Software Design Description for Online Fitting Room

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Table 1: Document version history

Version	Date	Reason for Change
1.0	10-Mar-2021	Added Scope and Purpose
1.1	12-Mar-2021	Added UseCase Diagram.
1.3	15-Mar-2021	Updated Data Design Section
1.4	18-Mar-2021	Added Context Diagram,Class diagram and it's description
1.5	20-Mar-2021	Added System Overview and Gant chart
1.6	26-Mar-2021	Modified System Overview, Context Diagram
1.7	28-Mar-2021	Added Algorithm viewpoint

GitHub: https://github.com/mohamedosama27/online-fitting-room

Contents

Abstract

Users encounter major problems when they shop online. These problems can be summarized in two main points; choosing suitable size and style of their clothes and returning these items if they find out they don't fit. Accordingly merchants' profit is affected severely. Our project aims to help decrease the negative impact of this problem on merchants and let these users find their perfect fitted clothes virtually from their home whether by uploading two images with different positions (front and side position) or entering his measurements manually. After taking these images and processing the clients measurements, a 3D model for the user with perfect sizes will be generated and another 3D model for the item he wants to try on.Also, we have segmented the cloth from image to get it's mask to map segmented cloth into texture.

1 Introduction

1.1 Purpose

The purpose of this documentation is to represent a detailed software design description (SDD) describes the architecture and system design of our system (Online Fitting Room). Online Fitting Room mainly helps client to fit chosen items virtually. This documentation will present a full description about our system which is a mobile application developed using Flutter and Python. We also provide a fulfilled description about each processing stage, inputs and outputs as well.

1.2 Scope

This document targets vendors and clients that would use the online fitting room application that helps them during online shopping which will save much time instead of visiting the stores Especially during COVID-19. Meanwhile, the application help client to try the clothes on his 3d body model and in choosing a suitable size. On the other hand, help vendor to increase the rate of sales and decrease the rates of returns.

1.3 Overview

This SDD document includes 7 sections. The first we start with introduction to our system including our scope,intended audience ,reference material and purpose. The second section is the system overview explaining our system workflow. The third section includes the architecture design of the system, context diagram, use case diagram and class diagram. The fourth section explain the data design in details. The fifth section explain our user interface design and describes how the user will interact with our system. The sixth section contain requirements matrix . The seventh section contain appendices.

1.4 Intended audience

1.4.1 Vendor:

The vendor will benefit from the system by increasing their sales and decrease returning rates of unfitting clothes.

1.4.2 Client:

The client will benefit from the system by helping them trying their items online on their 3D model and decreases their visits to stores to avoid COVID-19

1.5 Reference Material

Information	Source of information
Class Diagram	SRS
Class diagram description	SRS
Data Description	SRS
Databse design description	SRS
Requirement Matrix	Test Plan

1.6 Definitions and Acronyms

Term	Definition
Software Design Document (SDD)	Used as the primary medium for communicating software design information.
GUI	Graphical user interface that interacts with the user .
MICE	Multivariate Imputation by Chained Equations
CAESAR	Civilian American and European Surface Anthropometry Resource Project

2 System Overview

First of all, the user is asked to upload two input images with different positions (front and side image). User can also enter his body measurements if known or both of them to increase measurements' accuracy of the 3D model created and then store it in the database using mobile application. Then, images will go through image processing stage that deployed in heroku which starts with generated 3d model for client afterwards, segment cloth from image using tensorflow to get the mask of the item. Moreover,we train neural network using pytorch to map the segmented cloth into texture after all system generated 3d model for item so user can fit the item on his 3d body model.

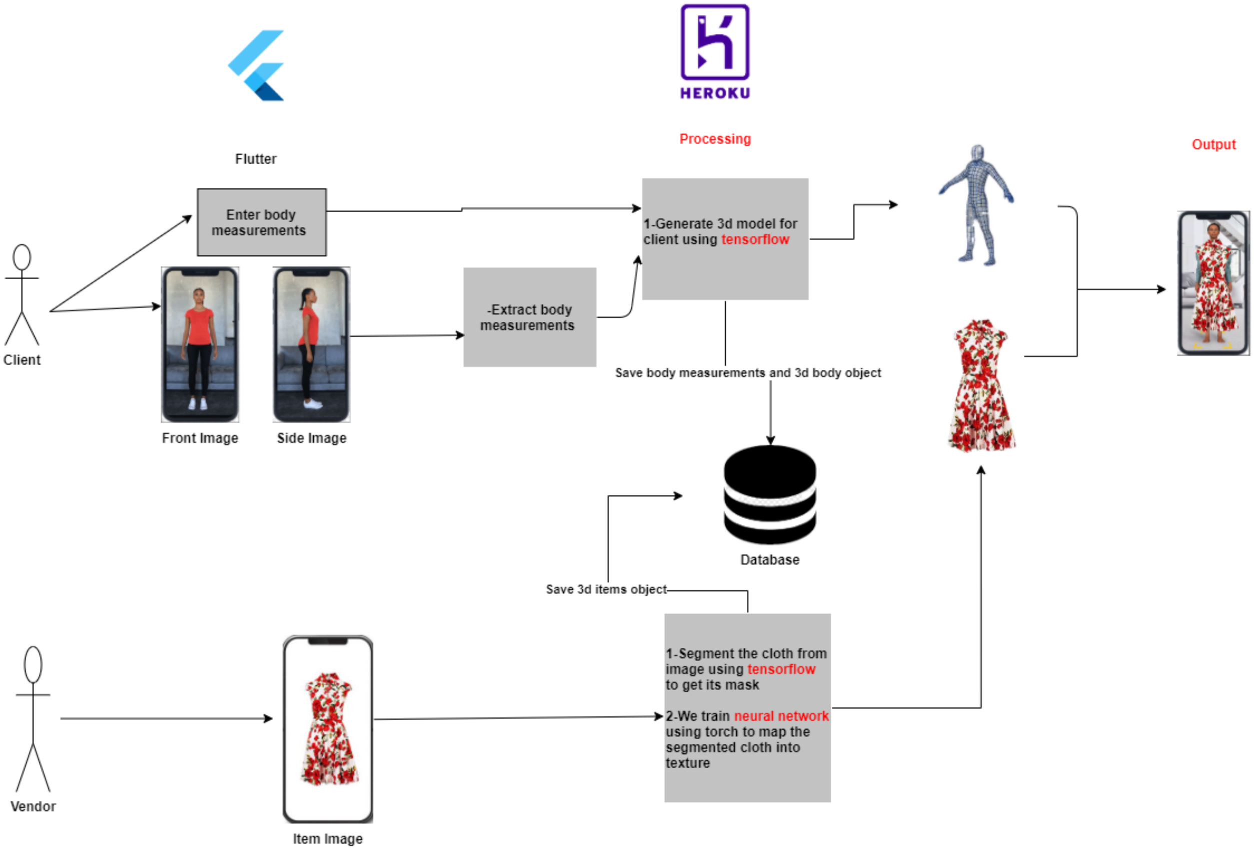

Flutter
HEROKU
Processing
Output
Enter body measurements
1-Generate 3d model for client using tensorflow
Client
-Extract body measurements
Front Image
Side Image
Save body measurements and 3d body object
Database
Save 3d items object
1-Segment the cloth from image using tensorflow to get its mask
2-We train neural network using torch to map the segmented cloth into texture
Vendor
Item Image

Figure 1: System overview

2.1 System Scope

The scope of the system includes several things:
1. The system will take user measurements or user images to extract body measurements to generate 3D model.
2. The system will take items from vendor and generate 3D model for each item.
3. Client can choose selected items and see if the selected item fits him or not.

2.2 System objectives

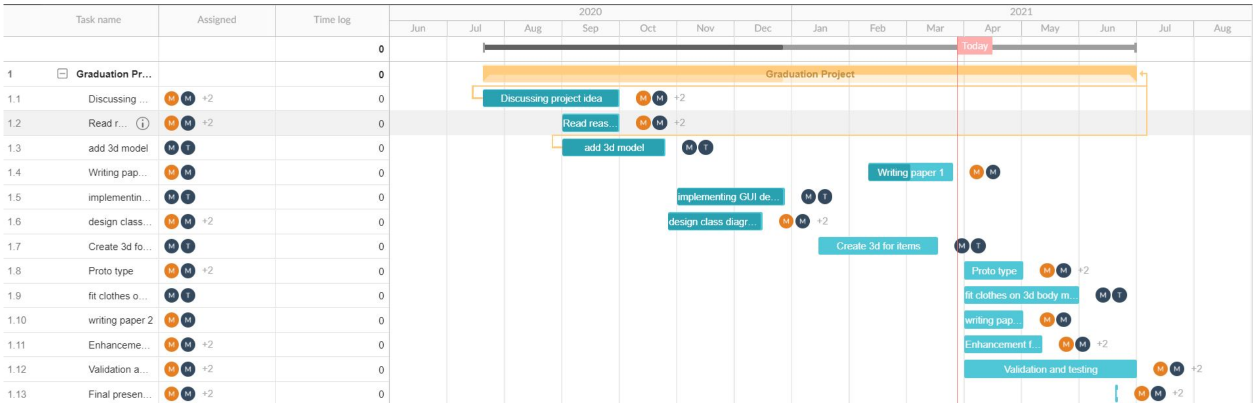
"Online Fitting Room" is a mobile application which serves the online stores.

1. The system aims to help the user to try different items in his 3d model
2. The system aims to help the user to increase accuracy of choosing the correct size
3. The system aims to help the vendor to increasing their sales.

2.3 System Timeline

Table 2: Online Fitting room time plan

Id	Task	Start Date	Number of Days	Team Member
1	Discussing project idea	20/8/2020	20	Mohamed Ayman, Mohamed Abdelaziz , Mohamed Osama , Tarek Medhat
2	Adding 3d model	1/10/2020	20	Mohamed Osama , Mohamed Abdelaziz
3	Writing paper 1	1/3/2021	15	Mohamed Ayman, Mohamed Abdelaziz
4	implementing GUI design	1/11/2020	15	Mohamed Osama , Tarek Medhat,Mohamed Ayman,Mohamed Abdelaziz
5	design class diagram and database	27/10/2020	15	Mohamed Ayman, Mohamed Abdelaziz , Mohamed Osama , Tarek Medhat
6	Create 3d for items	15/2/2021	20	Mohamed Ayman , Tarek Medhat
7	fit clothes on 3d body model	1/4/2021	20	Mohamed Osama , Tarek Medhat,Mohamed Abdelaziz,Mohamed Ayman
8	Enhancement for texture of items	10/4/2021	15	Mohamed Ayman, Mohamed Abdelaziz , Mohamed Osama , Tarek Medhat
9	writing paper 2	13/4/2021	15	Mohamed Ayman, Mohamed Abdelaziz
10	Validation and testing	15/4/2021	15	Tarek medhat , Mohamed osama,Mohamed Ayman, Mohamed Abdelaziz



	Task name	Assigned	Time log
			0
1	⊟ **Graduation Pr…**		**0**
1.1	Discussing …	M M +2	0
1.2	Read r… ⓘ	M M +2	0
1.3	add 3d model	M T	0
1.4	Writing pap…	M M	0
1.5	implementin…	M T	0
1.6	design class…	M M +2	0
1.7	Create 3d fo…	M T	0
1.8	Proto type	M M +2	0
1.9	fit clothes o…	M T	0
1.10	writing paper 2	M M	0
1.11	Enhanceme…	M M +2	0
1.12	Validation a…	M M +2	0
1.13	Final presen…	M M +2	0

Figure 2: Online Fitting Room GANTT Chart

3 Design viewpoints

3.1 Context viewpoint

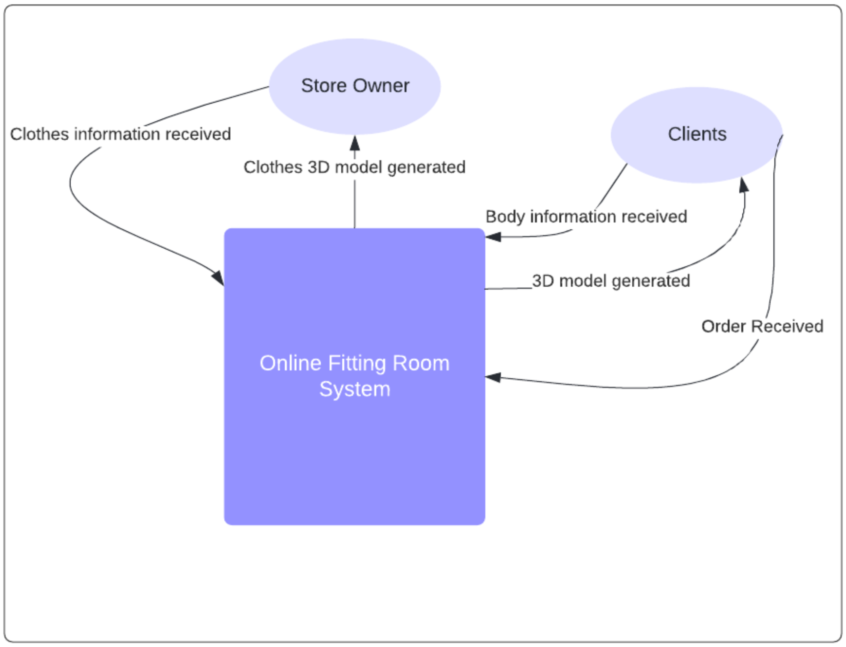

Store Owner
Clients
Clothes information received
Clothes 3D model generated
Body information received
3D model generated
Order Received
Online Fitting Room System

Figure 3: Context Diagram for the Online Fitting Room System

The proposed system context is starting from the store owner to put items of his brand in the system to be showed to clients to choose what he want. After items added to system, system generated 3D model to each items in the system. The client has to provide the system with his body measurements, the system takes the body information and generate the 3D model.So client will have his own 3D model and can choose any item he want and get it's 3D model and finally can try item 3D model on his 3D body model, see if it fits or not and adds it to his cart to make his order.

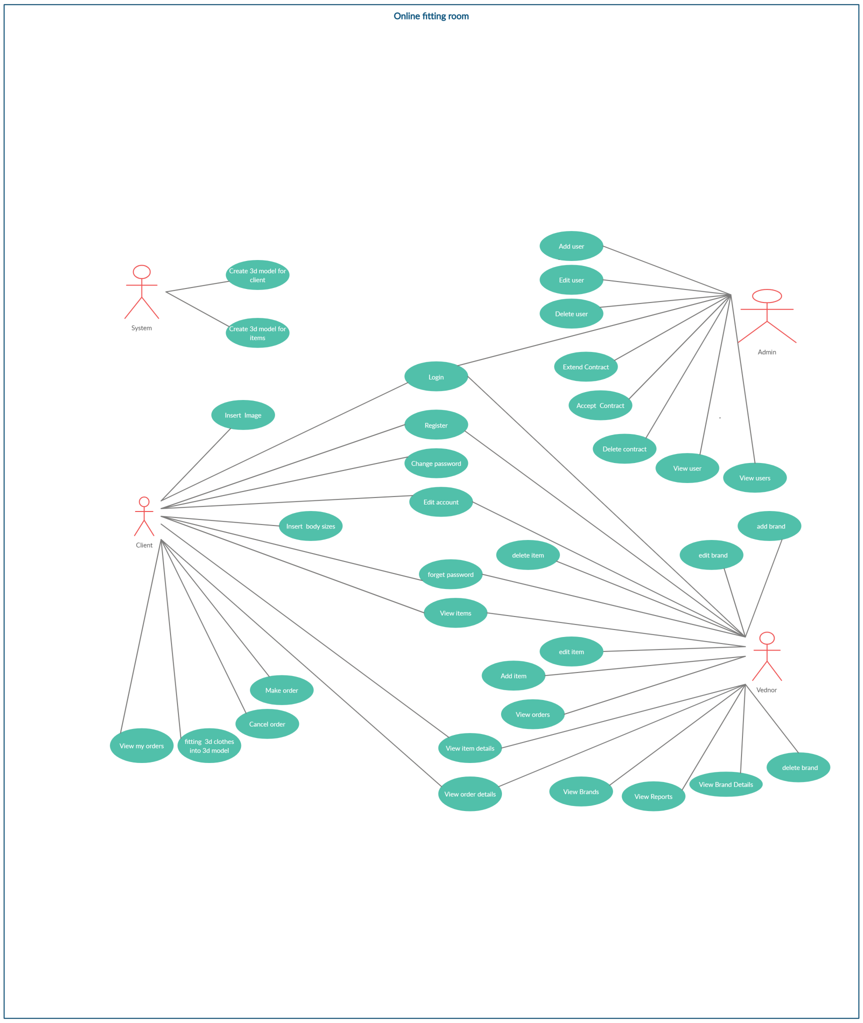


Figure 4: Use Case Diagram

3.1.1 Scenario 1

Vendor wants to put his brand on the mobile application so he send request to admin to add him on the application with special email and password to upload his brand with all types of items that he wants according to contract terms. So Vendor has all authorities to edit and delete in his brand's details. Also, he can view all orders' details or specific order details. He can also edit and delete item's details in his brands. At end of month or a week, vendor can see a report contains all sales operation of his brand.

3.1.2 Scenario 2

First of all, Client should register to access to our application to take advantage of its features. Then, client will have the choice to upload his front and side images or enter his body measurements if he knows them to create 3D model from his body measurements. After that, he can shop online easily through the application and he will be able to see all the existing brands with it's items and can choose whatever he wants. The items he chose will be converted to 3D model so he can try it on his 3D model to see whether it fits him or not. Finally, he can order and buy the items that fit him confidently.

3.1.3 Scenario 3

Admin can see users that access our mobile application whether vendor or client. Admin also can give access to vendor after he signs the contract and can extend the vendor's contract when it expires.

3.2 Composition viewpoint

3.2.1 Architecture Design

- **View**
  This part is responsible for the presentation of data and representing the User Interface (UI). We have two different interfaces one is responsible for client operations and the other one is responsible for vendor operations both of them placed on a mobile application

- **Controller**
  It is responsible for connecting both the View and Model together. All user interactions and requests made in the view are sent to the database in order to be fetched, this is done by the usage of the models. If these requests require a response it will be forward to the user through the view. Some controllers like the Auth Controller is responsible for only the user actions such as: login, signup and register. Client Details controller is responsible for edit,add,show measurements and enter images to generate 3D model.Brand management and brand details controller are responsible for for add,edit,delete and fetch brands that are in the system. Items management and item details controller are responsible for add,edit,delete and fetch items that are in the system. Ordering and order details controller are responsible for fetch orders that user ordered, fetch orders for each vendor and show canceled orders.Account controller is responsible for edit user's information.Verification controller is responsible for verifying new account's email. Admin backend controller is responsible for retrieve all user in the system.Report controller is responsiable for generating weekly or monthly report for each brand sales.

- **Model**
  This part is responsible for the functionality of the system

1. **Algorithm**

   - **MICE** :A multiple imputation method used to replace missing data values in a data set under certain assumptions.
   - **Feature selection**: Is the process of reducing the number of input variables when developing a predictive model. ... Filter-based feature selection methods use statistical measures to score the correlation or dependence between input variables that can be filtered to choose the most relevant features.

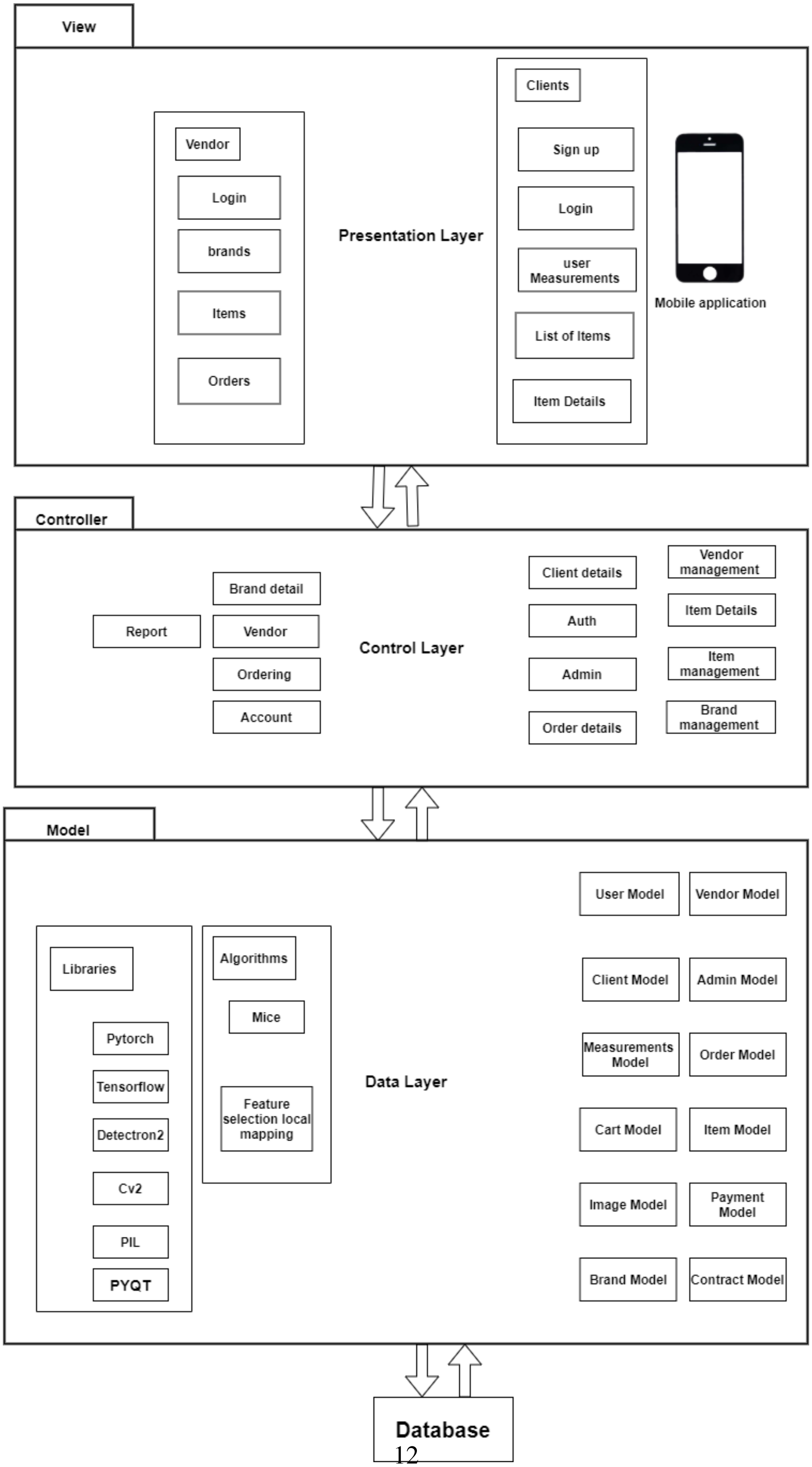


Figure 5: Architectural Design

2. **Libraries**

- **Pytorch**:PyTorch is an open source machine learning library based on the Torch library, used for applications such as computer vision and natural language processing, primarily developed by Facebook's AI Research lab. It is free and open-source software
- **Tensorflow**: Is a Python library for fast numerical computing created and released by Google. It is a foundation library that can be used to create Deep Learning models directly or by using wrapper libraries that simplify the process built on top of TensorFlow
- **Detectron2**:a popular PyTorch based modular computer vision model library. It is the second iteration of Detectron, originally written in Caffe2. The Detectron2 system allows you to plug in custom state of the art computer vision technologies into your workflow.
- **Cv2**: library of Python bindings designed to solve computer vision problems. ... OpenCV-Python makes use of Numpy, which is a highly optimized library for numerical operations with a MATLAB-style syntax
- **PIL**: is a free and open-source additional library for the Python programming language that adds support for opening, manipulating, and saving many different image file formats. It is available for Windows

3.2.2 Hardware Architecture

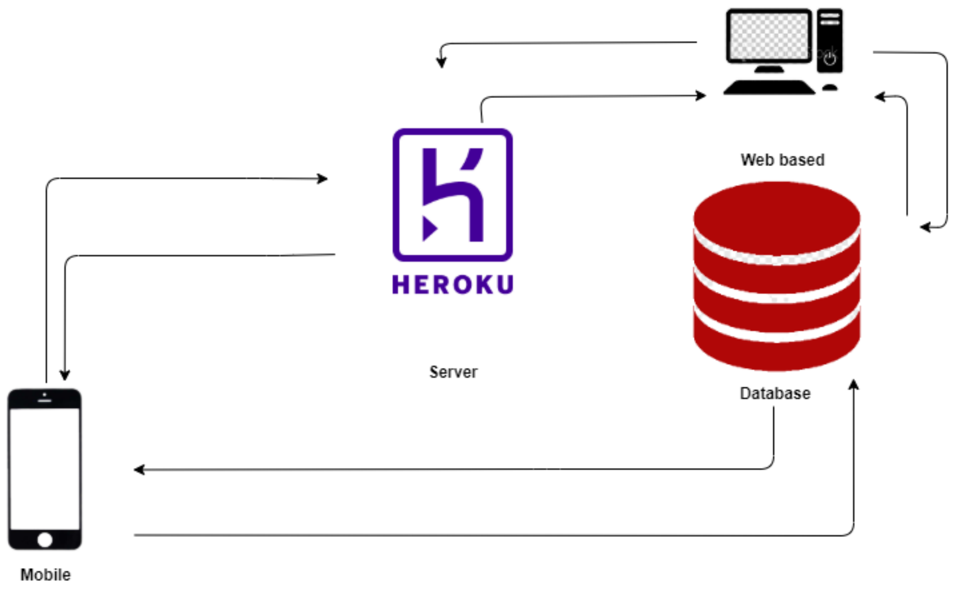


Figure 6: Hardware Architecture Diagram

Online Fitting Room hardware architecture consists from different components.Firstly, most of the work is done on the server from pre-processing . The server is connected to mobile.

3.2.3 Design Rationale

In the architectural design, MVC design is used for fast developing process and providing multiple views , has become popular for designing web applications as well as mobile apps Development of the application becomes fast.Easy for multiple developers to collaborate and work together. Easier to Update the application.

3.3 Logical viewpoint

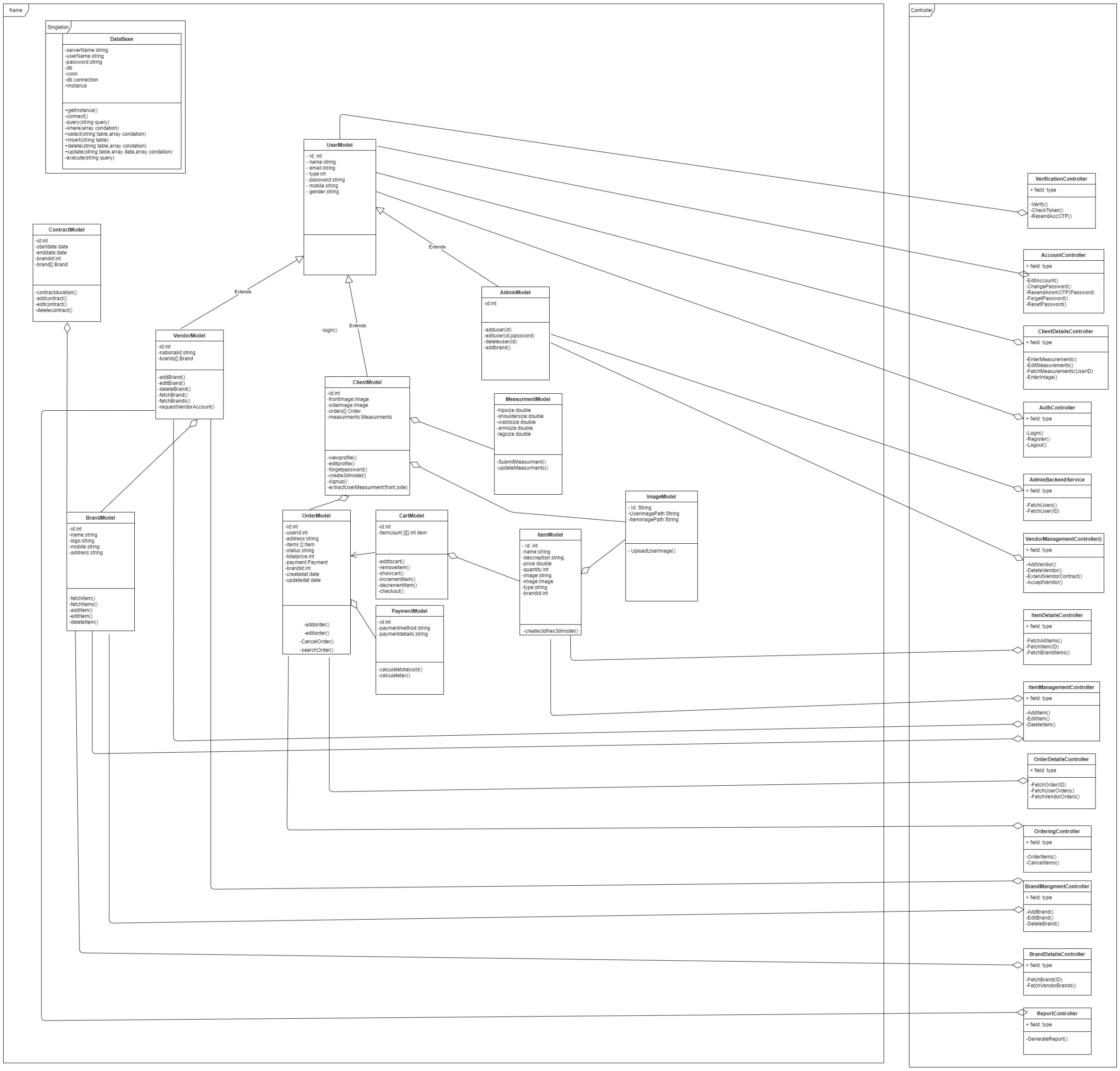


Figure 7: Class Diagram

Table 3: Class Name - UserModel

Abstract or Concrete:	Concrete.
List of Superclasses	None
List of Subclasses	ClientModel, VendorModel, AdminModel
Purpose	The purpose of this class is to store common information of all usertypes
Collaborations	-
Attributes	Name, email, type, password, mobile, gender
Operations	Login()
Constraints	If user doesn't have an account, he can't access to application

Table 4: Class Name - ClientModel

Abstract or Concrete:	Concrete.
List of Superclasses	UserModel
List of Subclasses	ImageModel,MeasurementsModel,OrderModel
Purpose	The purpose of this class is to store special information of all clients
Collaborations	This class is inherit from class UserModel, Aggregated with MeasurmentsModel, ImageModel, OrderModel
Attributes	Name, email, type, password, mobile, gender
Operations	viewprofile(), editprofile(), forgetPassword(), changePassword(), signUp(), extractUserMeasurments(), create3Dmodel()
Constraints	None

Table 5: Class Name - VendorModel

Abstract or Concrete:	Concrete.
List of Superclasses	UserModel
List of Subclasses	BrandModel
Purpose	The purpose of this class is to store special information of all vendors
Collaborations	This class is inherit from class UserModel,Aggregated with BrandModel
Attributes	NationalID, Array of brands
Operations	addbrand(), editbrand(), deletebrand(), fetchbrand(), fetchbrands(), requestVendorAccount()
Constraints	None

Table 6: Class Name - AdminModel

Abstract or Concrete:	Concrete.
List of Superclasses	UserModel
List of Subclasses	None
Purpose	The purpose of this class is to store special information of all admins
Collaborations	This class is inherit from class UserModel
Attributes	ID
Operations	adduser(), edituser(), deleteuser(), addbrand(),
Constraints	None

Table 7: Class Name - OrderModel

Abstract or Concrete:	Concrete.
List of Superclasses	None
List of Subclasses	PaymentModel
Purpose	The purpose of this class is to store items that client want to order
Collaborations	This class is Aggregate from class PaymentModel, Associate with class Cart
Attributes	ID, userid, address, Array of Items, status, totalprice, Object from PaymentModel, brandid
Operations	addorder(), editorder(), cancelorder(), seacrhorder(),
Constraints	None

Table 8: Class Name - BrandModel

Abstract or Concrete:	Concrete.
List of Superclasses	None
List of Subclasses	None
Purpose	The purpose of this class is to store all brands
Collaborations	None
Attributes	ID, name, logo, mobile, address
Operations	additem(), edititem(), deleteitem(), fetchitems(), fetchitem(),
Constraints	None

Table 9: Class Name - CartModel

Abstract or Concrete:	Concrete.
List of Superclasses	None
List of Subclasses	ItemsModel
Purpose	The purpose of this class is to store all items that client want to buy
Collaborations	Associate with OrderModel,Aggregate from ItemModel
Attributes	ID, Two Dimensional Array ItemCount
Operations	addtocart(), removeItem(), showcart(), incrementItem(), decrementItem(), checkout()
Constraints	None

Table 10: Class Name - PaymentModel

Abstract or Concrete:	Concrete.
List of Superclasses	None
List of Subclasses	None
Purpose	The purpose of this class is to show all payments that client did to buy
Collaborations	None
Attributes	ID, paymentMethod, paymentDetails
Operations	calculateTax(), calculateTotalPrice()
Constraints	None

Table 11: Class Name - ContractModel

Abstract or Concrete:	Concrete.
List of Superclasses	None
List of Subclasses	BrandModel
Purpose	The purpose of this class is to show all contracts between vendor and admin
Collaborations	Aggregate from BrandModel
Attributes	ID, startDate, endDate, brandid, Array of Brands
Operations	contractDuration(), addcontract(), editcontract(), deletecontract()
Constraints	None

Table 12: Class Name - ImageModel

Abstract or Concrete:	Concrete.
List of Superclasses	None
List of Subclasses	None
Purpose	The purpose of this class is to store all images that the client upload.
Collaborations	None
Attributes	ID, UserImagePath, ItemImagePath
Operations	UploadUserImage()
Constraints	None

Table 13: Class Name - MeasurementModel

Abstract or Concrete:	Concrete.
List of Superclasses	None
List of Subclasses	None
Purpose	The purpose of this class is to store all Measurements that client enter.
Collaborations	None
Attributes	ID, Hipsize, Waistsize, Armsize, Legsize
Operations	UpdateMeasurements(), SubmitMeasurements()
Constraints	None

3.4 Patterns use viewpoint

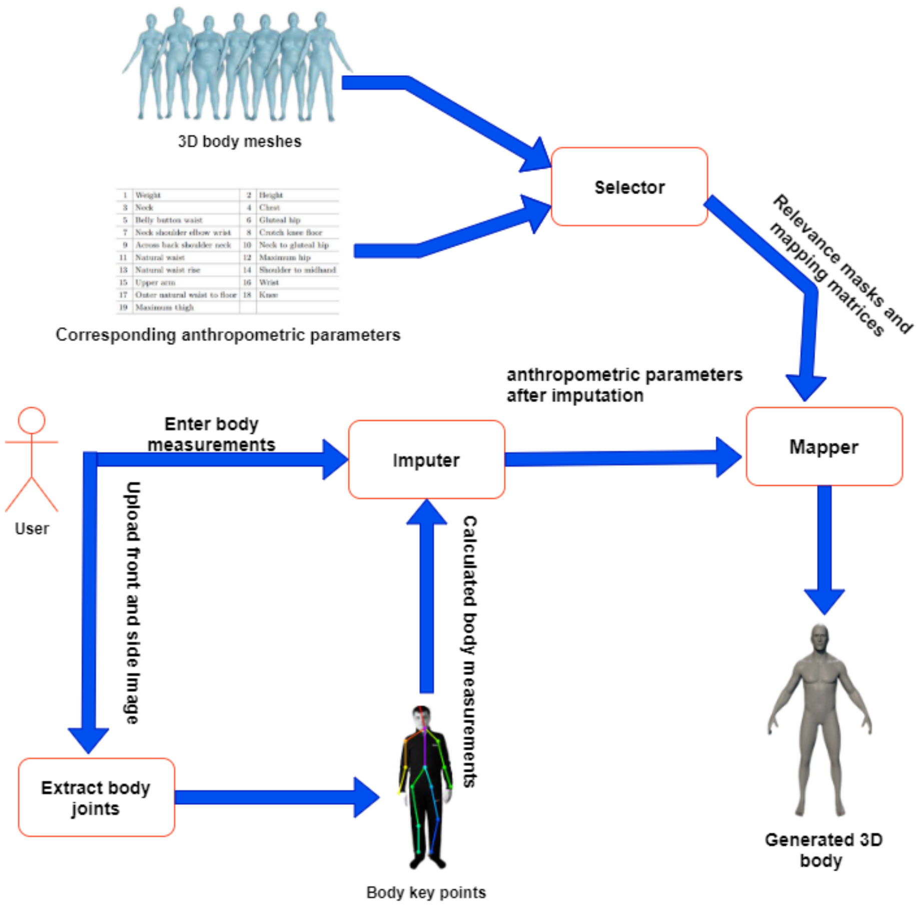
This viewpoint addresses design ideas focusing on the used design patterns. UML class diagram and the UML package diagram can be used here to illustrate the used design patterns.

3.4.1 Design Rationale

3.4.2 Singleton

Singleton is a creational design pattern which ensures that a class has only one instance and also provides a global point of access to it. In our project we used singleton in connection to the database class so a single connection is made to the database class by each user.

3.5 Algorithm viewpoint


3D body meshes
Corresponding anthropometric parameters
Selector
Relevance masks and mapping matrices
anthropometric parameters after imputation
User
Enter body measurements
Imputer
Mapper
Upload front and side image
Calculated body measurements
Extract body joints
Body key points
Generated 3D body

1	Weight	2	Height
3	Neck	4	Chest
5	Belly button waist	6	Gluteal hip
7	Neck shoulder elbow wrist	8	Crotch knee floor
9	Across back shoulder neck	10	Neck to gluteal hip
11	Natural waist	12	Maximum hip
13	Natural waist rise	14	Shoulder to midhand
15	Upper arm	16	Wrist
17	Outer natural waist to floor	18	Knee
19	Maximum thigh		

Figure 8: Generated 3d model for human

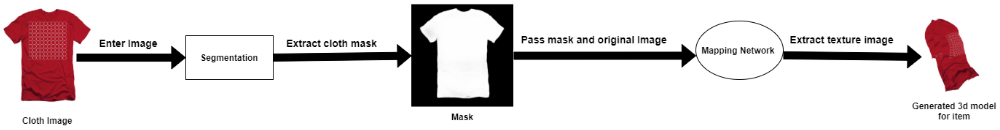


Figure 9: Generated 3d model for the items

3.6 Interaction viewpoint

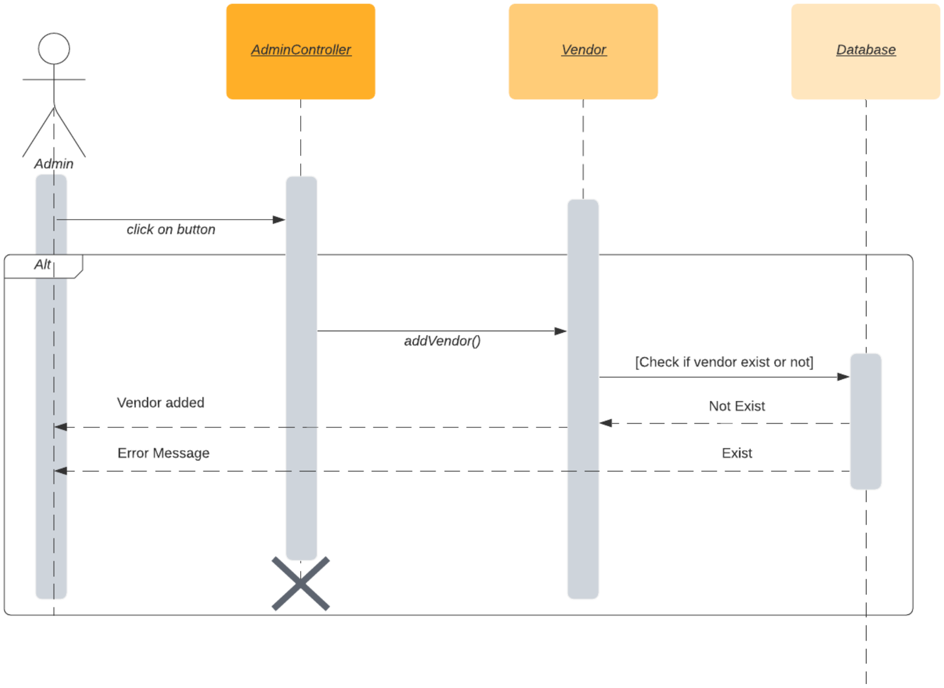


Figure 10: Admin adding vendor Sequence Diagram

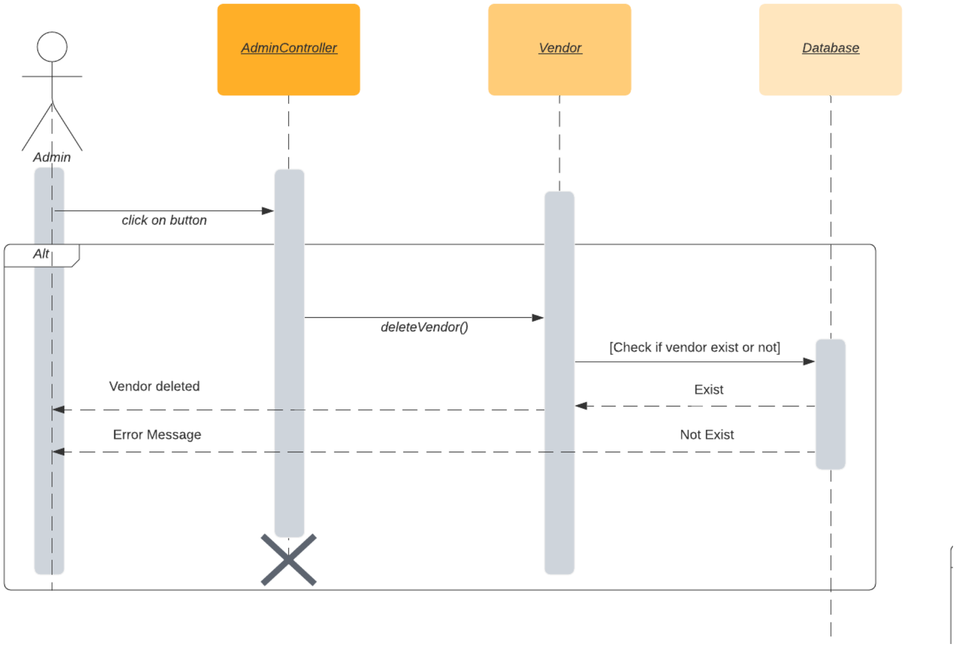


Figure 11: Admin deleting vendor Sequence Diagram

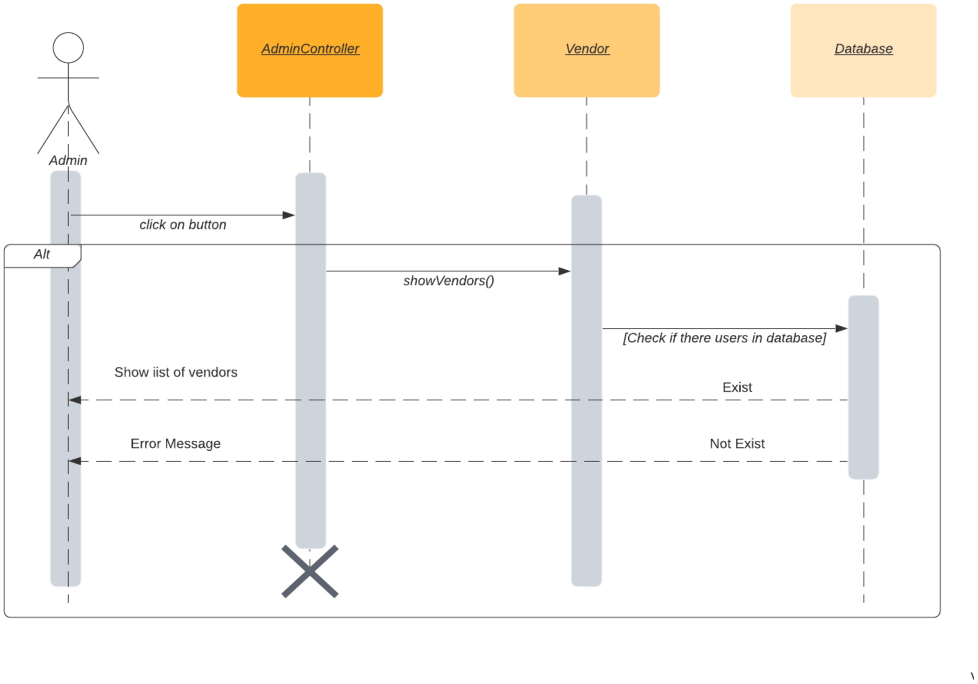


Figure 12: Admin listing vendor Sequence Diagram

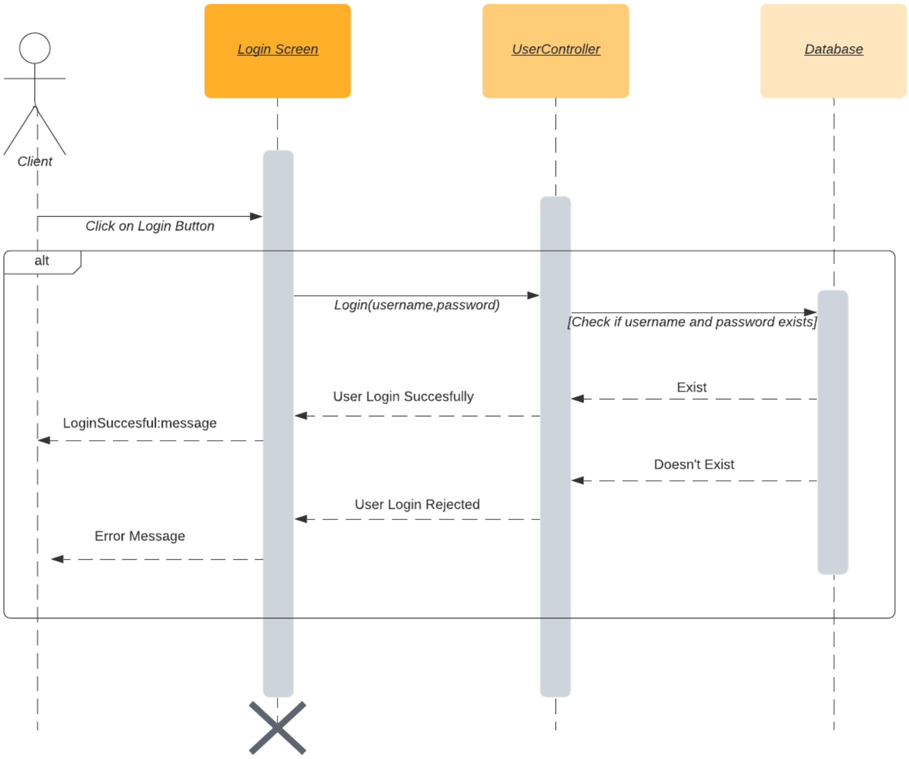


Figure 13: Client login Sequence Diagram

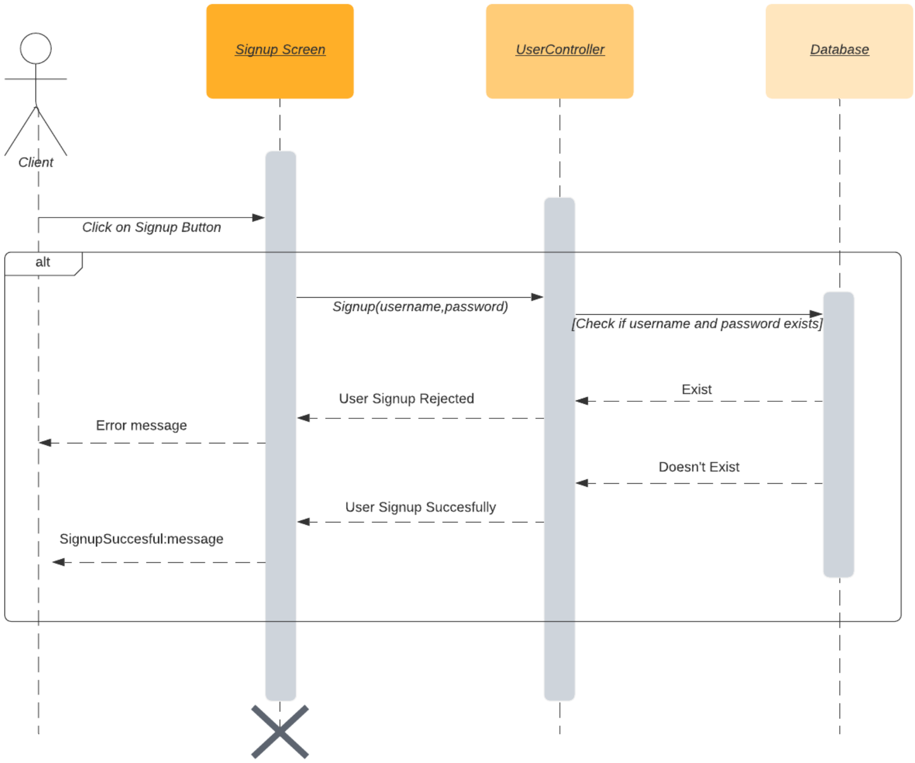


Figure 14: Client Register Sequence Diagram

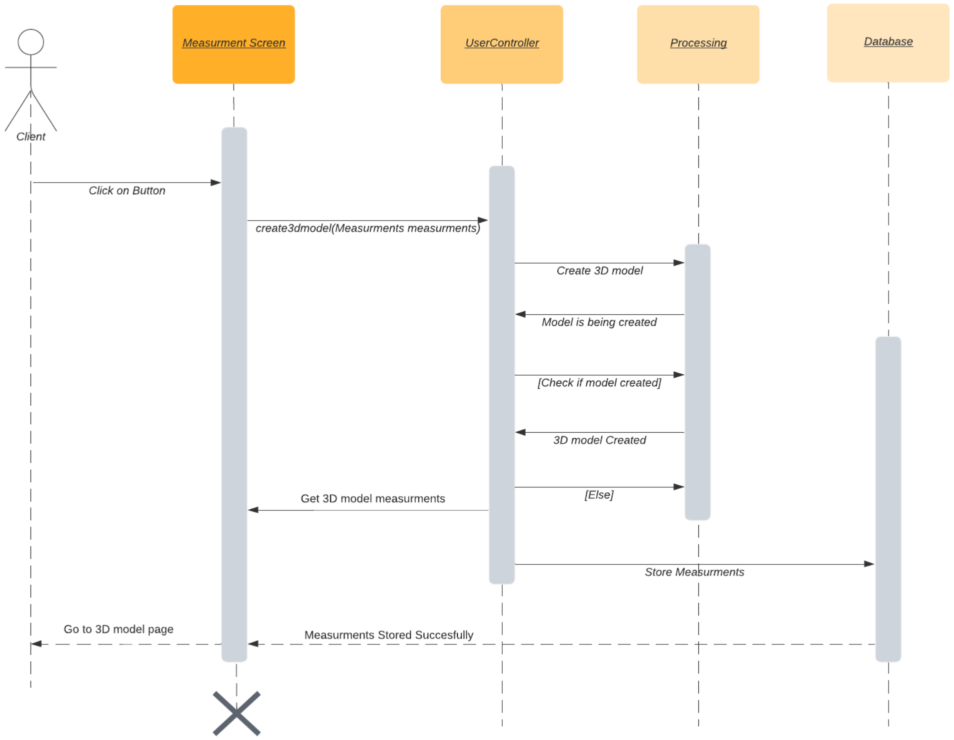


Figure 15: Client 3d model Sequence Diagram

3.7 Interface viewpoint

The Interface viewpoint provides programmers, and testers the means to know how to correctly use the provided services. This viewpoint consists of a set of interface specifications for each entity. NOTE: User interfaces are addressed separately in section 5.

4 Data Design

4.1 Data Description

User entity which contains id as primary key, name, email, phone, password, and type as its attributes. It has relation with user type which contains id as primary key and the other attribute is type. The user entity has another relation with notification which contains id as primary key, message, and title as other attributes. There are two entities inherit from user, the two entities are vendor and client. Vendor entity contains id as primary key, national id as its attributes and has relation with brand entity which contains id as primary key, name, address, logo and mobile as its attributes. Vendor has another relation with contract entity which contains primary key id, start date and expired date. Client has relation with order entity which contains primary key id, address, total price and status as its attributes. Client entity has relation with cart that has primary key id and count attributes. Client has another relation with measurements entity which contain primary key id, height, weight, and shoulder size. Items entity has primary key id, image, name, description, and price. this entity has a relation with item type which contains primary key id and type.

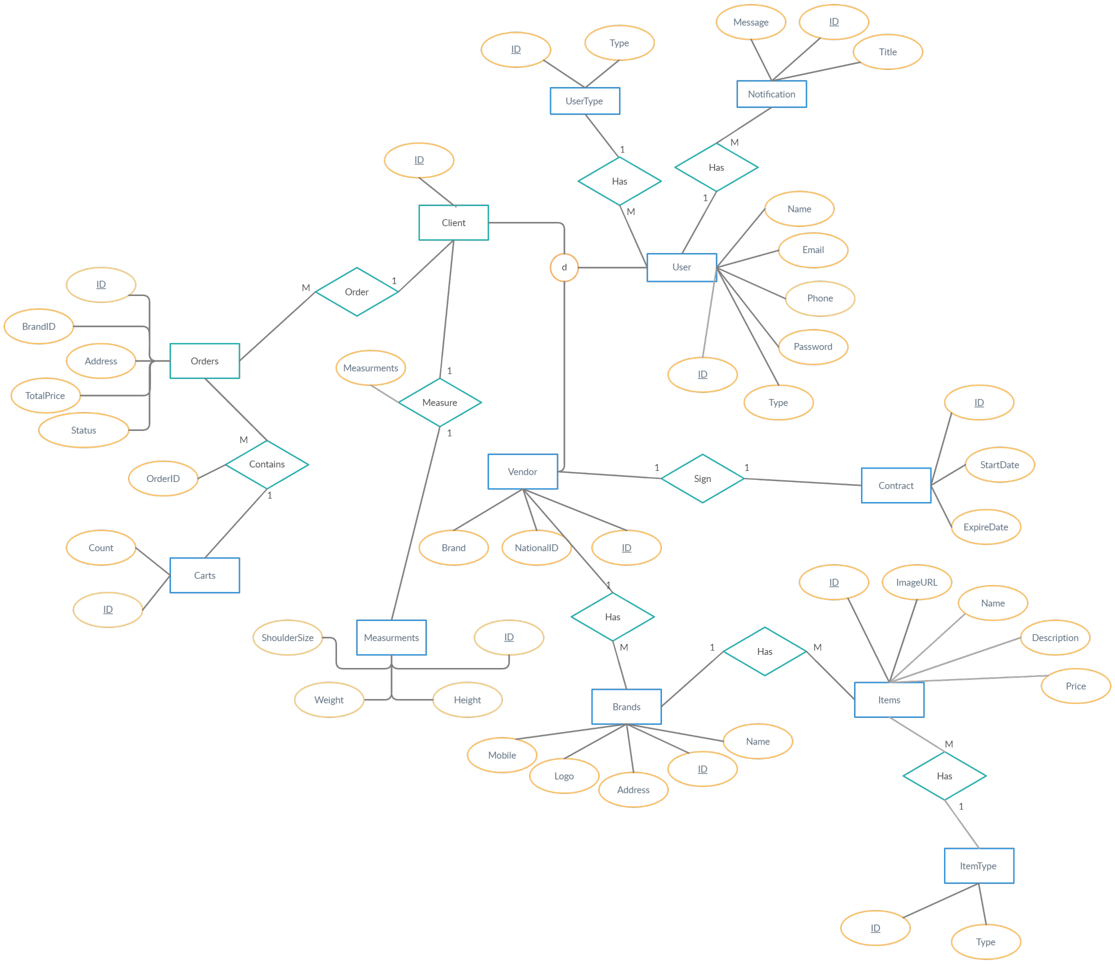


Figure 16: ER Diagram

4.2 Dataset Description

Table 14: Dataset

Dataset Name	SPRING
Link	https://graphics.soe.ucsc.edu/data/BodyModels/index.html [1]
Size	Dataset of 2GB which contains 3D scan meshes of 1517 male and 1531 female. Each mesh has 12500 vertices and 25000 facets
Number of subjects	3000 subjects
Notes	The data is derived from the CAESAR dataset

4.3 Database design description

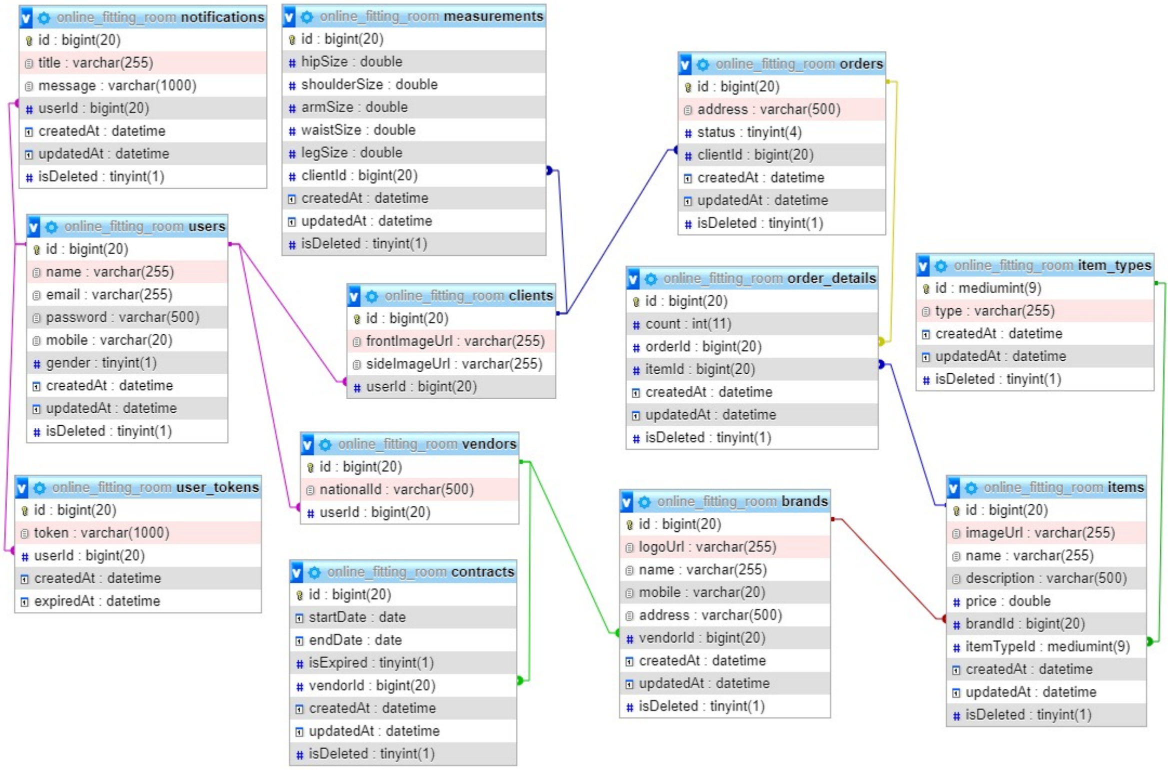


Figure 17: Database Schema

5 Human Interface Design

5.1 User Interface

All users must log in before using any page on mobile application

5.1.1 Client Side

The client will be able to choose between two options whether to enter his body measurements or to enter two images of his body in order to generate 3D model for him. The client shall be able to choose item from list of items that showed in application then after chosen it, system will generate 3D model of that item to try it on his 3D model.If it fit him , client can add it to his cart and be able to make an order of his items.

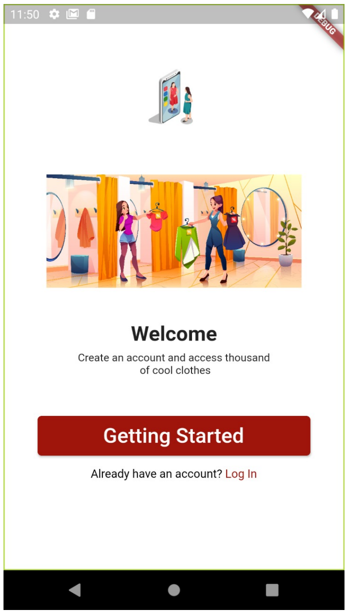
5.1.2 Vendor Side

The vendor will be able to add his new brand and add new items of his brand and can see all the orders that clients has ordered.

5.1.3 Admin Side

Admins are the ones responsible for updating security rules,add new vendor, view all users and can extend vendor contract.

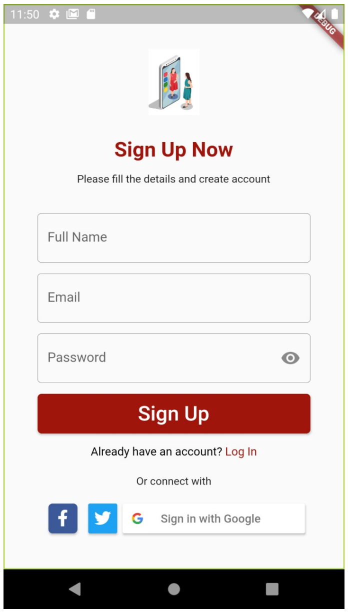
5.2 Screen Images



Welcome

Create an account and access thousand of cool clothes

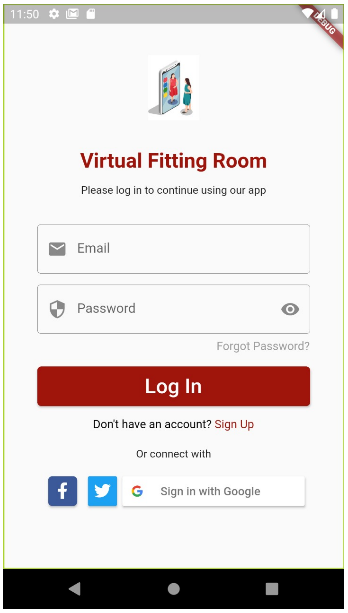
Figure 18: Welcome page



Sign Up Now

Please fill the details and create account

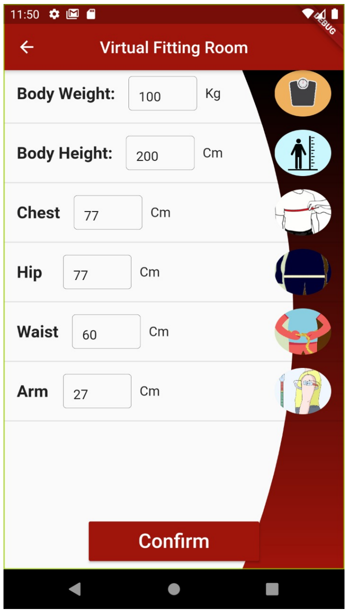
Figure 19: Signup page



Virtual Fitting Room

Please log in to continue using our app

Figure 20: Login page



Body Weight: 100 Kg

Body Height: 200 Cm

Chest 77 Cm

Hip 77 Cm

Waist 60 Cm

Arm 27 Cm

Figure 21: User measurements page

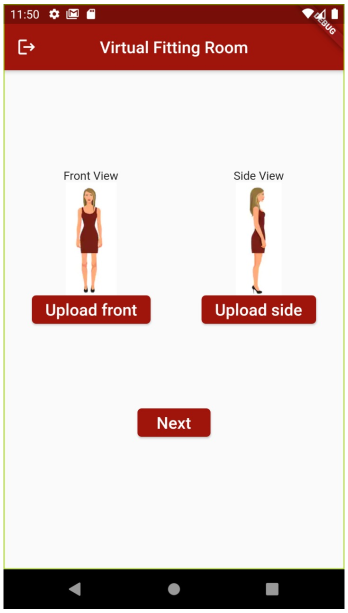
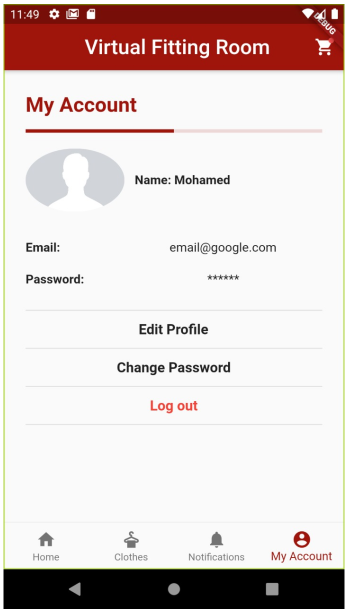


Figure 22: Upload Image Page

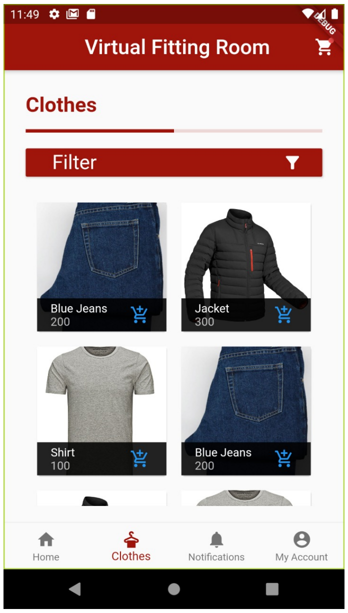


Name: Mohamed

Email: email@google.com

Password: ******

Figure 23: Profile page



Blue Jeans 200

Jacket 300

Shirt 100

Blue Jeans 200

Figure 24: Items page

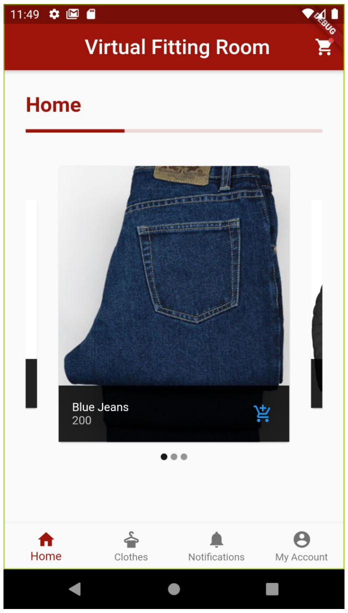
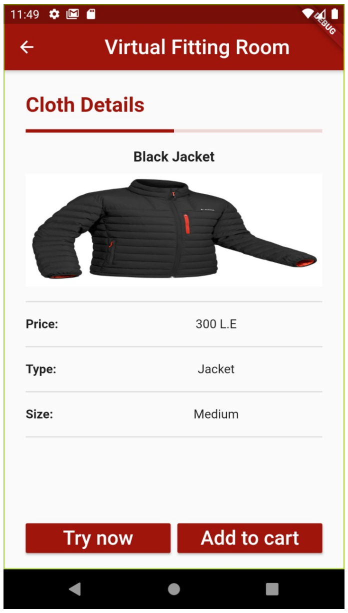


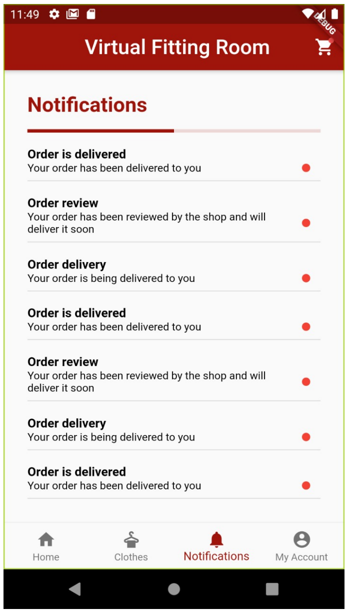
Figure 25: Item detail page



Black Jacket

Price:	300 L.E
Type:	Jacket
Size:	Medium

Figure 26: Item details page



Notifications

Order is delivered
Your order has been delivered to you

Order review
Your order has been reviewed by the shop and will deliver it soon

Order delivery
Your order is being delivered to you

Order is delivered
Your order has been delivered to you

Order review
Your order has been reviewed by the shop and will deliver it soon

Order delivery
Your order is being delivered to you

Order is delivered
Your order has been delivered to you

Figure 27: Notification page

5.3 Screen Objects and Actions

Welcome Page:
The client can be able login or signup linked to Google API or enter his email and password that stored in database.
Show Items:
Retrieve all items that are stored in database.
Add measurements:
Page that takes measurements that user entered and send it to heroku to generate 3D model of his body.
Profile Page:
Page retrieve the specific details of user from the dataset that login to the system.
Uploading image Page:
Page gives client choice to uploading front and side images to extract measurements and create 3D body model.

6 Requirements Matrix

Table 15: Requirements Ratrix

Req. ID	Req Desc	Class	Test Cases ID	Status
FR02	New customers must Register to access to our mobile application	SignUp	TC01,TC02,TC03, TC04	Developed
FR04	Check email and password to make customer access to his profile	Login	TC05, TC06,TC07,TC08	In-progress
FR06	The Administrator only will be able to view the users that accessed the system whether it's customer or brand owner	List Users	TC15, TC16	In-progress
FR09	Customer upload image of him to be used after that in to convert it to 3d model	Add CustomerImage	TC17 , TC18	Developed
FR10	Vendor upload image of his clothe's brand to be used after that in to mobile appli-cation	Add Cloth-Image	TC19,TC20	Developed
FR11	Vendor can add his brand details to mobile application	Add Brand	TC21, TC22,TC23,TC24,TC25	In-progress
FR12	Vendor can edit his brand details to mobile application	Edit Brand	TC03, TC04	In-progress
FR13	Vendor can delete his brand details to mobile application	Delete Brand	TC26, TC27	In-progress
FR14	Customer enter his measurements to help in generating 3d model for human bodyand help in make size of clothes accurate	Add User-Measurements	TC09, TC10, TC11,TC12	Developed

Table 16: Requirements Ratrix

Req. ID	Req Desc	Class	Test Cases ID	Status
FR15	Vendor can add items to his brand. application	Add Items	TC03, TC04	Developed
FR16	Vendor can edit items details of his brand application	Edit Items	TC03, TC04	Developed
FR17	Vendor can delete items details of his items	Delete Items	TC03, TC04	Developed
FR18	Customer can edit his measurements.	Edit User-Measurements	TC03, TC04	Developed
FR21	the Administrator only will be able to view the users that accessed the systemwhether it's customer or brand owner	View Users	TC13, TC14	Developed
FR22	Client can view all items types of brands of what he want	View Items	TC03, TC04	Developed
FR23	Administrator only has authority to delete any customer from the system	Delete User	TC03, TC04	Developed
FR24	Customer after enter his measurements, the system take this measurements andmake use it to generate 3D Model	Create 3D model for human body	TC03, TC04	Developed
FR25	Customer chooses what type of cloth he prefer then the system take cloth's image and make some operation to convert 2D images to 3D images	Create 3D model for clothes	TC03, TC04	Developed
FR26	Customer chooses the image of cloth's type that he want then system take it and make operations to convert it to 3D model	Choose ClothImage	TC03, TC04	Developed
FR30	Customer clicks logout so system is no longer available and getting out of session.	Logout	TC03, TC04	Developed

6.1 ICES

Appendices may be included, either directly or by reference, to provide supporting details that could aid in the understanding of the Software Design Document.

6.2 Github

Add screenshots from Github repository showing your project.

References

[1] Yipin Yang, Yao Yu, Yu Zhou, et al. “Semantic parametric reshaping of human body models”. In: *2014 2nd International Conference on 3D Vision*. Vol. 2. IEEE. 2014, pp. 41–48.