A Mobile Based Application For Face Shape Recognition And Hairstyle Suggestion

Odero, Jeremy Ong'ech

By

Student ID: 99187

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School Of Computing And Engineering Science

Strathmore University

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Abstract

A good hairstyle improves anyone's self-confidence and self-worth, especially women. However, to choose a good hairstyle, a person may be limited to rely on the knowledge of a beauty expert. Face recognition is an important embodiment of human-computer interaction, which has been widely used in system access and identity verification. The system proposes to recognize and recommend hairstyles based on facial structures recognized and face shape. Once a hairstyle is selected the time comes to go and have it done but converting the idea of the hairstyle to reality often comes with more of a hustle than is required. There are long queues and stylists sometimes double booking. Stylists also falsely advertise their capabilities leading to dissatisfied customers. The project is a hairstyle recommendation system for women based on hairstyle experts' knowledge and optimizing a face shape classification scheme that other authors devised in previous studies and furthermore aims to overcome the shortcomings of customer dissatisfaction. It is a system that facilitates making appointments with hairdressers. The system was developed on android studio platform, CNN and SVM for extracting and recognition of facial structures. Python and Java for the development languages. Firebase serves as the database.

Declaration and Approval

I declare that this work has not been previously submitted and approved for the award of a bachelor's degree by this or any other University. To the best of my knowledge and belief, the proposal contains no material previously published or written by another person except where due reference is made in the proposal itself.

Student:

Sign: _____ Date: _____

Supervisor:

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List of Abbreviations

AAM - Active Appearance Model

ACNN - Artificial Convolutional Neural Network

AHP - Analytical Hierarchy Process

ANN - Artificial Neural Network

CNN - Convolutional Neural Network

LDA - Linear Discriminant Analysis

SVM - Support vector Machine

Chapter 1: Introduction

1.1 Background

The ever-changing nature of ICT has made it possible to create new inventions that have been able to improve many services across many industries. The industry of focus is the service industry where customers visit a beauty shop or communicate with a free agent to get a haircut done or to get their hair plaited or nails done.

Communicating with the free agents to allocate a time slot for a client proves to be cumbersome as often upon arrival to the saloon there is still a long queue sometimes caused by a beautician who double booked clients. Sometimes upon arrival the client would like a different hairstyle and the stylist does not have the tools necessary to finish that hairstyle necessitating the customer to wait even longer. Sometimes due to lack of equipment they are sent back or simply told that they are unable to fulfil the customers desired style. Upon completion of the hairstyle sometimes the beautician weighs the amount of time and effort taken to complete the job and raise the price despite having discussed with the client prior to the appointment. This leads to dissatisfied customers. The next best option would be to visit a beautician who works at a chain store or a saloon. Presently stores are operated in an old fashion manner. The customer is serviced in order of arrival with some having to wait a very long time before their turn arrives. Sometimes even after calling the beautician or the hairdresser in advance, upon arrival the customer is still required to wait for a long time before being attended to. Some hairdressers tend to overshoot their skill and claim to be able to do a certain hairstyle as advertised with no prior proof but word of mouth which sometimes leads to disappointing results.

Product satisfaction and service satisfaction are the most important driving factors of customer satisfaction. The study of satisfaction in the traditional environment has shown that higher quality of goods and services always lead to more satisfaction of the customers (Qing-hua, 2009). Customer satisfaction is the antecedent of customer loyalty. The higher customer satisfaction is, the more amounts of commodities and services they will purchase, and the more durability their loyalty is. “Service Profit Chain” model made a clear point that customer loyalty is a direct result of customer satisfaction.

Nowadays, assuring the quality of product or service is a mandatory strategic context for competing with external competitors which hits the customer's purchase intention regarding long-term retention (Polasetal, 2018). Accordingly, the continuous purchase intention might be changed by the actual quality received and value paid for. Furthermore, quality is about mostly satisfying the expectations of consumers and needs to be developed continuously to enhance the over edge quality degree perfectly in the market (Bansal and Taylor, 2015).Customer satisfaction has a positive effects on customer loyalty. It is therefore a necessity for the business to achieve maximum customer satisfaction for the prosperity of the business.

Technological advancements are being implemented daily with many industries opting to computerize many of their processes for efficiency and effectiveness. The information system aims to deal with this problem by having a mobile application that will allow customers to book appointments in advance with the beautician of choice within the time slots available via chat, the beautician and the client will be in communication which will facilitate the bookings in response to their schedules. This will help in avoiding double bookings and long waiting times.

The system proposes to incorporate a face recognition algorithm that measures your face and based on your facial structures suggests a couple of hairstyles that are recommended for your face shape.

1.2 Problem Statement

The current management of beauty stores and barbershops has been found to lead to dissatisfied customers. The process leads to unsatisfied customers which leads to customers defecting to beauticians who tend to satisfy their needs. The quality of a product or service is the first consideration to retain the same brand in the long-term (Bhattacharjee, 2018). In the market, the quality of products or or the services being provided to a consumer changes rapidly due to the high competition in the short-term necessitating the need for continual improvement. Quality makes the product or service unique and is crucial in obtaining the competitive advantage among the same service providers. The aim of the project is to provide a unique service to the customers.

Customers sometimes do not have an idea as to what hairstyle they would want to wear and sometimes end up choosing a hairstyle that does not suite their face shape. The aim of this project was to solve the problem mentioned by providing a chat functionality with which customers and stylists can communicate with each other. The system will also have a face shape classifier that based on expert's opinion will suggest a hairstyle suited for the face shape.

1.3 Aim

The aim is developing an information system to solve the problem identified in section 1.2.

The system solves the problem of customer dissatisfaction by ensuring that appointments handled accurately to avoid double bookings through chat. The customer has their ability to vet past beauticians based on the work the stylists have done in the past. It also aims to include a face recognition algorithm that based on your facial structures can suggest hairstyles suited for your face. The system benefits both clients and customers in that they shall discuss prior to the appointment what style they want and receive the beautician's expert opinion.

1.4 Specific Objectives

i. To review and critique current face recognition software.
ii. To develop an application that suggests hairstyles.
iii. To develop an application that facilitates appointment booking and handling of customers.
iv. To create a platform that enables beauticians and customers to communicate.
v. To test the system.

1.5 Justification

In recent years, the quality of customer service has become an important factor to thrive in the global market. Since the service quality has significant contribution to business performance, cost, customer satisfaction, customer loyalty, and profitability, it has become a major area of attention for practitioners, managers, and researchers. [Orel and Kara, 2014]. Creating an information system that will lead to maximum customer satisfaction regarding the quality of services rendered and the

quality of customer care. To achieve success of a business in the service industry. Service quality is the activity that affects the business performance by the quality of customer service. In almost every type of service industry, service quality is applied to gain competitive advantage and cost effectiveness. As the service quality attribute play an essential role for the cost efficiency and growth, a business may pursue AHP application to determine the priorities that could make profound changes in the service planning. This strategic direction benefits continually to improve service performance, critical to customer satisfaction(Rahman, 2015). Rahman continues to further state that the balance between customer expectations and company's commitment to customer service is important for business success. Service industries increasingly encounter many intangible factors alongside the tangible objects. Intangible factors such as innovative ideas, new service attributes, learning principles and self-service technologies have great impacts on business success and customer satisfaction.

However, these attributes are versatile, associated with service personnel action, customer relation, service practices, self-service technologies, service information and relationship with trade partners. The higher the quality of customer service the more inclined a customer will be to visit you due to the directly proportionate high customer satisfaction. With continual revisits from past customers and referrals to new customers the business will thrive. The information system aims to promote self-employed beauticians who are free agents to access a larger customer base than they would have been able to. The information system aims to achieve maximum customer satisfaction reduce the waiting time for clients and ensuring that service rendered to the customer is of the best quality and at per with customer standards.

It aims to connect stylist’s withe the highest customer service and product delivery to customers who require their services.

1.6 Scope

The project focused on developing a mobile application that scans a client’s face, and suggest a hairstyle suited for it. The application would also have the ability to alert both client and stylist on appointment information and will provide a mirror platform by accessing the camera for the client to check their makeup. The application also

proposes to have a stylist portfolio from where the client will select the stylist they would prefer to work on their hair.

Chapter 2: Literature review

2.1 Introduction

This chapter reviews the existing information on the current techniques used to manage beauty parlor activities, existing systems that have been put in place, current existing literature on the trends in mobile technology, the current facial recognition software, the current hairstyle recommendation systems, the adoption of mobile technology in other industries and its influence. It begins by exploring the challenges that exists in the current hairstyle recommendation system finally depicts various technologies used in mobile application development.

2.2 Description of current beauty systems

Presently a customer is serviced in order of arrival with some having to wait an exceptionally long time before their turn arrives. Sometimes even after calling the beautician or the hairdresser in advance, upon arrival the customer is still required to wait for a long time before being attended to. Some hairdressers tend to exaggerate their skill and claim to be able to do a certain hairstyle as advertised with no proof but word of mouth which sometimes leads to disappointing results leading to a dissatisfied customer. Product satisfaction and service satisfaction are the most important driving factors of customer satisfaction.

2.2.1 Challenges experienced with current systems.

The available systems analogue systems do not cater for the period between appointments hence they lead to at times double booking and long waiting times by the clients. They also do not offer a grading or ranking system for stylists hence clients are not fully aware of their capabilities in certain hair styling techniques. This often leads to disappointing results and at times loss of clients by the business. The current systems also do not enable clients to review their look and how their facial features affect or are affected by the hairstyle of choice hence cautious clients tend to stick to one style with fear of the consequences of exploration.

2.3 A review of current beauty systems.

There are a couple of beauty systems available such as the ‘hairstyles for your face shape’ by Gregorio Bello and ‘face shape’ by Firestom SRL. There also exists face detection and hair recommendation systems which will be the object of focus in the literature review. Face recognition, as an important field of human and computer interaction, has greatly promoted the development of artificial intelligence. Since the concept was first proposed in the 1960’s, there have been about five methods to implement face recognition which include the geometrical characteristic method ,the subspace analysis method , the elastic graph matching method, the hidden Markov model method, and the neural network method. Generally, the first four methods are classified as shallow learning since they can barely make use of some basic features of images, and they all rely on artificial experience to extract sample features. The methods based on neural network are considered as deep learning since they could extract more complicate features, for example, corner point and plane features.

2.3.1 Face recognition based on convolution neural network and support vector machine.

This system was proposed by Shanshan Guo, Shiyu Chen and Yanjie Li in 2016. They combined Convolutional Neural Network (CNN) and Support Vector Machine (SVM) to recognize face images. CNN is used as a feature extractor to acquire remarkable features automatically. The weight sharing is the main advantage of CNN that makes it like the biological neutral network. In their system, all samples that were used were scaled to 32 32 × pixels and preprocessed by flipping up. The Fig. 1 respectively shows their training framework.

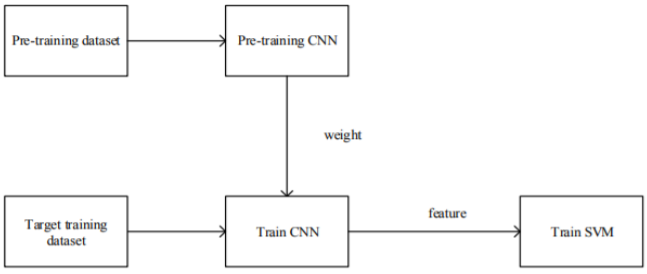


Figure 1 The whole training system framework (Shansan, 2016)

It describes the approximate recognition process of their system. (S. Guo, S. Chen and Y. Li, 2016) firstly used part of images of Casia-Webfaces database to train CNN and get weights that represent facial features. Then they used these weights to initialize the layers of CNN except its last layer. For the last layer, initializing its weights by random initialization. After setting weights of all layers, they trained CNN with target training dataset to extract facial features and utilize these features to train SVM. For the target testing dataset, they used the trained CNN extractor to extract features and use these features to recognize all the samples by the trained SVM classifier.

They chose SVM to recognize faces as its excellent performance in solving linear inseparable problem. SVM may find an optional separating hyperplane, which makes the distance of the training samples close to it maximization. SVM is aimed to minimize empirical risk and confidence interval to achieve good statistical rules of samples and improve the generalization ability of machine learning. For linear inseparable problem, SVM maps input in low dimensions into a higher dimension feature space that makes separation easier. In their system, the input of SVM is the facial features of the output layer in CNN. The input training dataset and the testing dataset of SVM are the output features of the training dataset and the testing dataset of CNN, respectively. The training label and the testing label of SVM are respectively same to the training label and the testing label of CNN.

They analyzed and compared the results of CNN used alone as for facial recognition and CNN + SVM and tables their results as follows.

Table 1 The recognition rate based on CNN + SVM.

Dataset selection	CNN	CNN + SVM
Test Samples 126	94.50%	95.36%
Test Samples 123	98.25%	98.63%
Test Samples 135	99.66%	99.83%
Test Samples 145	97.59%	98.45%
Test Samples 235	97.20%	97.59%
Test Samples 246	94.16%	95.19%

To improve the performance of CNN, they made use of some optimization techniques to train CNN. Pre-training CNN with some ancillary data to improve the generalization ability of network, which takes much less time to extract facial features of target dataset. Taking the features of output layer as the input of SVM, which gets

more accurate recognition result with its advantages in classification. The model that CNN combined with SVM spends less training time and obtains high recognition rate.

Table 2 Comparison of training time between ACNN AND CNN+SVM

Algorithm	Training time(s)	Test recognition rate
Global expansion ACNN [9]	275	91.67%
Global + local Expansion ACNN [9]	343	93.30%
CNN + SVM	28	97.50%

To compare and analyze the performance of the algorithms in detail, they listed the training time and the testing recognition rate in Table 3. To compare the training time with the test recognition rate, they selected the ORL dataset as the goal dataset. The recognition rate of CNN+SVM can reach 97.5% at the 28th second while global + local expansion ACNN reaches 93.30% at the 343rd second. When CNN+SVM is used in the new samples, it is also quickly to get the recognition result. Therefore, the performance of the training time of CNN+SVM is relatively excellent.

2.3.2 Hairstyle recommendation based on face shape using image processing.

This system was developed by S.V. Rajapaksha and BTGS Kumara. To identify the faces, they used the Haar Cascade classifier in the OpenCV. A Haar-like feature considers adjacent rectangular regions at a specific location in a detection window, sums up the pixel intensities in each region and calculates the difference between these sums.

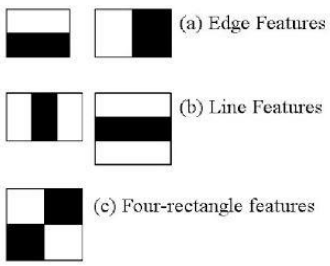


Figure 2 Integral Images used to detect points (Paul ,2001)

Haar Cascade is a machine learning object detection algorithm used to identify objects in an image or video and based on the concept of features proposed by Paul Viola and

Michael Jones in their paper "Rapid Object Detection using a Boosted Cascade of Simple Features" in 2001.It uses the haar wavelet technique to analyse pixels in the image into squares by function. This uses machine learning techniques to get a high degree of accuracy from the training data. It employs integral image concepts to compute the features detected. Haar cascade uses the adaboost learning algorithm which both selects the best features and trains the classifiers that use them. This algorithm constructs a strong classifier as a linear combination of weighted simple weak classifiers.

Face Landmark detection is most the important part when it comes to face shape identify. To detect facial feature and important landmarks the following technologies were used; the Dlib machine learning library, which is written in the C++ library.

The OpenCV/ C++ library was used for python, there is an API support for python. To identify the Figure 3 shown points, the researchers used thresholding techniques to separate the forehead from the hair.

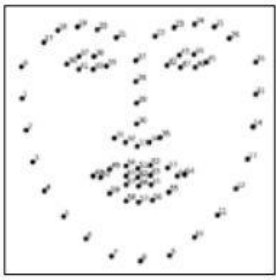


Figure 3 Important face landmarks

Rajapaksha and Kumara have tried on simple thresholding techniques such as Binary inverse thresholding, Otsu thresholding and zero thresholding. The most complex task was to identify the threshold value because the documents have different colors and during scanning, pixel luminance may change. To overcome the problem research used the adaptive thresholding Otsu method. Since researches are trying to make binomial images along the process we are doing and it is the best input to Otsu thresholding because of Otsu thresholding algorithm find the bimodal values and try to find the threshold that minimizes the weighted within-class variance.They documented their findings as follows.

Their research was only done for colour images and aligned images. The failure case was without using aligning images which were difficult to detect faces and give less accuracy for identifying face shapes.

Uploaded images were received from users of the system and they contained different noise types and lighting, which may have contributed to their low accuracy of the facial features landmark detection. The images whose values are confined to some specific range of values only. For brighter images they had all the pixels confined to high values. However, a good image should have pixels from all regions of the image. Therefore, they applied histogram equalization with the aim of improving the contrast of the image. The median filter was used to remove the different types of noises.

In the results evaluation phase of the system, the concluded that the the user satisfaction of hairstyle suggestion got 90% percentage. The system was able to identify face shape more than average 4.00 out of 5.00. It is a good result of this system. The facial feature point detection assessment was at more than average 4.00. The evaluation was not implemented in a control room but in different environments. The facial feature point detection was poor which could have resulted to the poor hairstyle simulation performance.

2.3.3 Hair recommendation system for women.

According to Sunhem and Pasupa (2016) approach, which was based on an Active Appearance Model (AAM) and a face segmentation technique which produces a set of features that can be evaluated by several popular machine learning methods namely, Linear Discriminant Analysis (LDA), Artificial Neural Networks (ANN), and Support Vector Machine (SVM). Their results showed that the Support Vector Machine with Radial Basis function kernel was the best algorithm that predicted accurately up to 72%.

Sunhem and Pasupa (2016) proposed the approach to classify women face shapes for hairstyle recommendation. To classify face shapes, it was divided into steps as follows:

i. Data collection: a database of face images was collected and labelled by qualified volunteers. The shapes were divided into five classes, they include heart-shape, oval-shape, oblong-shape, round-shape and squared-shape.
ii. Feature extraction: Features of all images in the database were extracted by AAM and a colour-based face segmentation technique. AAM was applied to find feature points of a face, eyebrows, eyes and mouth and the colour-based face segmentation was applied to find a point which separates a forehead and a hair.

These points then were used to calculate 19 discriminant attributes in order to train face shape classification models.

iii. Learning Models: This process generated face shape classifier models from 19 attributes by popular machine learning techniques which are SVM, Artificial Neural Network (ANN) and Linear Discriminant Analysis (LDA). According to their results, SVM with a radial basis function kernel (RBF) was found to be the best algorithm.

Hong (2013) and Derrick (2015) discussed a way to consider proper hairstyles for each face shape. The approach could be summarized into following steps with the first step being to identify face shapes from among the five face shapes: round, oval, oblong, squared and heart. Next was to determine the hair style which would be appropriate, and four hairstyle's attributes were recommended.

Length - there were four categories which included pixie, short, mid-length and long as shown in Fig. 4.

Figure 4 Length: Pixie, Short, Mid-length, Long

Style - there were three categories, namely, straight, wavy and mix as shown in Fig. 5.

Figure 5 Style; Straight, Wavy, Mix

Bang - there were three categories, which included none, blunt and side swept as shown in Fig.6.

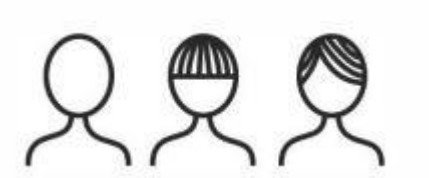


Figure 6 Bang; None, Blunt, Side-swept

Layered - there were two categories, including non-slide and slide as shown in Fig.7.

Figure 7 Layered, non-slide, slide.

According to the results, their system achieved more than four out of five in most of the cases, except an ability of face shape feature point detection and satisfaction of hairstyle's simulation. One of important factors which degraded the detection performance was lighting in their environment.

The users evaluated the system based on its ease of use, user interaction, the interface design, contents available in the system and a chance of using the system again in the future. they applied the five-level Likert principle to measure the assessments defining the highest to be 5, high 4, medium 3, low 2, and the lowest being 1. The results were documented in table 3.

Table 3 Assessment based on usage.

Topic	Average Score
Ease of use	4.28
User interaction	4.06
Contents in the system were easy to understand	4.22
Chances of using the system again in the future	4.17
Average	3.94

They evaluated the performance based on the satisfaction of the face shape classification results, and the ability of face shape feature point detection as shown in table 4.

Table 4 Performance assessment

Topic	Average Score
Satisfaction of result of face shape prediction	4.17
Ability of position detection around outline of the face	3.94
Average	4.06

This assessment comprised of a satisfaction of recommended hairstyles and hairstyle's simulation. The 5-level Likert scale was used as shown in Table 5.

Table 5 Satisfaction assessment

Topic	Average Score
Satisfaction of recommended hairstyles	4.00
Satisfaction of hairstyle's simulation	3.89
Average	3.95

They documented their findings as follows. Their system classified the user's face shape into five categories which were suitable for hairstyle recommendation. The hairstyle recommendation rules were based on beauty experts' suggestions. Moreover, the system ranked proper hairstyles in the database according to their relevant scores. The system was evaluated by volunteers on three assessments, including user an interaction, a system performance, and a satisfaction on hairstyle recommendation by the system. The average of three assessments was at 4.05 out of 5.00.

2.4 Gaps in existing beauty systems

Current systems are heavily focused on the management of the business itself rather than the clients. The systems do not offer the technology required by the client to explore various hairstyles and how it impacts their look. Furthermore, the current system does not offer a way to gauge the skills of the stylist hence clients have to trust what they say without being able to confirm it with previous client experiences which at times leads to devastating results. The current systems do not facilitate interaction of customers with free agents rather only those who are employed by a saloon. The proposed system aims to try and find a balance point of recognition rate and training time based on a deeper CNN with more optimization techniques and a larger dataset.

2.5 Conclusion.

The systems in place do not focus on individuals rather they focus on organizations and thus a user specific system is required that despite having the ability of just recommending hairstyles one can still book appointments with beauticians. They also do not have an option of reviewing the stylist and ranking the stylist based on customer feedback and satisfaction.

Chapter 3: System development Methodology

3.1 Introduction.

This chapter states a basic summary of the methodology that will be used for the proposed system. The aim of the methodology was to ensure that the proposed system can improve the overall customer satisfaction and the relationship between customers and the relevant service providers in the hair and beauty industry. The chapter will cover the following areas: development methodology, justification of the methodology, functional, non-functional requirements and tools and techniques.

3.2 System Development methodology.

System development methodology refers to the structure that is followed in creation of a new system. The structure followed consists of several methods processes that were implemented which ensured that the system was created within the scheduled duration.

3.2.1 Prototyping.

Prototyping is defined by Avison and Fitzgerald (2006) as an approximation of a concept that exhibits essential features of the final product. This system methodology is based on an iterative mechanism that allows users to be involved in the formulation of the system.

The steps for prototyping as illustrated in figure 8 include:

i. Initial Requirements-This refers to the customer's needs that justify the creation of the new system. This is the adjustments or the creation of function that the customer requires.
ii. Design-This is coming up with actual concepts that show how the systems looks like and the functions it performs.
iii. Prototyping-This refers to bringing the concept to life.
iv. Customer Evaluation-This refers to presenting the customer with the concept that has been created to ensure that the concept matches the needs of the customer.
v. Review- This is the stage in which the process in which any amendments made by the customer are implemented.

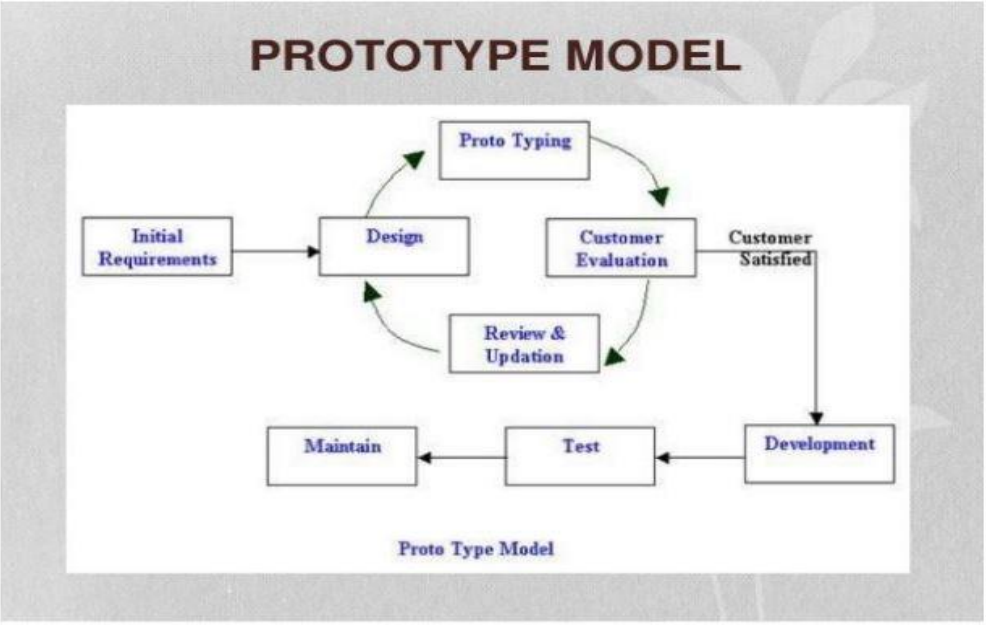


Figure 8 A prototype model as represented by (Satoa, 2012).

3.3 Justification of Methodology

Prototyping is the best methodology as it allows for iteration to be done severally before the full system goes into production Satoa (2012). Iteration is good in developing a machine learning system as the system and model will require to be trained continuously to achieve accurate results.

3.4 Functional Requirements

According to Berg (2012) the functional requirements refer to the functionality and the services that will be provided by the system for the system to function as intended.

3.4.1 User Authentication

According to American Academy of Periodontology (2012) a login page is the first enemy of defense that filters out unauthorised parties.
It is preventing them from interacting with the system. A functioning log in page is necessary to filter out the data from the public.

3.4.2 Facial Recognition

The application should be able to recognize, measure your face and recommend a hairstyle as accurately as trained.

3.4.3 Appointment booking

The application allows clients to book an appointment with the stylist of their choice and receive notification updates on their appointment through a chat module.

3.4.7 Data storage

The system should be able to store generated reports for retrieval if need arises. It also stores users' photos and data.

3.5 Non-functional requirements

The definition by Berg (2012) states that the non-functional requirements are the requirements that specifies the criteria that will be used to judge the system.

3.5.1 Performance

The performance refers to the action of doing a task or function Satoa (2012). The system should be able to perform the tasks at a certain speed to ensure tasks are completed efficiently.

3.4.6 Search

The system makes searches of users in the system.

3.4.4 Reporting

The system should be able to generate reports based on different criteria specified.

3.6 Tools and Techniques

This refers to the tools that were used to ensure that the system will be created in an efficient manner. The IDE to be used will be Android studio.

3.7 Tools

The tools used will be:

a) Android studio- This is the IDE that facilitated the creation of the new program in the system.
b) Firebase -This is the tool that was used as a database to the program. It will be used to save critical information concerning the system.
c) Java- This is the programming language that will used to facilitate the design of the system.
d) Python-This is the programming language that will be used in the creation of the modules.
e) CNN+SVM – This is the neural network that will be trained to recognize the face and extract facial features.
f) Engine X - The application server to be used to host the face recognition module.

3.5.2 Accuracy

This refers how correct the data and information is. The data collected should be collected accurately to give correct results thus promoting efficiency.

3.5.3 Usability

This refers to the ease of use of the system that the user is interacting with. The system should not be complicated such that it requires constant challenges with its use.

3.8 List of Design Diagrams to Drawn

The design diagrams to be used are use case diagrams, database schema and sequence diagrams. Use case diagrams helps represent users' interaction with the system to perform specific tasks. Database schema represents the organization of data to be stored within the database. There are logical and conceptual schema which show structure and constraints of the database and the information needs of the system respectively. Sequence diagrams will show the event scenarios and expected responses within the systems while mockups will help represent the systems graphical design.

3.9 Method to be used to test the developed system.

As describe in chapter two, the method of testing that will be employed is functional testing in form of System testing the third level of testing after integration testing and before acceptance testing. System testing is used to determine whether the system has satisfied the given requirements. The method used is black box testing. This is a method whereby the system is viewed as closed box, meaning that it is assumed that there is no knowledge of what processes occur within the system. Pfleeger (2014) "the test's goal is to ensure that every kind of input is submitted and that the output observed matches the output expected" (p. 236). The advantage is that the test is not limited by the constraints of imposed by the internal structure of the system. Considering that it is an object-oriented system, it is important to check the objects and classes for problem areas and possible limitations that need to be addressed; such as missing objects and unnecessary classes.

3.5.4 System Security

According to Satoa (2012) system security refers to the methods and procedures that ensured that the system is kept safe from intruders. This was done by hashing the passwords stored in the database where it would not be cracked easily.

3.10 Domain of Execution

The domain of execution is mobile based. This is because the system developed is a mobile application to increase portability. It is also because the Internet is flexible, and users can access the system from anywhere with access to the Internet.
This also allows for support during the development life cycle considering there are communities of mobile application developers on the internet.

Chapter 4

4.1 Introduction

In this chapter we are going to cover more on the system itself and what the system seeks to achieve with reference to the system's functional and non-functional requirements. This chapter will also highlight the approaches that were employed in the process of gathering the functional and non-functional requirements during the system analysis stage and how the system will operate and the arrangement of the different modules within the system. It also includes the design diagrams based on the object-oriented design. The design diagrams to be used are use case diagrams, database schema and sequence diagrams. In addition to that, the system architecture, that entails the: mobile-based application accessed by both the admins and health workers, has been illustrated.

4.2 Requirements Gathering

This refers to the collection and identification of the requirements that the system was able to satisfy either functional or non-functional. It involved analyzing and interaction with the different users of the system to be able to know on what specific task will be accomplished by the system and how the user will be an actor to the different types of task putting in mind that the different users of the system will not perform the same function together but will require some indirect type of relationship for some actions to be fulfilled. For the data collection there was use of documentation reviews questionnaires, observation, interview, and personal experience in the identification of our requirements. They were used to obtain the users perspective of the system.

4.3 System Requirements

Pfleeger (2010) "A requirement is an expression of desired behavior" (p. 169). It deals with objects within a system and their functions, state, and characteristics. The system analysis aids in the identification of these requirements.

4.3.1 Functional Requirements

These are the requirements that specify the systems behavior and required activities.

i. **User authentication –** the system accepts only validated users and give them access to the information and functions they are required to interact with.
ii. **Provision of reports –** the system generates and provides usage reports of how many likes are received per post.
iii. **Search –** the system makes searches of users in the system.
iv. **Data storage –** the system should be able to store generated reports for retrieval if need arises. It will also store users' photos and data.
v. **Facial Recognition** - The application should be able to recognize, measure your face and recommend a hairstyle as accurately as trained.
vi. **Appointment booking**- The application will allow clients to book an appointment with the stylist of their choice and receive notification updates on their appointment through a chat module .

4.3.2 Non-functional requirements

The definition by Berg (2012) states that the non-functional requirements are the requirements that specifies the criteria that will be used to judge the system.

i. **Performance** - The performance refers to the action of doing a task or function Satoa (2012). The system should be able to perform the tasks at a certain speed to ensure tasks are completed efficiently.
ii. **Accuracy** - This refers how correct the data and information is. The data collected should be collected accurately to give correct results thus promoting efficiency.
iii. **Usability** - This refers to the ease of use of the system that the user is interacting with. The system should not be complicated such that it requires constant challenges with its use.
iv. **System Security** - According to Satoa (2012) system security refers to the methods and procedures that ensured that the system is kept safe from intruders. This was done by hashing the passwords stored in the database where it would not be cracked easily.

4.4 System Architecture

The system architecture illustrates the interaction between the system components is as shown in figure 9 below.

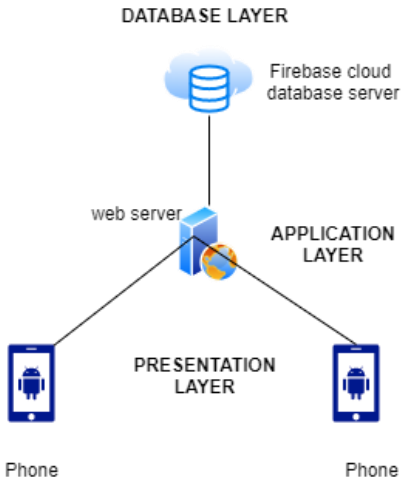


Figure 9 System Architecture

The app will be run using an android device whilst in the field and utilize cloud services for data storage on firebase. The actors who define the modules in the system include the stylists and their clients of the system. The presentation layer contains the user interface. The cloud database and application servers comprise the server-side architecture and deals with the management of data and the face recognition model stored.

4.5 Design

System diagrams aid in illustrating the visual model of a system's components and their interactions (Salustri, 2018).Below are the system diagrams that are to illustrate the visual model of the mobile application. They include a use-case diagram, a sequence diagram, a class diagram, an entity relationship diagram, and a database schema, as previously mentioned in chapter 3.

4.5.1 Use case diagram

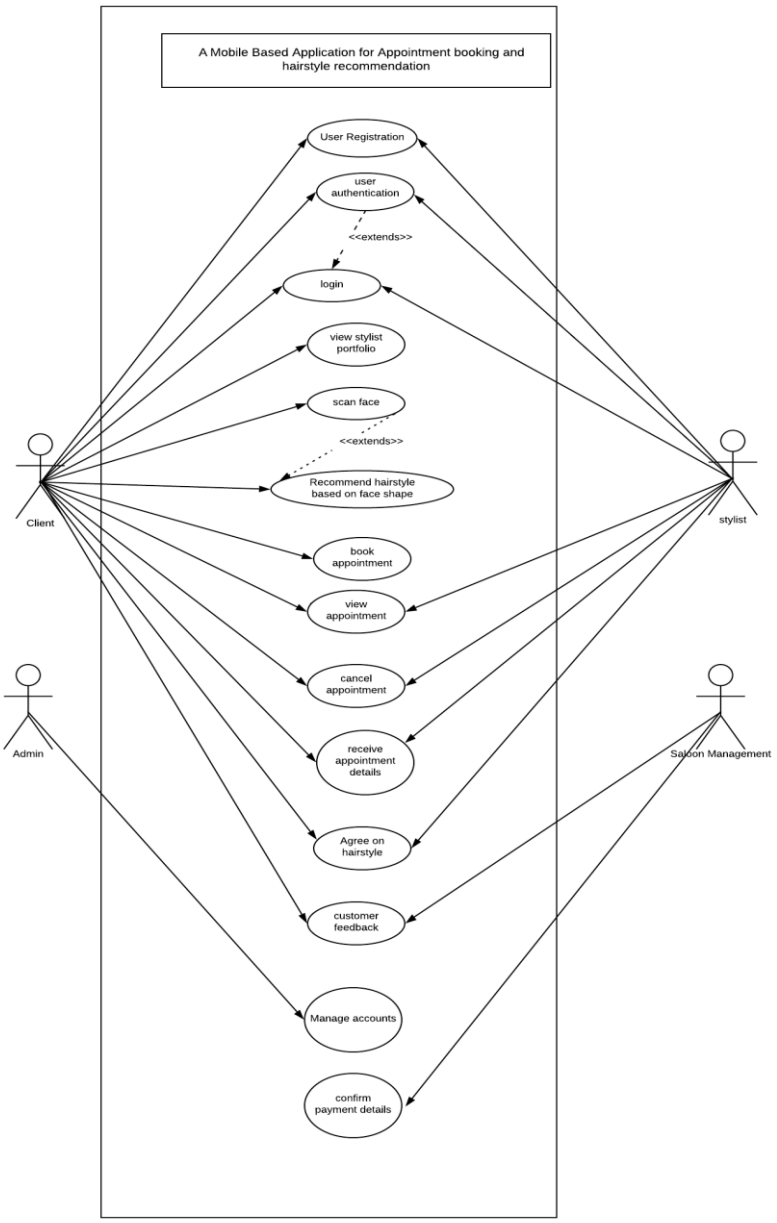


Figure 10 Use Case Diagram

4.5.2 Sequence Diagrams

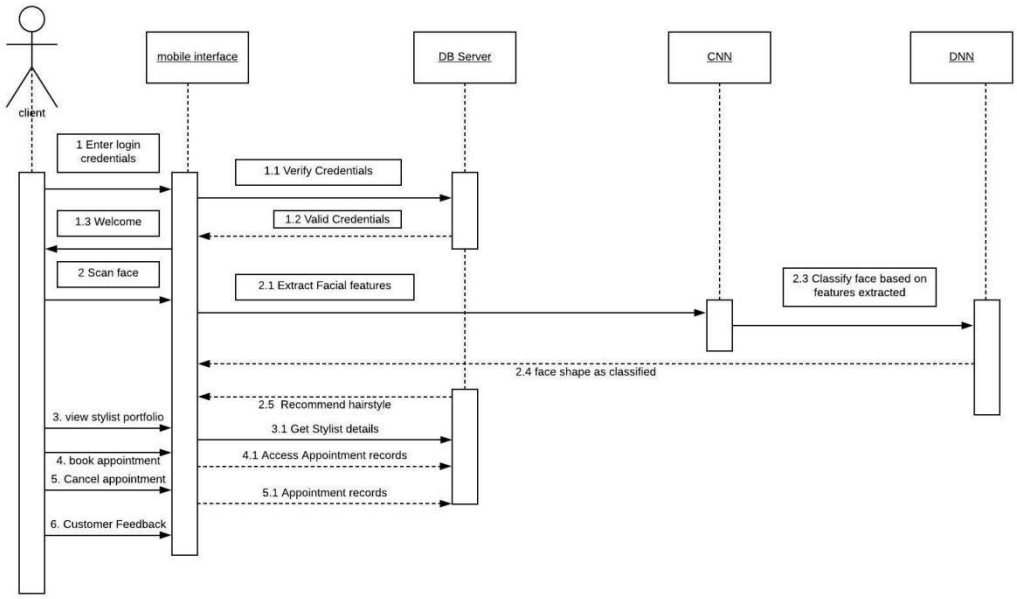


Figure 11 Sequence Diagram

4.5.4 Class Diagram

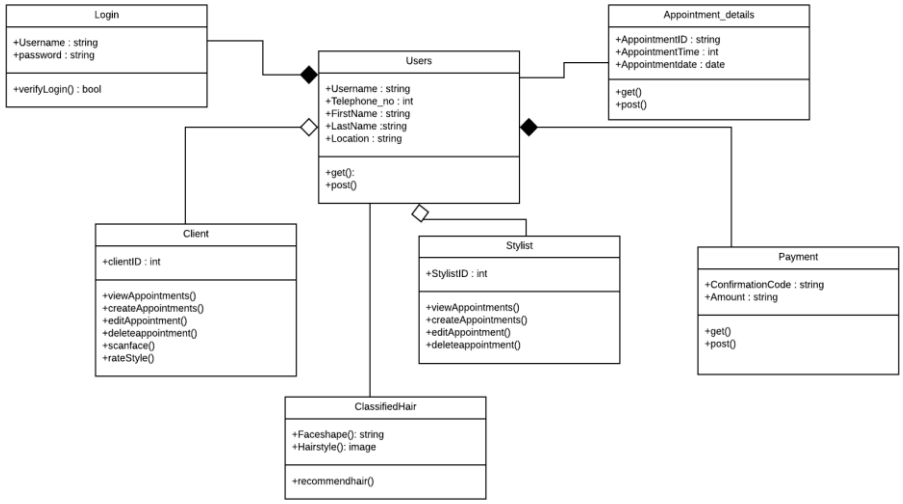


Figure 12 Class Diagram

4.5.5 Database Schema

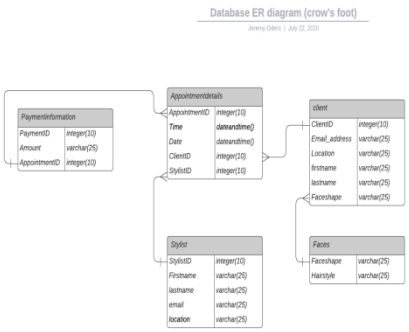


Figure 13 Database Schema

4.5.6 Entity Relationship Diagram

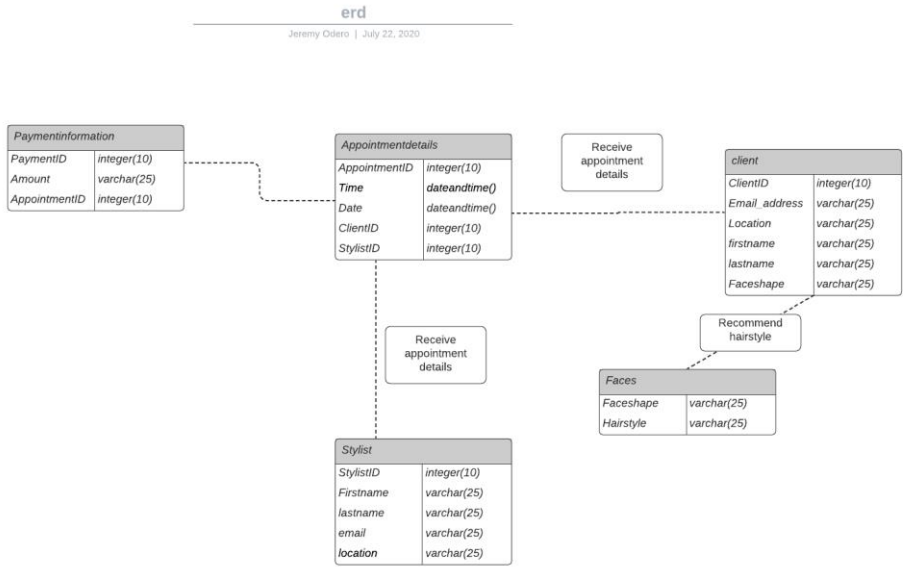
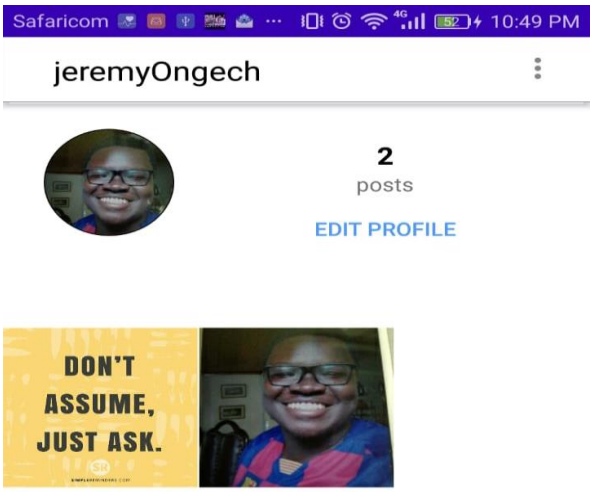
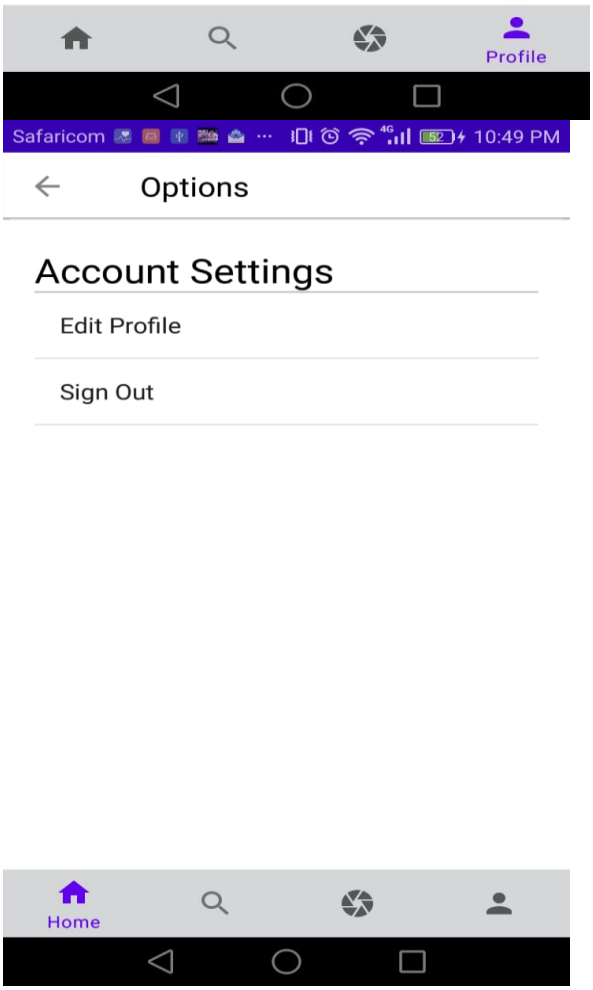


Figure 14 ERD

4.5.7 User Interface Mock-up





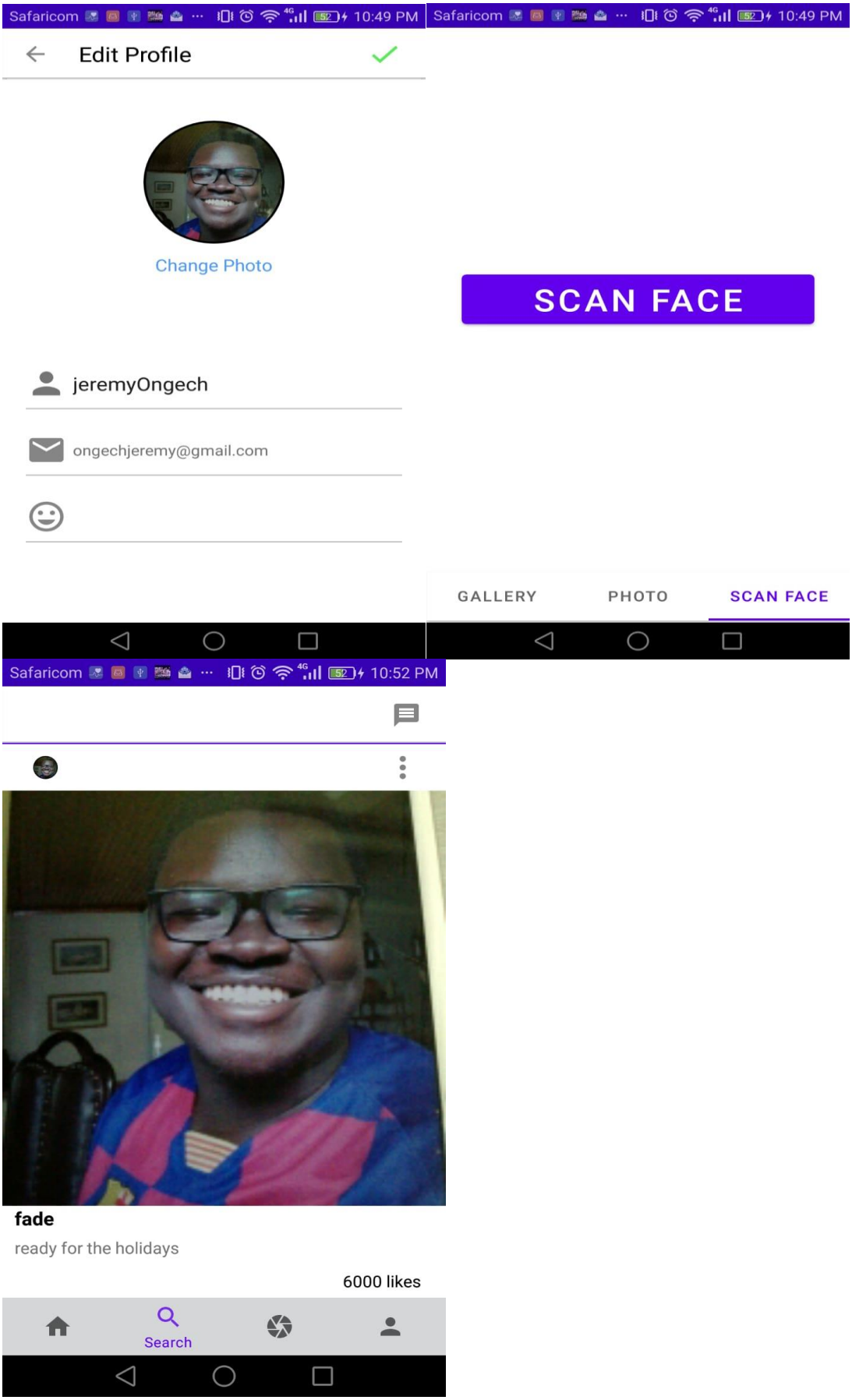


Figure 15 User Interface mockups

Chapter 5 System Implementation and Testing

5.1 Introduction

This chapter contains the system specifications required when using the system. In addition, it contains test cases performed during development and test results.

5.2 System Implementation

The system was developed on the Android studio development platform in the JAVA programming language. Using the proposed system development methodology, it was developed using an object-oriented approach that helped in providing a systematic and efficient development process.

5.3 System Implementation

This section aims to focus on the system testing and whether the system has succeeded through functional testing, usability testing and unit. The manner in which the system was built in regard to the system analysis and design methodology as mentioned in section 3.3.3 has been explained in section 5.2.1, 5.2.2 and 5.2.3

5.3.1 System Logic construction

The system was constructed with the client server architecture in mind. Engine X is the server that hosts the face shape recognition model. The user Logs into the application. Once their credentials are recognized the have the option on checking other users' profile, scanning a face to determine the face shape or posting a photo of a hairstyle done already.

5.3.2 Face shape Classifier model

This are the steps undertaken in creation of the model.

1.Collecting the dataset

Using Kaggle which allows users to find and publish data sets, explore, and build models in a web-based data-science environment, work with other data scientists and machine learning engineers I obtained a dataset.

2. Building the model

In building the model instead of using the more common 2D convolutions, I decided to go with Depth-Wise Convolutions. The depthwise separable convolutions have become the basis for modern models such as the Xception model. In a nutshell a depthwise separable convolution convolves the input image depth by depth(channel by channel) independently before mixing the output channels together using a pointwise (1 x 1) convolution. This convolution results in fewer trainable weight parameters while still preserving the spacial feature of the image and in addition this offers faster training.

3. Testing the accuracy of the model

After the model was built it was necessary to test it

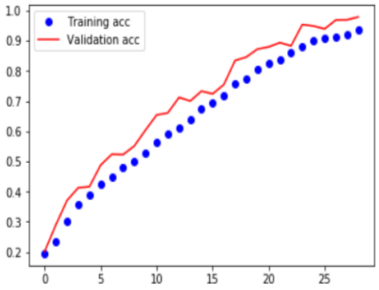


Figure 16 Graph showing the model's Accuracy.

n [8]:

```
acc = history.history['acc']
val_acc = history.history['val_acc']

loss = history.history['loss']
val_loss = history.history['val_loss']

import matplotlib.pyplot as plt


epochs = range(len(acc))
plt.plot(epochs,acc,'bo',label='Training acc')
plt.plot(epochs,val_acc,'r',label='Validation acc')
plt.legend()


plt.figure()
plt.plot(epochs,loss,'bo',label='Training loss')
plt.plot(epochs,val_loss,'r',label='Validation loss')

plt.legend()
plt.show()
```

Figure 17 Code Snippet showing plotting of the models accuracy.

5.4 Testing

This section aims to focus on the system testing and whether the system has succeeded through functional testing, usability testing and unit.

5.4.1 Testing the model.

Below is a snippet of the results of testing the models accuracy.

```
assignment to the variable value or `x = x * y` if you want a new python Tensor object.
Epoch 1/50
250/250 [==============================] - 134s 537ms/step - loss: 1.6099 - acc: 0.1948
- val_loss: 1.6069 - val_acc: 0.2013
Epoch 2/50
250/250 [==============================] - 120s 481ms/step - loss: 1.5948 - acc: 0.2355
- val_loss: 1.5643 - val_acc: 0.2895
Epoch 3/50
250/250 [==============================] - 122s 489ms/step - loss: 1.5415 - acc: 0.3028
- val_loss: 1.5091 - val_acc: 0.3705
Epoch 4/50
250/250 [==============================] - 122s 488ms/step - loss: 1.4624 - acc: 0.3575
- val_loss: 1.4047 - val_acc: 0.4128
Epoch 5/50
250/250 [==============================] - 124s 496ms/step - loss: 1.4130 - acc: 0.3872
- val_loss: 1.3601 - val_acc: 0.4163
Epoch 6/50
250/250 [==============================] - 123s 492ms/step - loss: 1.3498 - acc: 0.4238
- val_loss: 1.2399 - val_acc: 0.4878
Epoch 7/50
250/250 [==============================] - 125s 501ms/step - loss: 1.3035 - acc: 0.4495
- val_loss: 1.1853 - val_acc: 0.5238
Epoch 8/50
250/250 [==============================] - 123s 493ms/step - loss: 1.2524 - acc: 0.4815
```

Figure 18 Snippet showing testing results of the model.

5.4.2 Test Cases of the system

Requirement	Test ID	Inspection Check	Pre-Condition	Test Data	Priority Level
User	T1	Authenticati	User of the	ongechjeremy@gmail.c	High

Authentication		on	system must have login credentials	om Password 12345678910	
Search	T2	Search	User must be able to search	Username Jeremy	High
Facial Recognition	T3	Facial Recognition	Face should be recognized	Scan a face	High
Appointment	T4	Chat	Users can communicate	Texts	High

Table 6 Table showing test cases of functional requirements.

Chapter 6 Conclusions, Recommendations, Future works.

6.1 Conclusion

This Project assists clients and beauticians in communication. It also assists them in face shape recognition and through the face shape recognition a hairstyle can be suggested. This is done by allowing for users with similar face shapes to document and showcase their previous hairstyles.

6.2 Recommendation

For best results it is advised that device being used to access the application be connected to an internet connection.

6.3 Future works

For future works, for hairstyle recommendation there could be use of suggestion algorithm such as the one used by Netflix in suggestion movies and tv shows to their users.

References

F. Orel and A. Kara, "Supermarket self-checkout service quality customer satisfaction and loyalty: Empirical evidence from an emerging market", Journal of Retailing and Consumer Services, vol. 21, pp. 118-129, 2014.

6. J. Defeo and J. Juran, "Juran's Quality Essentials for Leaders" in , McGraw-Hill Education, 2014

M. A. Rahman and A. Ali, "Defining service quality index preferences in a service industry using Analytic Hierarchy process," 2015 International Conference on Industrial Engineering and Operations Management (IEOM), Dubai, 2015, pp. 1-7, doi: 10.1109/IEOM.2015.7093921..

W. Sunhem and K. Pasupa, "An approach to face shape classification for hairstyle recommendation," 2016 Eighth International Conference on Advanced Computational Intelligence (ICACI), Chiang Mai, 2016, pp. 390-394, doi: 10.1109/ICACI.2016.7449857.

S. Guo, S. Chen and Y. Li, "Face recognition based on convolutional neural network and support vector machine," 2016 IEEE International Conference on Information and Automation (ICIA), Ningbo, 2016, pp. 1787-1792, doi: 10.1109/ICInfA.2016.7832107.

Maheshwari, S. (2002). A Comparative Analysis of Different types of Models in Software Development Life Cycle. International Journal of Advanced Research inComputer Science and Software Engineering, 285-290.

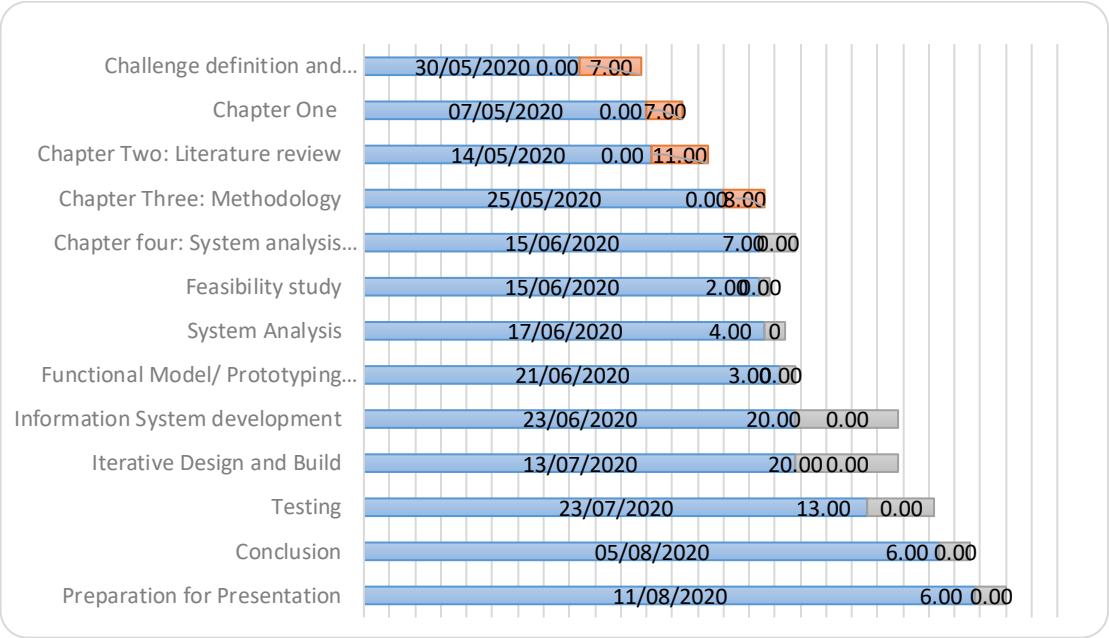
American Academy of Periodontology. (2012). Population Based Surveillance. Clinical Science.

Avison, D., & Fitzgerald, S. (2006). Historical Perspective. In V. 2. IFIP Internation Federation for Information Processing. The Past and Future of Information Systems, 27-38.

C. Hong. "Nice Korean Hairstyle", Bangkok, Thailand: Nation International Edutainment PCL., 2013.

Mobius, Markus, M., and Tanya S. Rosenblat. 2006. "Why Beauty Matters." American Economic Review, 96 (1): 222-235.

Appendix A TimeLine of activities



Appendix B User Manual

Once the Application is downloaded

i. Open the Application

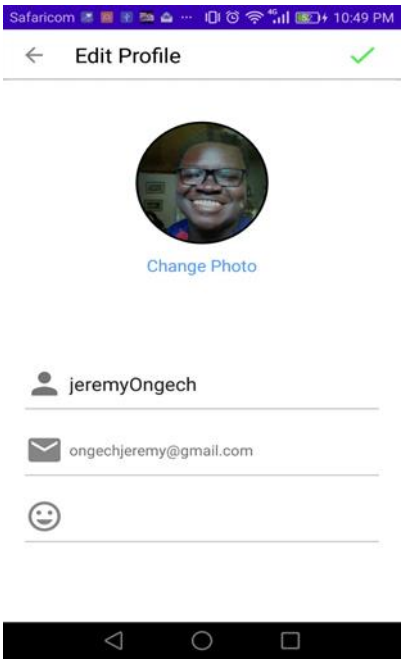
On starting the application the login screen will require you to put in an email address

ii. Verify your email address

Verify the email address by checking in your email inbox for the verification email

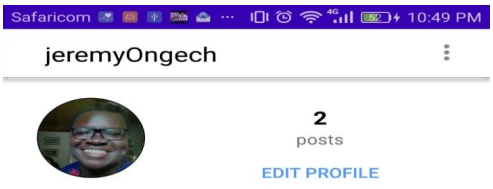
iii. Create an Account

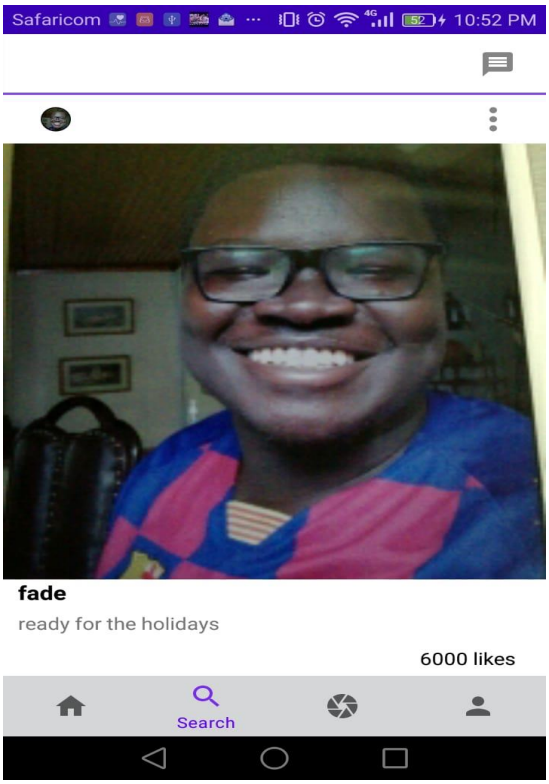
Once verified the sign up screen will appear where the user is required to register their details



iv. Scan your face

The button will let you open the phones camera a photo will be taken there after it will be scanned and your face shape determined





v. Communicate with other Users

The chat option is available for those who would like to communicate with the stylist and make an appointment also generally to communicate with other users of the system.

vi. Log out

Upon completion of a session the user can proceed to logout.