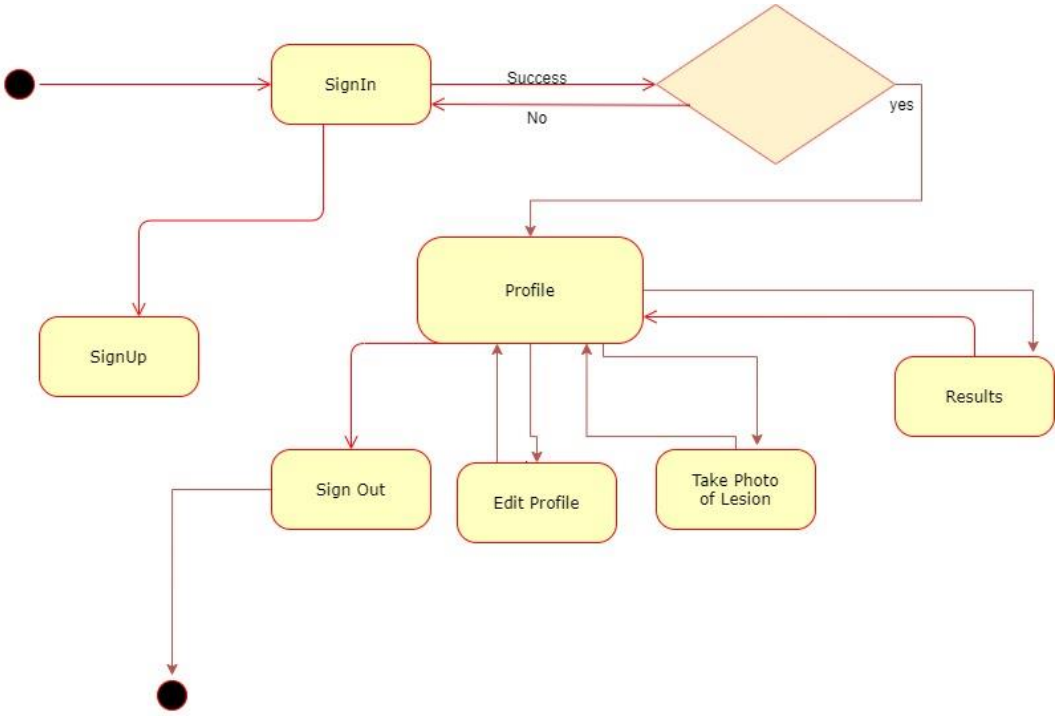
4.5.12 State Dynamics Viewpoint

4.5.10.1 Design Concern

The user starts the application, user is redirected sign up page. User can sign up if he/she has an account. When the user signs up the application, he/she can reach various feature of application.

4.5.10.2 Design Elements

Design entities and design relationships are observed with the state transition diagram particularly in the section bellow.



5. TEST CASES

5.1. Version Control

Version No	Description of Changes	Date
1.0	First Version	Apr 2019

5.2. Overview

Usage status of exhibitor and manager AppDermis system users determined in SRS document will be tested

5.2.1 Scope

This document corresponds to the test plan, test design specifications, and test scenarios test plan of usage scenarios.
.

5.2.2Terminology

Acronym	Definition
GUI	Graphical User Interface (GUI)

5.2 FEATURES TO BE TESTED

This part lists and describes a mini description of major properties for testing.

5.2.1. Graphical User Interface (GUI)

In this project, graphical user interface components are used. User registration is mandatory, so there are subdivisions that open after two main menus. Sign up or Login are the main home page. After that there are sections divided into the main menu and sub-sections. These sub-sections include Profile button, Edit Profile button, Take Photo button, View Results button, Album button.

6.3 Test Design Specification

6.3.1 User Interface (GUI)

6.3.1.1 Registering user (GUI.RG)

The user who wants to use the system must give his/her required information to system.

6.3.1.2 Login (GUI.LG)

User who has done his/her registration can login with entering e-mail and password.

6.3.1.3 Profile (GUI.VP)

User will see the information about his/her own information such as age, gender and skin type.

6.3.1.4 Edit Profile (GUI.EDT)

User will be able to edit the information from here. This button takes part under the profile page.

6.3.1.5 Album (GUI.VA)

User will see the photos that taken at the past.

6.3.1.6 Take Photo (GUI.TP)

The user can take a picture of the region where the spot is located.

6.3.1.7 Results (GUI.RES)

User will see the results that taken photos from this page.

.

6.4 Test Cases

TC ID	Requirements	Priority	Scenario Description
GUI.RG 01		H	Enter the information that required and then click register button. Button redirecting login page.

TC ID	Requirements	Priority	Scenario Description
GUI.LG 01	3.2.1	H	Enter username and password then login button redirects to Profile page.

TC ID	Requirements	Priority	Scenario Description
GUI.VP 01	3.2.1	H	Display personal information of user

TC ID	Requirements	Priority	Scenario Description
GUI.EDT 01	3.2.1	H	Editing all personal information

TC ID	Requirements	Priority	Scenario Description
GUI.VA 01	3.2.1	H	Selecting Album button. Shows the photos that taken.

TC ID	Requirements	Priority	Scenario Description
GUI.TP 01	3.2.1	H	Select “Take Photo” button. Able to take photo.

TC ID	Requirements	Priority	Scenario Description
GUI.RES	3.2.1	H	Select “Results” button. Display the results of risk.

6.5 DETAILED TEST CASES

6.4.1. GUI.REG 01

TC_ID	GUI.REG 01
Purpose	Enter the required information that system needs.
Requirements	3.2.1
Priority	High
Estimated Time Needed	No estimated time needed
Dependency	The simulation is executed
Setup	No setup installation needed
Procedure	Enter register button, it directs login page.
Cleanup	No cleanup function

6.4.2. GUI.LG 01

TC_ID	GUI.LG 01
Purpose	Enter username and password
Requirements	3.2.1
Priority	High
Estimated Time Needed	No estimated time needed
Dependency	The simulation is executed
Setup	No setup installation needed
Procedure	Enter login button it directs to profile page.
Cleanup	No cleanup function

6.4.3. GUI.VP 01

TC_ID	GUI.VP 01
Purpose	Display personal information of user.
Requirements	3.2.1
Priority	High
Estimated Time Needed	No estimated time needed
Dependency	The simulation is executed
Setup	No setup installation needed
Procedure	Display personal information of user.
Cleanup	No cleanup function

6.4.4. GUI.EDT 01

TC_ID	GUI.EDT 01
Purpose	Editing personal information of user.
Requirements	3.2.1
Priority	High
Estimated Time Needed	1-3 second
Dependency	The simulation is executed
Setup	No setup installation needed
Procedure	Select “Edit Profile” button from Profile page it directs to Edit Profile page.
Cleanup	Go back to previous page

6.4.5. GUI.VA 01

TC_ID	GUI.VA 01
Purpose	Displays the photos that taken.
Requirements	3.2.1
Priority	High
Estimated Time Needed	1-2 second
Dependency	The simulation is executed
Setup	No setup installation needed
Procedure	Select “Album” button. Display photos.
Cleanup	Go back to previous page

6.4.6. GUI.TP 01

TC_ID	GUI.TP 01
Purpose	Select “Take Photo” button.
Requirements	3.2.1
Priority	High
Estimated Time Needed	1-3 second
Dependency	The simulation is executed
Setup	No setup installation needed
Procedure	Camera is opening and able to take photo.
Cleanup	Go back to previous page

6.4.7. GUI.RES 01

TC_ID	GUI.RES 01
Purpose	Select “Result” button.
Requirements	3.2.1
Priority	High
Estimated Time Needed	1-2 second
Dependency	The simulation is executed
Setup	No setup installation needed
Procedure	Display the estimated risk of melanoma.
Cleanup	Go back to previous page

7. TEST RESULTS

7.1. Individual Test Results

TC ID		Priority	Date Run	Result	Explanation
GUI.RG 01		H	15.05.2020	Pass	Registered user to system
GUI.LG 01		H	15.05.2020	Pass	Username and password entered
GUI.VP 01		H	15.05.2020	Pass	Information displayed
GUI.EDT 01		H	15.05.2020	Pass	Updated personal information
GUI.VA 01		H	15.05.2020	Pass	Album displayed
GUI.TP 01		H	15.05.2020	Pass	Photo taken

GUI.RES 01		H	15.05.2020	Pass	Result displayed

7.2. Summary of Test Results

Priority	Numbers of TCs	Executed	Passed
H	8	8	8
M	0	0	0
L	0	0	0
Total	**8**	8	8

We have terminated 8 test cases and all test cases have done successfully.

Criteria	Yes or No
100% of test cases were achieved	Y
Over 95% of test cases terminated	Y
Over 95% of High and Medium Priority test cases achieved	Y
No high priority or serious errors are noticeable	Y
Confirm that the software development processes are terminated among the stipulated schedules.	Y
Confirm that the software development processes are terminated within the stipulated schedules.	Y

It has run all test cases and 100% of test cases has completed. It also passes 100% of high priority test scenarios. Software development process are completed among the prescribed time schedule. Exit criteria are passed.

8.Conclusions

In this project, we have tried to explain what appDermis is and how we will help the people who has suspicious about melanoma skin cancer. Our aim was building an app for being guide to people who has think that its mole can be melanoma risk so this way we can reduce the risk of deadly results and of course helping to create conscious society. Our researches showed us we can take best results with using CNN classification and grayscale median blur for preprocessing of lesions. For the evaluation, ROC curve and confusion matrix are used. Mobile part has done with React Native. We will take a picture of mole and our algorithm will show to user the risk of melanoma of that mole and user can be able to see the photos from album the mole so when user wants to check is there anything change, like being bigger or changing color of that mole, user will observe it.

- ## References

[1] Uzma Bano Ansari, Tanuja Sarode "Skin Cancer Detection Using Image Processing",

International Research Journal of Engineering and Technology , Vol. 4, Issue 4, April 2017.

[2] Hiam Alquran, Isam Abu Qasmieh , et al. “The Melanoma Skin Cancer Detection and Classification using Support Vector Machine”, 2017 IEEE Jordan Conference on Applied Electrical Engineering and Computing Technologies, 2017

[3] Pratik Dubal, Sankirtan Bhatt, Chaitanya Joglekar and Dr. Sonali Patil “Skin Cancer Detection and Classification”, 2017 6th International Conference on Electrical Engineering Informatics, 2017

[4] Akila Victor and Muhammad Rukunuddin Ghalib “Automatic Detection and Classification of Skin Cancer”,International Journal of Intelligent Engineering and Systems, June 2017

[5] Enakshi Jana, Dr.Ravi Subban , S. Saraswathi “Research on Skin Cancer Cell Detection using Image Processing”, 2017 IEEE International Conference on Computational Intelligence and Computing Research (ICCIC), 2017

[6] Abeer Mohamed, Wael A.Mohamed, and Abdel Halim Zekry “Deep Learning Can Improve Early Skin Cancer Detection”, INTL JOURNAL OF ELECTRONICS AND TELECOMMUNICATIONS, 2019, VOL. 65, NO. 3, PP. 507-512

[7] Santosh Achakanallı, G. Sadashivappa “Statistical Analysis Of Skin Cancer Image” International Journal of Electronics and Communication Engineering (IJECE), Vol. 3, Issue 3, 2014

[8] Shivangi Jain, Vandana jagtap, Nitin Pise “Computer Aided Melanoma Skin Cancer Detection Using Image Processing”, International Conference on Intelligent Computing, Communication & Convergence (ICCC), 2015

[9] Omar Abuzaghleh, Buket D. Barkana and Miad Faezipour “Automated Skin Lesion Analysis Based on Color and Shape Geometry Feature Set for Melanoma Early Detection and Prevention”, IEEE, 2014

[10] Miss Pooja Koli, Prof. S. S. Ingaleshwar, Nagraj V. Dharwadkar ”Computer Aided Melanoma Detection Using GLCM matrix Analysis”, International Conference on Advancements in Computing & Management (ICACM) ,2019

[11] A.P. Kassianos, J.D. Emery, P. Murchie and F.M. Walter “Smartphone Applications For Melanoma Detection By Community, Patient And Generalist Clinician Users: A Review”, British Journal of Dermatology (2015) 172, 2015

[12] T. Maier, D. Kulichova, K. Schotten, R. Astrid, T. Ruzicka, C. Berking, A. Udrea “Accuracy of a Smartphone Application Using Fractal Image Analysis of Pigmented Moles Compared to Clinical Diagnosis and Histological Result”,European Academy of Dermatology and Venereology(JEADV), 2014

[13] N. Durga Rao et al. Int. Journal of Engineering Research and Application,’’Skin Cancer Detection’’ 2016

[14] Novel Approaches for Diagnosing Melanoma Skin Lesions Through Supervised and Deep Learning Algorithms (J. Premaladha & K. S. Ravichandran), 2016

[15] Computer-Aided Diagnosis of Micro-Malignant Melanoma Lesions Applying Support Vector Machines (Joanna Jaworek-Korjakowska), 2016

[16] Melanoma Recognition in Dermoscopy Images Using Lesion’s Peripheral Region Information (Neda Zamani Tajeddin , Babak Mohammadzadeh Asl), 2018

[17] Skin lesion classification with ensembles of deep convolutional neural networks (Balazs Harangi), 2018

[18] IEEE. “IEEE Std 830- 19 98 IEEE Recommended Practice for Software Requirements Specifications”. IEEE Computer Society. October 20, 1998.

[19] P. Mohanaiah*, P. Sathyanarayana**, L. GuruKumar “Image Texture Feature Extraction Using GLCM Approach”, 2013

[20] Uzma Bano Ansari, Tanuja Sarode “Skin Cancer Detection Using Image Processing”, International Research Journal of Engineering and Technology , Vol. 4, Issue 4, April 2017.

[21] Hiam Alquran, Isam Abu Qasmieh , et al. “The Melanoma Skin Cancer Detection and Classification using Support Vector Machine”, 2017 IEEE Jordan Conference on Applied Electrical Engineering and Computing Technologies, 2017

[22] Pratik Dubal, Sankirtan Bhatt, Chaitanya Joglekar and Dr. Sonali Patil “Skin Cancer Detection and Classification”, 2017 6th International Conference on Electrical Engineering Informatics, 2017

[23] Akila Victor and Muhammad Rukunuddin Ghalib “Automatic Detection and Classification of Skin Cancer”,International Journal of Intelligent Engineering and Systems, June 2017

[24] Enakshi Jana, Dr.Ravi Subban , S. Saraswathi “Research on Skin Cancer Cell Detection using Image Processing”, 2017 IEEE International Conference on Computational Intelligence and Computing Research (ICCIC), 2017

[25] Abeer Mohamed, Wael A.Mohamed, and Abdel Halim Zekry “Deep Learning Can Improve Early Skin Cancer Detection”, INTL JOURNAL OF ELECTRONICS AND TELECOMMUNICATIONS, 2019, VOL. 65, NO. 3, PP. 507-512

[26] Santosh Achakanallı, G. Sadashivappa “Statistical Analysis Of Skin Cancer Image” International Journal of Electronics and Communication Engineering (IJECE), Vol. 3, Issue 3, 2014

[27] Shivangi Jain, Vandana jagtap, Nitin Pise “Computer Aided Melanoma Skin Cancer Detection Using Image Processing”, International Conference on Intelligent Computing, Communication & Convergence (ICCC), 2015

[28] Omar Abuzaghleh, Buket D. Barkana and Miad Faezipour “Automated Skin Lesion Analysis

Based on Color and Shape Geometry Feature Set for Melanoma Early Detection and Prevention", IEEE, 2014

[29] Miss Pooja Koli, Prof. S. S. Ingaleshwar, Nagraj V. Dharwadkar "Computer Aided Melanoma Detection Using GLCM matrix Analysis", International Conference on Advancements in Computing & Management (ICACM) ,2019

[30] A.P. Kassianos, J.D. Emery, P. Murchie and F.M. Walter “Smartphone Applications For Melanoma Detection By Community, Patient And Generalist Clinician Users: A Review”, British Journal of Dermatology (2015) 172, 2015

[31] T. Maier, D. Kulichova, K. Schotten, R. Astrid, T. Ruzicka, C. Berking, A. Udrea “Accuracy of a Smartphone Application Using Fractal Image Analysis of Pigmented Moles Compared to Clinical Diagnosis and Histological Result”,European Academy of Dermatology and Venereology(JEADV), 2014

[32] N. Durga Rao et al. Int. Journal of Engineering Research and Application,’’Skin Cancer Detection’’ 2016

[33] Novel Approaches for Diagnosing Melanoma Skin Lesions Through Supervised and Deep Learning Algorithms (J. Premaladha & K. S. Ravichandran), 2016

[34] Computer-Aided Diagnosis of Micro-Malignant Melanoma Lesions Applying Support Vector Machines (Joanna Jaworek-Korjakowska), 2016

[35] Melanoma Recognition in Dermoscopy Images Using Lesion’s Peripheral Region Information (Neda Zamani Tajeddin , Babak Mohammadzadeh Asl), 2018

[36] Skin lesion classification with ensembles of deep convolutional neural networks (Balazs Harangi), 2018

[37]