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E-Commerce Store Based On Augmented Reality

Bachelor of Science in Computer Science

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June, 2022

Certificate

We accept the work contained in the report titled "E-Commerce Store Based on Augmented Reality", written by Mr. MUAZ AHMED AND Ms. MANAL KHALID as a confirmation to the required standard for the partial fulfillment of the degree of Bachelor of Science in Computer Science.

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Abstract

E-Commerce plays more important role in people life. It affects the basic necessities of people life however customer in the online shopping is just get the information of the product like pictures and some words etc. There is no sense of real experience and the perception of products is not too good. With the progress of Science and development Augmented Reality technology a new type of technology has got attention of many people in daily life. Augmented Reality Plays a vital role in E-Commerce. It will change the future online shopping. Customer will buy the products that they like Just like reality. It will improve the customer perception and produce more interest in purchasing of items. Our app is to facilitate the customer in a real-world experience of products to help them in order to purchase the right product. Our Application will allow users to personalize the shopping experience. User can actually experience the product before purchasing it online Like if user wants to buy a table, he can actually see how table will look in his room by pointing mobile phone camera at the place where he wants to place the table and select the table that he wants to buy. The functionality is provided by Augmented Reality through Augmented Reality Core (AR Core). The user does not need any additional hardware like Virtual Reality box. This make Adoption easier.

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"We think someone else, someone smarter than us, someone more capable, someone with more resources will solve that problem. But there isn't anyone else."

Regina Dugan

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Acronyms and Abbreviations

SRS Software Requirement Specification
API Application Program Interface
MS WIN Microsoft Windows
UI User Interface
GUI Graphical User Interface

Chapter 1

Introduction

E-commerce websites are used for online trade of goods and services, and augmented reality is an advanced technology that improves online trading by merging the virtual and physical worlds via a camera. Augmented reality (AR) merges the virtual and physical worlds while also making them interactive. An application that assists the customer/buyer in selecting the appropriate goods. By merging physical environment information with virtual product models, this project can deliver more information and more direct experiences to online buyers. Customers are able to make more informed purchasing selections and would have a higher probability of obtaining the correct products. The major goal is to replace the traditional internet purchasing system with the new advanced technology known as "Augmented Reality." Users may live experience things in a unique way, allowing them to make the best possible purchase decisions. Also, one of our goals is to make the application accessible to both users and administrators[6].

It affects the basic necessities of people's lives. However, customers in online shopping just get the information of the product like pictures and some words etc. There is no sense of real experience and the perception of products is not too good. With the progress of Science and development, Augmented Reality technology a new type of technology has got the attention of many people in daily life. Augmented Reality plays a vital role in E-Commerce. It is going to change the future of online shopping.

Customers buy the products that looks realistic. It improves the customer perception and produce more interest in purchasing items. Our app is to facilitate the customer in a real-world experience of products to help them in order to purchase the right product. Our Application allows users to personalize the shopping experience. Users can actually experience the product before purchasing it online. Like if a user wants to buy a wall painting, he can actually see how the panting looks on his room's wall by pointing a mobile phone camera on them and select the painting that he wants to buy. The functionality is

provided by Augmented Reality through AR Core. The user does not need any additional hardware like Virtual Reality boxes. This makes adoption easier.

Figure 1.1: Augmented Reality [1]

1.1   How to describe Augmented Reality?

An AR structure is authoritatively described as an application that fulfills the accompanying three properties, to be explicit,

- Prepared to blend real and virtual substance in a certified environment.

- Is constant and natural.

- Can Enroll virtual substances in a 3D environment.

Augmented reality is like virtual reality, yet rather than replacing the actual world, AR improves the actual reality by coordinating virtual objects into the actual world. The virtual objects become an equivalent piece of the natural environment.

1.2   How does it offer a view of the physical environment?

When viewed through the screen, it provides a picture of the physical surroundings in real time with computer-generated visuals, altering your perspective of what you see in front of you. The use of augmented reality is justified because E-Commerce applications are sections of an online shopping site with expected characteristics that give the appearance of a new, distinctive, and exciting product during an E-Commerce shopping experience.

1.3   How is the use of AR-based Applications easier?

Augmented reality helps clients to shop appropriate products because it helps customers to realize products even before buying them. The use of augmented reality in E-Commerce apps makes products look realistic, increases customers gratification, and also improves product sales. Users can project virtual products in the real world using their mobile phone cameras, and they can see the effect of objects placed in the real world. For example, if a user wants to buy a chair for his living room, AR technology can help them project the chair to the camera, and they can see the effect or model of the chair placed in the environment, which helps them determine whether it is what they want or not[7].

Customers can imagine the product in real size on their gadget camera using a well-defined model. Users/clients can handle the products according to their desires. For example, in the case of purchasing a chair, users can rotate or move the model to see where it suits better and can also change the size or color of the product by setting the position of their camera. It is also beneficial for the clients to make purchasing decisions.

Currently, as everyone is getting more into online shopping, it does have some advantages and disadvantages. In traditional shopping, customers can get some appropriate

Figure 1.2: Shopping using AR[2]

products like for eating they can taste them before buying or some other products can be seen before buying that are they worth buying or not, but in case of buying large products such as furniture they are not sure if they are buying the accurate product of right shape, size or color. Online shopping consumes less time as compared to traditional methods of shopping, but it also ends up buying unnecessary items. This problem can be solved using augmented reality in e-stores. Products on these E-Commerce apps can be 3D. Users can handle them to their desired location and angle with a mobile phone's camera to see how the certain product looks at a certain place. For instance, buying furniture items like a sofa or chair user opens their camera and projects to that corner of the room where he wants that chair it sets according to its appropriate size. The use of augmented reality in shopping apps makes them convenient to use and also increases users satisfaction. Most of the time people buy the wrong products in online shopping as the experience is totally different from in-person shopping but AR technology helps them make the right choices by buying the right products.

Augmented reality is beneficial for both retailers and clients as it is an advanced technology that improves users' involvement and buying decisions. It additionally produces better client and business esteem.

1.4 Framework for the E-Commerce Industry's Adoption of Augmented Reality
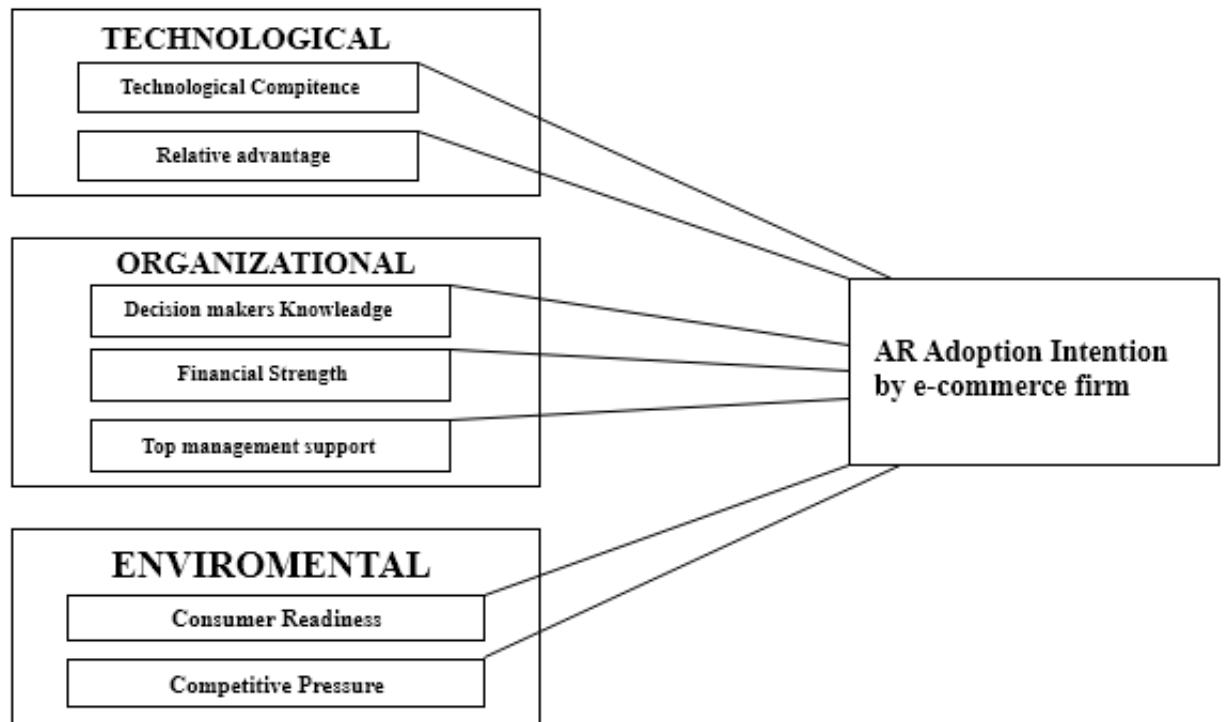
Figure 1.3: Framework for the E-Commerce Industry's Adoption of Augmented Reality[3]

1.5   Virtual Reality to Augmented Reality

Virtual reality is already present in E-Commerce as it provides a new experience of shopping by dealing with the virtual product, still, there is the need for more realistic product interaction. Therefore, augmented reality merges computer-created objects in the real world sequence, containing the virtual objects in the natural environment. Virtual reality to augmented reality for computer devices further goes for mobile devices as well (Mobile Augmented Reality). In MAR users select the product they want and point them towards the location with their mobile phones or tablets camera that shows them a real environment with more information[8].

Virtual reality is fully immersive whereas augmented reality simply augments the real world that is already present. You can easily visualize it but VR gives you an experience of the artificial world. Secondly, virtual reality requires equipment or a specific device like wearing a headset with controllers in your hands whereas augmented reality needs only a smartphone also you are more aware of your environment. The third point that differs augmented reality from virtual reality is that AR is more accessible for people than VR because the number of people having that specific equipment for VR is less than the number of people having smartphones in recent times[9].

1.6   Problem Statement

Today is the era of E-commerce. Typical old methods of shopping are being replaced by online shopping. Users do not even need to go outside their home, instead, they explore their mobile, choose products for their needs, and place orders. Especially, in the recent time of Covid, people are more into online shopping rather than going to shopping malls, also most of the people are not satisfied with the online shopping such as just seeing the pictures of clothes, shoes or furniture they are not sure if that is going to look nice on them or that particular sofa that they selected for their lounge looks good with the other interior of the lounge or not.

This is the very major issue people are facing nowadays as they want to do online shopping. Most of the customers point of view is that pictures are not enough for them to make appropriate purchasing decisions. So, they demand for something more realistic that gives them a certain amount of surety that they are buying right items. They need such a system that give them more confidence, so they can do more online shopping without any fear.

1.7   Project scope

The developed system is Android-based. E-Commerce Store Based on Augmented Reality is an android based Application with the major goal to provide convenience, and an easy-to-use mobile interface for users to offer the commonly needed services.

The project addresses customer concerns about online buying, therefore the current focus of our project is on ensuring that clients receive the correct product. It can be expanded and applied to a different type of service after successful use and future development.

1.8   Technologies/Tools used

Given the fact that the appropriate tool may solve a problem more effectively, selecting the right development tools for software development is critical. The following tools and technologies were used to complete the project: Android Application, Front-End Languages (XML), Back-End Languages (JAVA). Project is completed with the following framework: Scene form, AR Core.

1.9   Database

Firebase is used for the back-end database management, as it provides a powerful database. It is a reliable and secure system to manage databases. It is a Real-time Database that

synchronizes across all the clients in Real time. Data is stored and synchronized with a NoSQL cloud database. Through Firebase User gets an update within a second.

1.10   Operating Environment

Android Application "Augmented Reality E-Commerce Android App" runs on android platforms that have a Minimum SDK is 15 but for AR Core Minimum SDK is 21 and below SDK 21 AR Core feature would not run. And Maximum is the latest SDK version.

1.11   Limitations and constraints

The service of Augmented Reality runs on those devices that supported AR Core feature.

Chapter 2

Literature Review

In one of the articles on augmented reality in E-Commerce with mark-less tracking published by IEEE in 2010, the author states that 2D images and text do not convey a lot of information to users about the products at first[10], This is due to the disparity between the online and offline worlds. However, according to the author, augmented reality solves this issue by fusing the real world with a computer-generated virtual object. In addition, the author claims that augmented reality provides a more realistic perspective of products, allowing users to trust online buying more. AR is presently being employed in a variety of fields, including human-computer interaction, multimedia computing, medical training, and military training, according to the author of this research[10].

Further the author writes that for seeing virtual objects in the real world, an augmented system must be aware of the precise geometric relation between clients' viewing position where to locate virtual objects and the real objects. Virtual objects need to remain aligned with 3D orientations of real objects. Tracking methodologies are responsible for precision of alignment. Tracking methods like vision based and fiducial markers are doing well but in some applications that are based on AR it is not convenient to use markers. As a result, marker-less virtual tracking systems that use scene natural properties instead of markers are far more useful. The character of features and feature matching are the major challenges in the initialization phase of tracking as far as their use for tracking is concerned.

As written in the paper in the initializing phase of the tracking for increasing the precision of feature matching. The programmatic procedure was split into two parts. SIFT is used to extract features from reference images in the first step, which is done offline. That is partially constant to variations in illumination and views, as well as image rotation and scaling. Feature matching can be implemented productively and accurately by the neural network at the second step, where they changed the feature matching problem to an optimization problem[11].

In the paper, it is written that in the last few years, lots of new feature extraction algorithms have been created. These algorithms enable the algorithm identify the same features in additional images with different backdrops by selecting those features that are constant to changes in direction and colours. The scale invariant feature transform (SIFT) is used in this paper to extract features that are local extrema in the scale-space pyramid using distinction of-Gaussian filters. When compared to a section of other techniques used to discover characteristics for object recognition, the features found by this algorithm are invariant to minor relative image shifts and lighting changes, making them highly robust[12].

The uniqueness and variance of SIFT features are the main draws, resulting in a high chance of correct matches across a wide range of image types. Furthermore, a large number of these features densely populated in a typical image can be efficiently extracted, making them suitable for recognition and tracking in the presence of obstacles, and for the most part for algorithms benefiting from a large number of feature matches. The author offers us a brief overview of the feature extraction algorithm in this segment.

It is mentioned in the paper that the source image I(x,y) is twisted using a 2D Gaussian function G(x,y,) to construct the scale space of an image, which is characterised as a function L(x,y,) in the initial phase of the algorithm: L(x,y,)=G(x,y,)I(x,y), where * represents the convolution operation in x and y, and G(x,y,)=122e(x2+y2)22, where the image's scale axis is represented by Finally, the authors claim that the length of the descriptor vector varies depending on the number of direction histograms used to aggregate the samples after employing this feature matching approach. With 128 dimensions, the best results are achieved, but smaller values are acceptable. As a result, these descriptors are used in the feature matching process.

As previously stated, the task is separated into two stages, the second of which is specified as an optimization problem. The neural network for picture feature matching is described by the authors as a 2D array with a design that can be considered. Assume that a reference image is represented by feature points set G of size M, and that an input scene image, which may contain one or more intersecting objects, is represented by feature points set S of size N. As a result, the network's number of neurons are MN. The neural V_{ij}'s outcome status addresses the matching criterion of point No. I, as well as the negative. j. Assuming I was able to match j,

The author summarises two SIFT and TCNN at the end of the following section as follows: SIFT features are isolated from the model picture and scene image separately, and then the network's beginning state and status are updated until a steady state is achieved[13].

They used an IBM ThinkPad R50e with a Pentium 4 CPU (1.6 GHz) and a Logitech QuickCam 1M USB camera to take input photographs for the experiment. The SIFT algorithm discovered 356 features in this image. The number of matching features is

56, and the match probability is 90.3 percents, according to some of the trial data. The feature matching phase of markless tracking is the first step. To eliminate the remaining outliers, the matched sets are tested by fitting a relative transform. RANSAC creates a homographic network between the current and reference image using the leftover inliners (Random Sample Consensus). The homographic matrix can be used to determine the camera's movement bounds as well as the registration of virtual entities.

The following paper concludes at this point that SIFT is utilize to extract features from reference images, and TCNN is utilized to optimize the feature matching process, which is handled by the minimization of an energy function, according to the following paper. By tracking the characteristics of products, augmented systems without the usage of markers can observe virtual or actual fusion outcomes.

In another paper, the author explains that they chose the Furniture business as their E-Commerce industry for the Furnished application [14]. Through the use of Augmented reality, the Furnished application aims to bring all of the things shown in their online furniture store to their customers in a way that no other company has done successfully before. The following are the techniques or tools that are utilized to create this application:

- The Android SDK (Software Development Kit) contains all of the necessary components for developing an Android application. SDK Build tools, Android Emulator, Platform Tools, SDK Platform, and Google APIs are all important parts of the Android SDK.

- Using the Sceneform SDK to create AR applications in Android typically necessitates learning OpenGL, which is an API for creating 2D and 3D vector drawings. Sceneform SDK, on the other hand, analyses the client's ability to build dynamic AR applications without knowing anything about OpenGL and makes the process fundamentally smooth. The Sceneform SDK is made up of three key components: An Android Studio plugin with a high-level scene graph API and a Physically Based Renderer provided by filament.

A scene graph is a data structure used in vector graphics applications that has nodes that represent the scene's information. Transformable nodes were used in the Furnished application to moor the 3D objects into the scene, as well as resizing and altering capacity. Physically Based Rendering is a rendering technique that ensures that all of the 2D/3D models in the view are accurate in terms of lighting[15]. As a result, PBR enables the depiction of objects in the environment by improving surfaces, shadows, reflections, and so on. Metals and wooden surfaces, for example, appear to be photorealistic. ARCore enables the usage of augmented reality on Android devices without the use of external sensors. Tango was previously used to provide augmented reality support for Android devices.

The paper also gives information regarding system design. Android devices and camera, User Interface, Database, Sceneform, ARCore, here the author states that for displaying

the model through ARCore several steps are followed: Icon Press, DisplayModel method, BuildModel method, On Tap Listener. The paper also gives an overview of the user flow: Login/register, homepage, categories, select product, AR view, and checkout[16].

The above discussed application is implemented in three stages as stated by the author: Data / 3D models collection, User Interface creation, Adding Products. The quality of the output achieved in the application using GLB models is adequate, as are the textures and colours. Because of the proper light evaluation, the reflections and shadows of the seat depicted in the AR Fragment are precise. The use of PBR allows the cowhide on the seat to seem shiny. Because it was created at runtime, the following model has a normal thickness in terms of intricacy. If a more complicated model is required, devices with a higher processing power and a larger data set transmission capacity can be used.

One of the papers writes that augmented reality is the future of E-Commerce shopping[17]. It is mentioned in the paper that one of the surveys performed by Google shows that nearly 66 percents of people showed interest in shopping from AR based E-Commerce stores/apps. Some of the famous brands have already started using E-Commerce stores based on augmented reality. 3D visualizations and virtual try-ons give users an experience as if they are shopping physically, which also increases users' satisfaction.

Further in that paper they also define what augmented reality is. AR produces and merges virtual objects like 3D models with cameras so the user gets a better understanding of how they look in the real world. Also it gives details about the benefits of augmented reality in E-Commerce. First benefit is that it enhances customer engagement by providing a lively feel of the product which is similar to shopping by goig to stores. 3D model utilization makes it easy for them to make buying decisions. Users spend more time on AR based E-Commerce apps that leads to more sales. The second benefit is the immersive product experience, when we talk about online shopping we see that most of the people do not like online shopping because of the previous bad experience. The product in pictures seems different and when they get delivered at your place it's totally different.

So, the AR solves this issue pretty well by giving immersive product experiences by 3D visualization. The third benefit mentioned in that paper is the customized shopping experience, customized products are the one that enhances customers' involvement, for example they can try on different colors of shirts to see which suits them the best or for furniture they can see different options like if the L-shaped or any other sofa looks good in their lounge. Another benefit is reduced return rates, one of the research shows that in the last year 49 percents of the UK shoppers returned the products they had purchased, the reason mentioned was that the products delivered are not same as described by the sites.this may be due to two reasons that either the merchants are not able to describe the product properly or the customers are not understanding them correctly so the augmented reality fills this gap to check or try on the product before purchasing that automatically reduces the return rates. Last mentioned benefit is improving conversion rate obviously

when a user get more clearer and detailed information about the product they convert to the AR based apps rather than staying on the simpler ones.

Some of the renowned brands are already implementing augmented reality in E-Commerce, for example Lenskart Virtual AR Experience, IKEA Studio app, Amazon Salon , Lakmé Virtual Try-On. It is expected that AR is getting an exponential growth between 2021 to 2028. so , it is not wrong to say that the future of the E-Commerce business is augmented reality. Still it is not fully adapted by the E-Commerce business so it is the best time for many E-Commerce businesses to implement AR to remain in the competition.

Another paper on smart E-Commerce framework based on augmented reality, mobile and cognitive application. The main goal is to create a framework that enhances user satisfaction by using augmented reality, mobile and cognitive functions. Research is experimental based which is required to develop the framework of smart E-Commerce. On the basis of this framework an application is developed that is using AR technologies and cognitive functions. The author of the following paper writes that their framework is based on three layers, those are: application model, augmented reality process, and cognitive functions[18].

Application model has the following models: user profile model(UPM), 3D product model, environment model,application infrastructure model. In the second layer it has the following ARE functions: create/load/update 3D products, load environment information, show 3D products and environment, at last it has mobile executable applications (Unity 3D, Vuforia for android OS),website and databases(E-Commerce). In the third layer it has cognitive function and artificial intelligence for keeping up the features (cognitive) of the application model[19].

The authors mentioned the following tools that are used in the making of the application: Unity 3D and Vuforia for Android OS, SDK used to develop mobile augmented reality applications, Deep learning methods are used by IBM Watson Visual Recognition to examine images for entities, TensorFlow is an open-source software library, With Microsoft Computer Vision, the client can extricate rich data from pictures to categorize and process visual information[20].

Further they discussed the results they obtained by developing an app using the framework of smart E-Commerce. They presented the IBM Watson Visual Recognition used for implementation of Product recognition as a Cognitive Function in the 3D Products Model (3D PM). As soon as the camera detects an object from the E-Commerce system the following app analyzes the object and creates 3D objects for utilization in AR. The customers can virtually use the product from a camera and see how it looks at the place where they want to place it in real life. Environment models have functions for the real environment based on recognition algorithms from cognitive function. Augmented reality displays this information in the user interface model. The functions of the user interface model display

the product as an AR object when an object is scanned from the real world[21].

The user profile model implements the cognitive functions for decision making assistant. On the basis of the user activities in the E-Commerce system (login, ratings of the products), 3D product library, properties of the product. Therefore , the application is going to be the smart decision making assistant. This paper concludes at that point that use of the cognitive technologies in the AR mobile applications can enhance the customers decision making, the described framework using the three layers offers the best customer support.

2.1 Comparisons

2.1.1 Comparison of Tools/Techniques and Experiment/ System design/ Surveys

S/No	Published on / by	Paper-Name/ Application type	Tools and techniques	Experiment/ System design/ surveys
1	2010 IEEE, Xinyu Li and Dongyi Chen	Augmented reality in E-Commerce with mark-less tracking	SIFT for feature extraction Feature matching problem to optimization problem. It is implemented productively and accurately by neural network can be considered as 2D array	They used an IBM Think-Pad R50e with a Pentium 4 processor (1.6 GHz) and a Logi-tech Quick-Cam 1M USB camera to capture the input images.
2	Syamantak N. Dhavle,Chaudhary Mohammed Qais,Prof. Bhavna Arora,Khan Mohd Saif Tabarakallah	Furnished application, area of the E-Commerce industry picked by them is the Furniture business	Android SDK (Software Development Kit) that provides all the components needed for the android application. The significant components of the Android SDK incorporate: SDK Build tools, Android Emulator, Platform Tools, SDK Platform, Google APIs.	Android devices and camera, User Interface, Database, Sceneform, ARCore, for displaying the model through ARCore several steps are followed: Icon Press, Display Model method, Build Model method, On Tap Listener. Also gives an overview of the user flow: Login/register, homepage, categories, select product, AR view and checkout.

| 3 | 2021, Alida Hight | Augmented reality is future of E-Commerce shopping | 3D visualizations | The surveys performed by the Google shows that nearly 66 percent people showed interest in shopping from AR based E-Commerce stores/apps |
| 4 | 2017, Claudiu BRANDAS,Otniel DIDRAGA,Dario HUMA | Smart E-Commerce framework based on augmented reality, mobile and cognitive applications | Unity 3D and Vuforia for Android OS, SDK used to develop mobile augmented reality applications, With Microsoft Computer Vision, IBM Watson Visual Recognition employs deep learning techniques to evaluate photos for objects. TensorFlow is an open-source software library | Research is experimental based which is required to develop the framework of smart E-Commerce. Based on this framework an application is developed that is using AR technologies and cognitive functions |

Table 2.1: Comparison Between the Literature

2.1.2 Comparison of Results and Conclusions

S/No	Published on / by	Paper-Name/ Application type	Results/outcomes	Conclusions
1	2010 IEEE, Xinyu Li and Dongyi Chen	Augmented reality in E-Commerce with markless tracking	The SIFT algorithm discovered 356 features in this image. The number of matching features is 56, and the match probability is 90.3 percent, according to the experimental data	SIFT is used to extract features from reference images, also, The feature matching process is managed with the minimization of an energy function, and TCNN is employed to optimise it. By tracking the characteristics of commodities, augmented systems without the usage of markers can observe virtual or actual fusion outcomes.
2	Syamantak N. Dhavle,Chaudhary Mohammed Qais,Prof. Bhavna Arora,Khan Mohd Saif Tabarakallah	Furnished application, area of the E-Commerce industry picked by them is the Furniture business	The quality of the output achieved in the application using GLB models is adequate, as are the textures and colours. Because of the proper light evaluation, the reflections and shadows of the seat depicted in the AR Fragment are precise. The use of PBR allows the cowhide on the seat to seem glossy.	Because it was created at runtime, the following model has a normal thickness in terms of intricacy. If a more complex model is required, devices with more processing power and a larger data set transmission capacity can be used.

3	2021, Alida Hight	Augmented reality is future of E-Commerce shopping	3D model utilization makes it easy for them to make buying decisions. Users spend more time on AR based E-Commerce apps that leads to more sales	Some of the renowned brands already implementing augmented reality in E-Commerce, for example Lenskart Virtual AR Experience, IKEA Studio app, Amazon Salon, Lakmé Virtual Try-On. It is expected that AR can get an exponential growth between 2021 to 2028.
4	2017,Claudiu BRANDAS,Otniel DIDRAGA,Dario HUMA	Smart E-Commerce framework based on augmented reality, mobile and cognitive applications	The results they obtained by developing an app using the framework of smart E-Commerce. They presented the IBM Watson Visual Recognition used for implementation of Product recognition as a Cognitive Function in the 3D Products Model (3D PM). As soon as the camera detects an object from the E-Commerce system the following app analyzes the object and create 3D objects for utilizing in AR	The use of the cognitive technologies in the AR mobile applications can enhance the customers decision making, the described framework offers the best customer support.

Table 2.2: Comparison of Results and Conclusions

2.2 Apps in Market

Some of the work that has already implemented AR:

2.2.1 Unified AR

Unified AR is an Australian-based Augmented Reality Solutions provider and self-service Augmented Reality Platform that provides customers get quick access to a variety of material without sacrificing quality. The app provides a convenient platform for consumers to access various types of internet information and news. The software can be used on a regular basis because it saves time and effort in locating relevant news based on the user's preferences. When the user places a camera on a specific object, the user can live the experience of that object by 3D Models if a user reads a newspaper with the help of this app and the 3D Models user can listen to the news through Augmented Reality and 3D Models. This app is free of cost just users go to App Store or Google Play Store and download it[22].
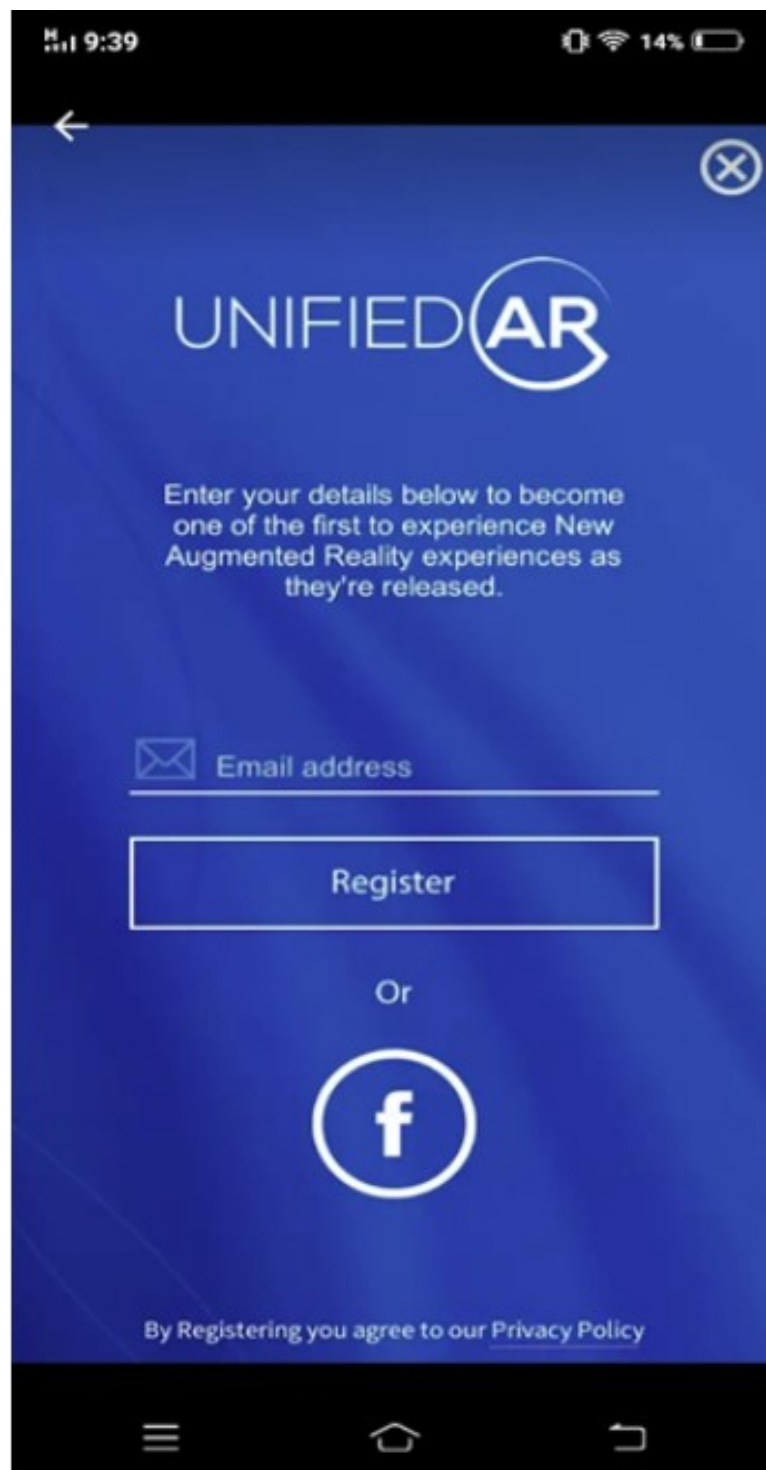
- Unified AR App: iOS, Android
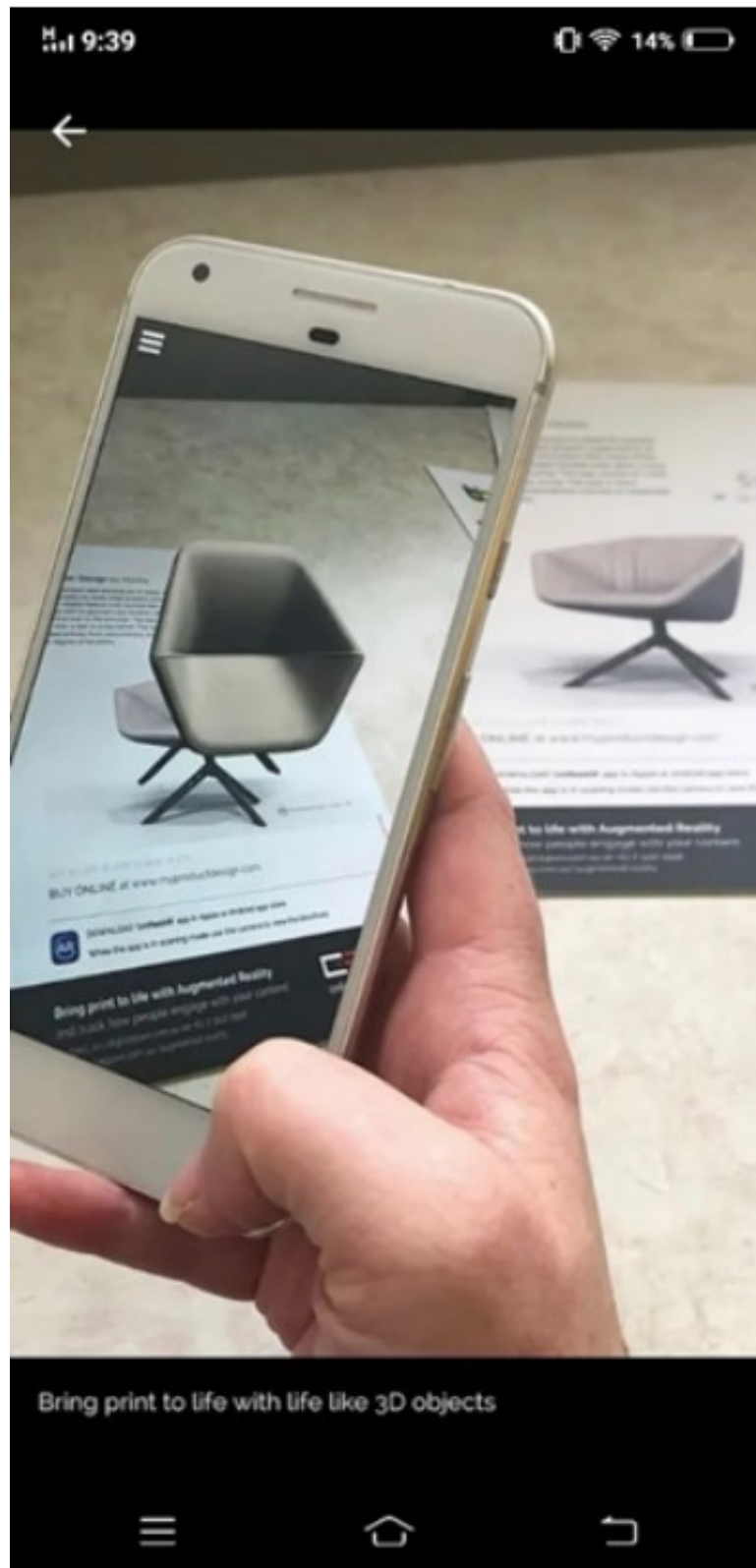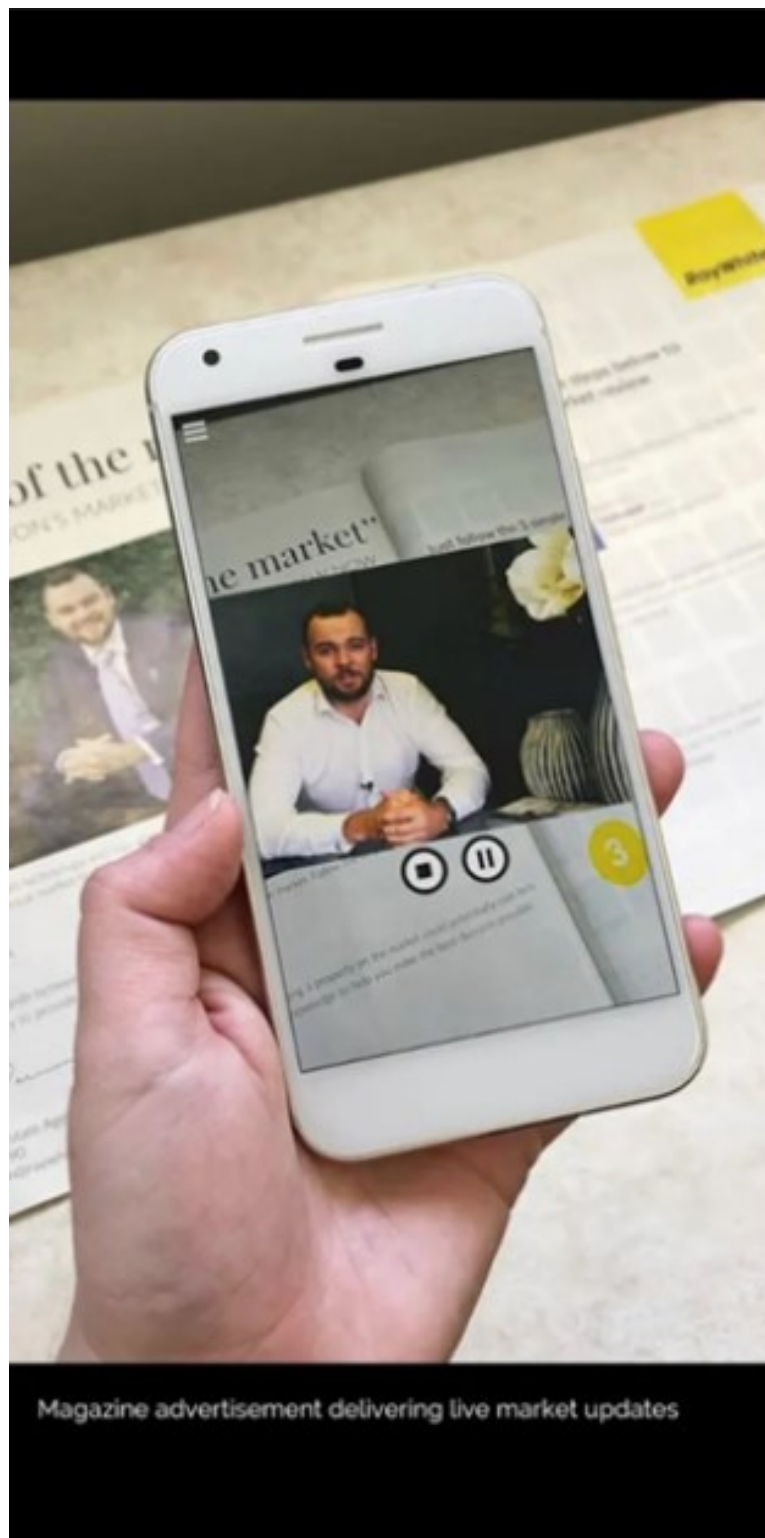
Figure 2.1: Unified AR 1 [4]

Figure 2.2: Unified AR 2 [4]

Figure 2.3: Unified AR 3 [4]

Through this technology it is almost very easy for users to choose the right product that they really want to buy. They can see the product in real world experience by 3D Models

and pointing cameras at them. So, we are solving the problem of customers by Augmented Reality through this people can buy the right product in an easy and efficient way.

2.2.2   AR Watches-Augmented Reality Commerce

AR watches is an American-based Watches buy application powered by ARLOOPA that is offering its watches products of different brands like Rolex, Hublot, IWatch, Tag Heuer etc. Through this app, customers can experience top watches on their wrist and find out what is a perfect fit for their wrist with Augmented Reality. The era of flat screen view e-commerce is over. Now users want to have a better consumer experience. They want to be sure that they buy what they really like.

- Payment type: Credit Card

- AR Watches App: Android

The customer is Live Experiencing watch on his wrist and can buy what really fits on his wrist.
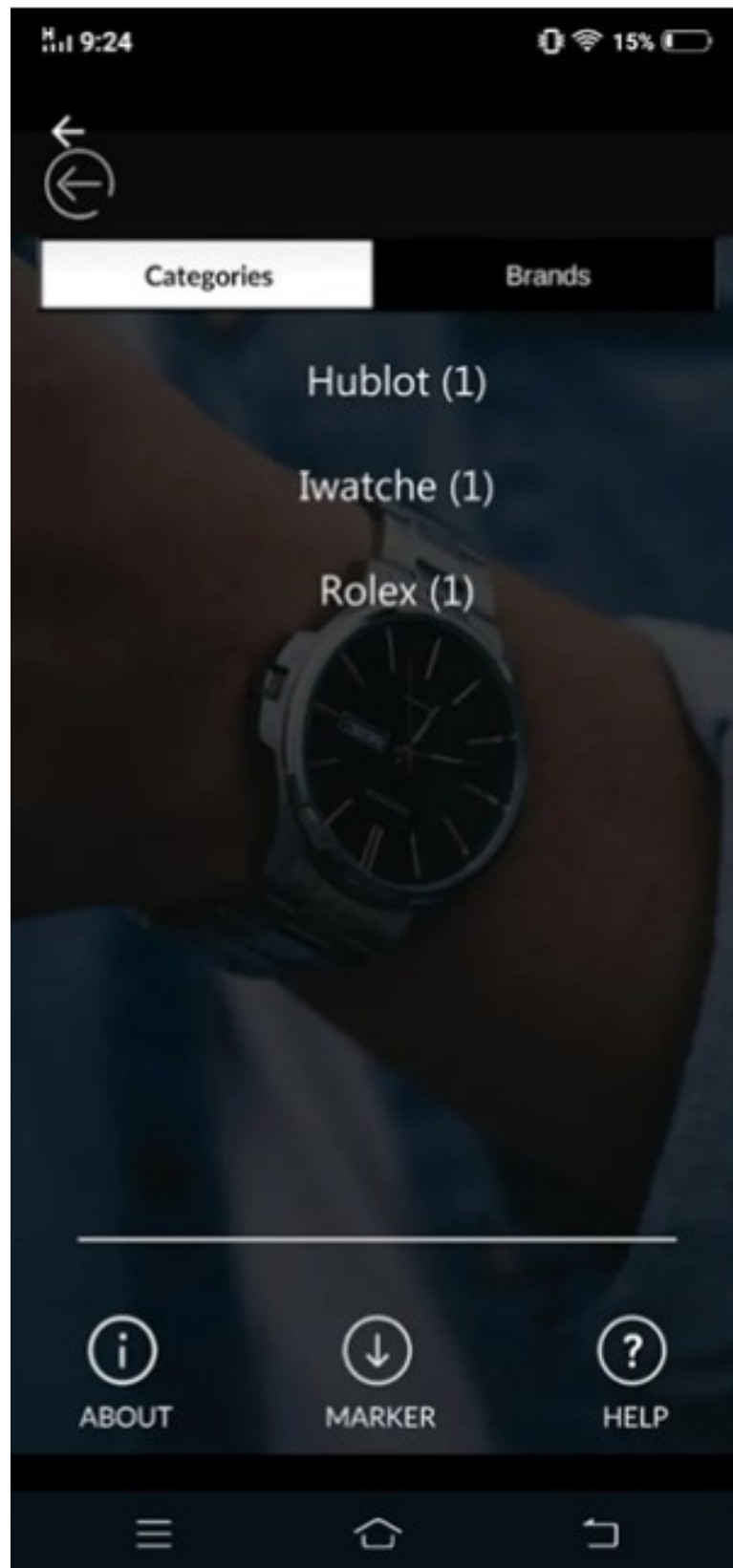

Figure 2.4: AR watches 4 [5]

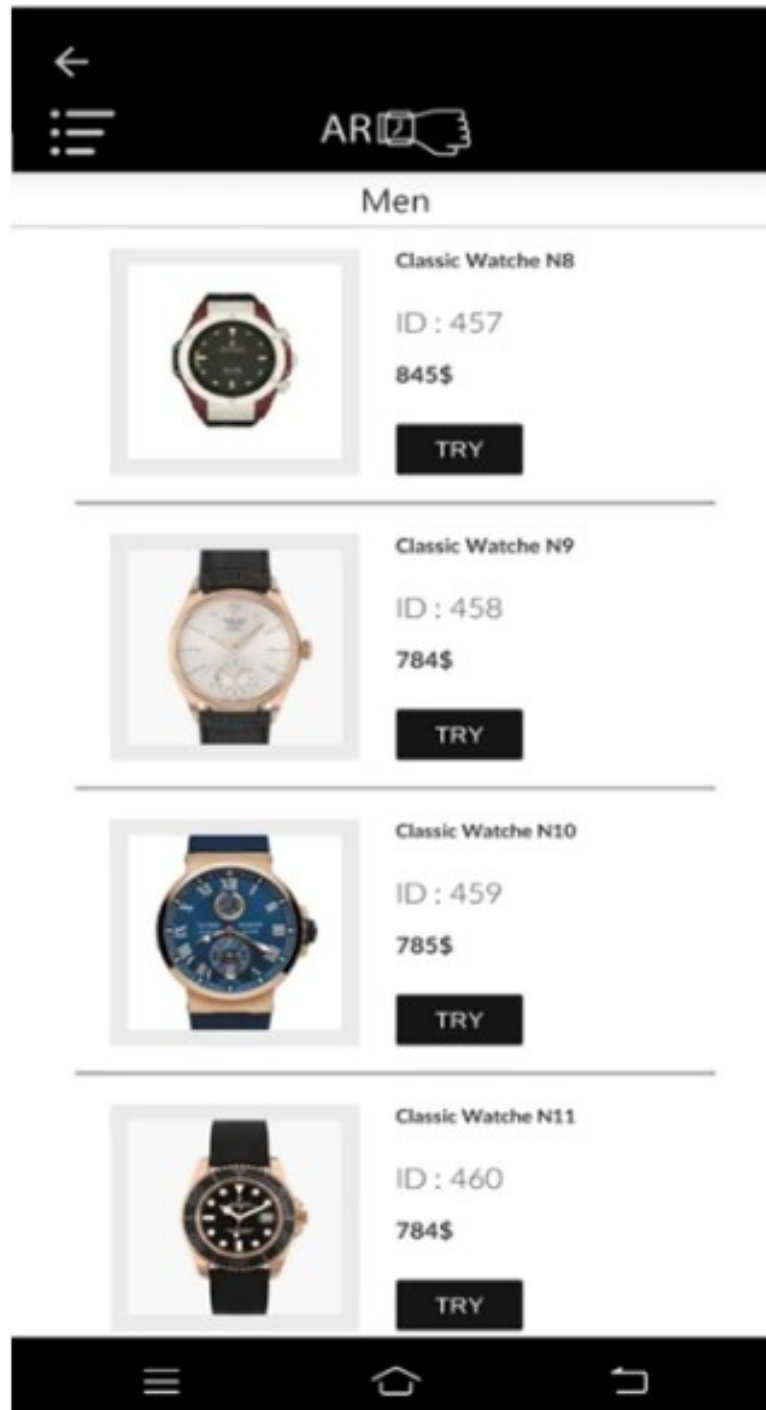Figure 2.5: AR watches [5]

Figure 2.6: AR watches 2 [5]

Figure 2.7: AR watches 3 [5]

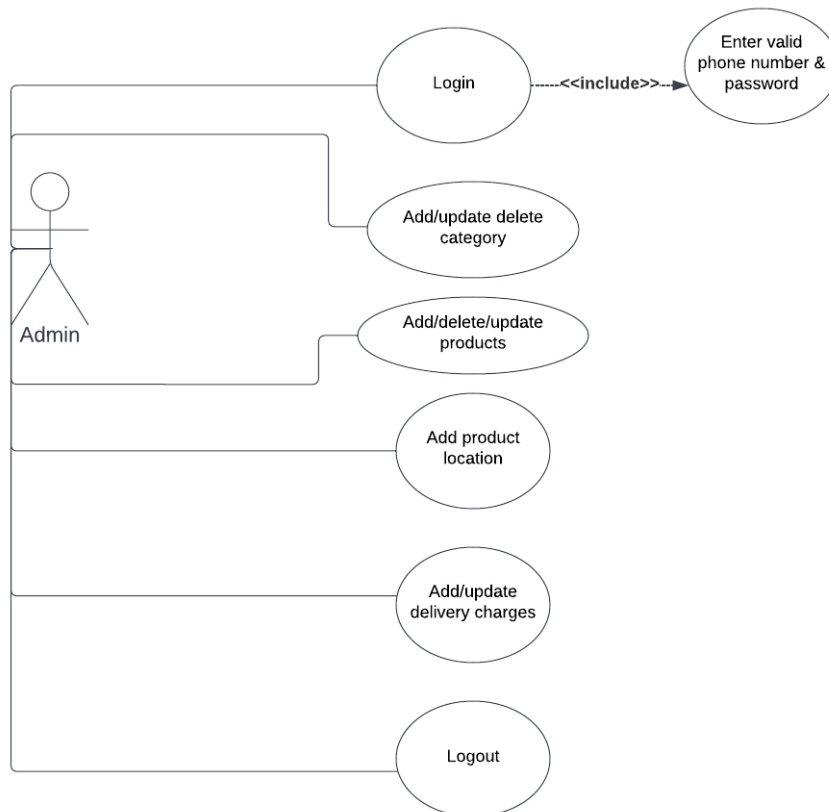# Chapter 3

Requirement Specifications

3.1 Use Case

3.1.1 Admin

Figure 3.1: Admin Use Case Diagram

3.1.2 User login
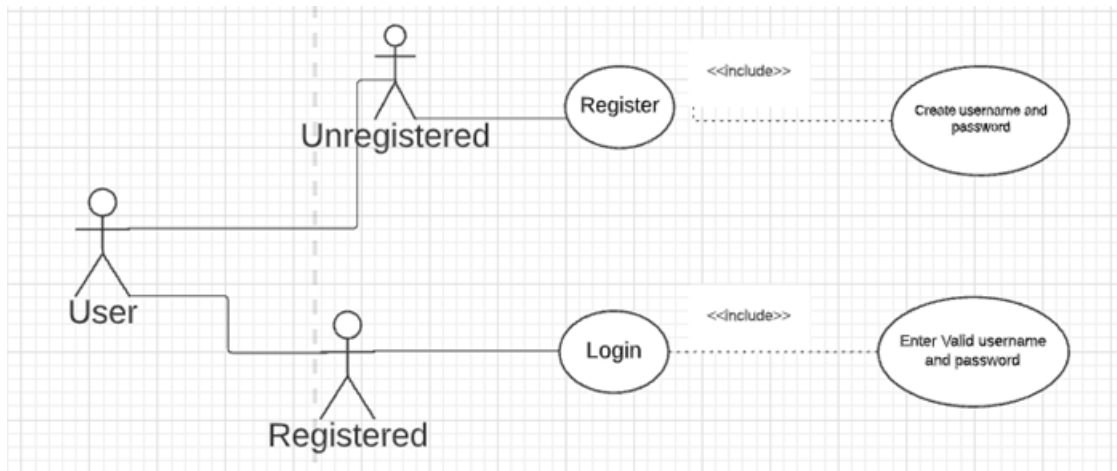

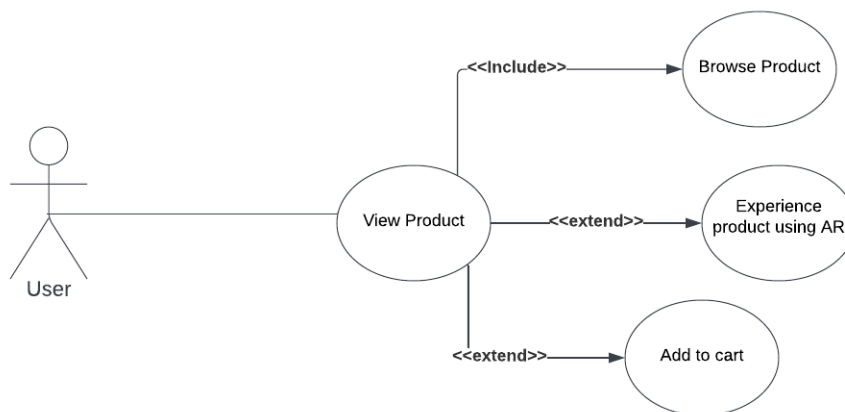Figure 3.2: user login Diagram

3.1.3 View Product

Figure 3.3: View Product Diagram

3.1.4 Checkout
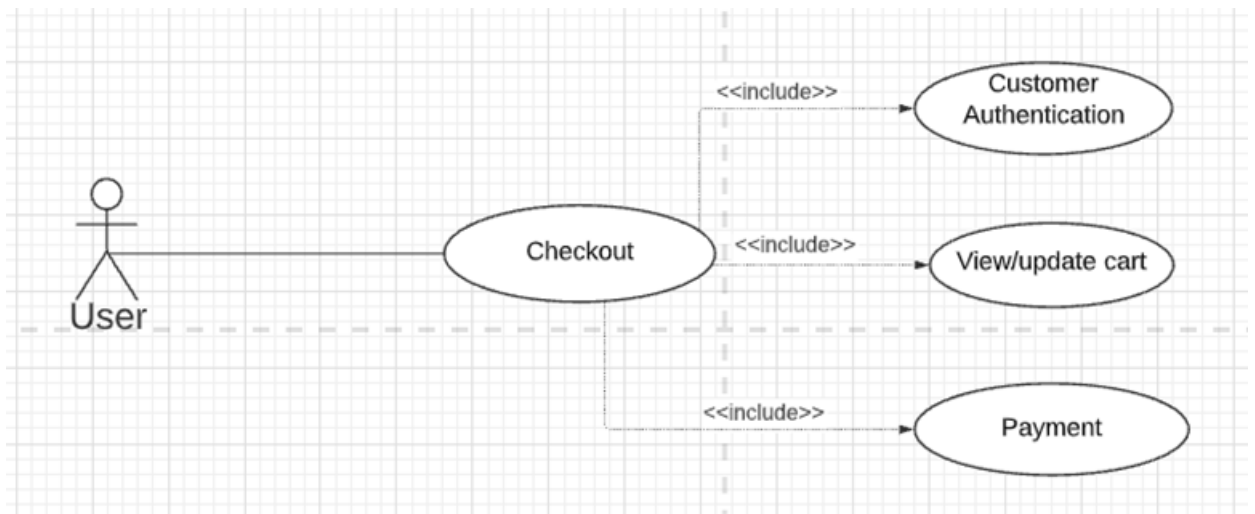

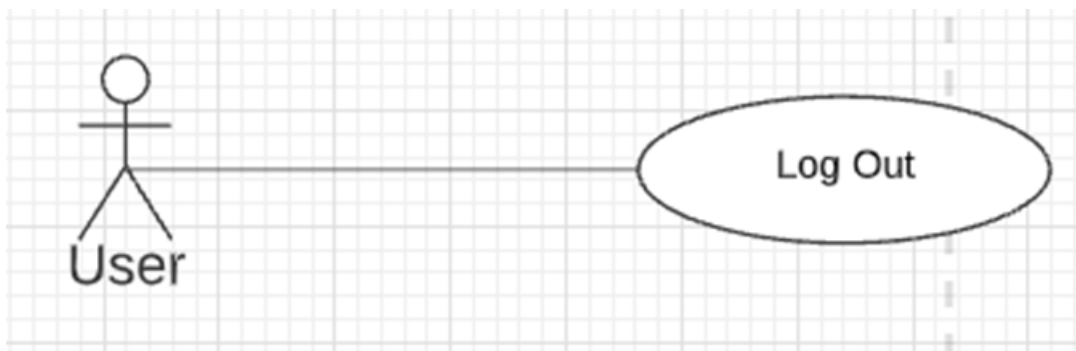Figure 3.4: Checkout Diagram

3.1.5 Log Out

Figure 3.5: Admin Logout Diagram

3.1.6   User Complete Use Case
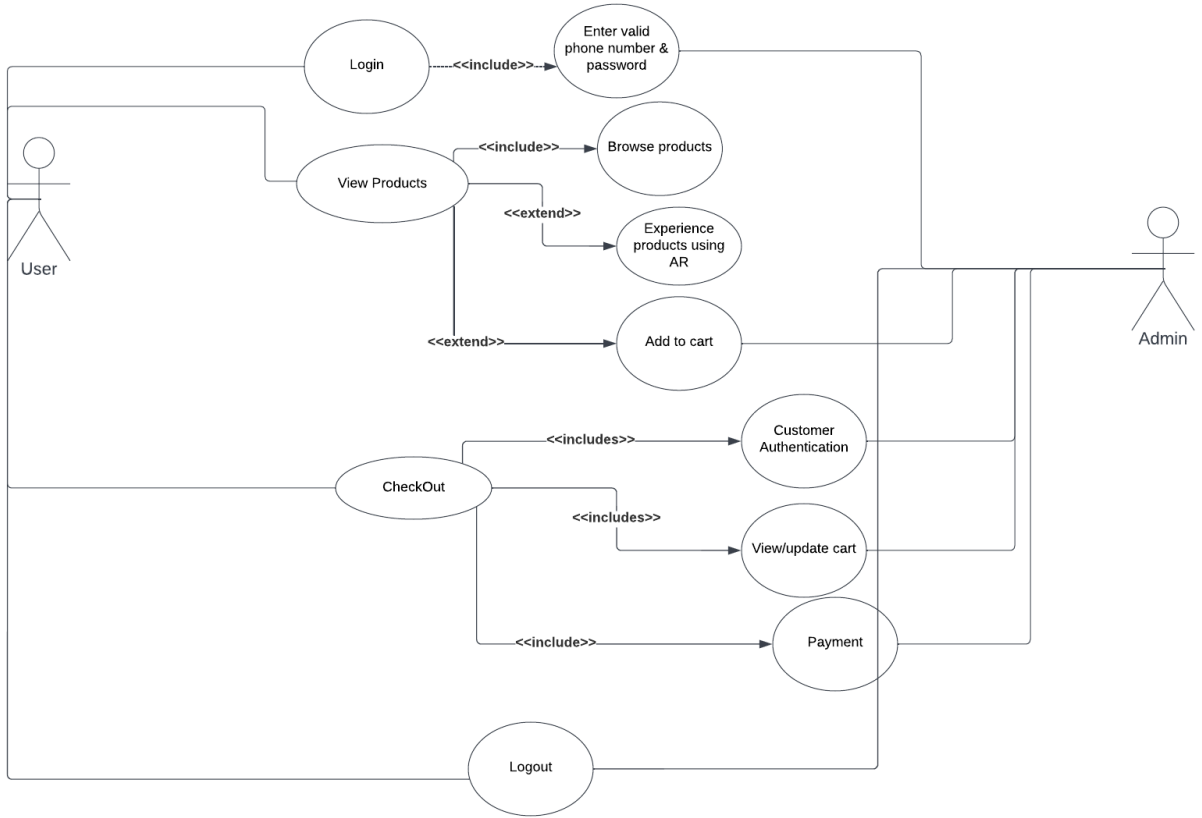
Figure 3.6: Admin Logout Diagram

3.2 Data Flow Diagram

3.2.1 DFD Level 0
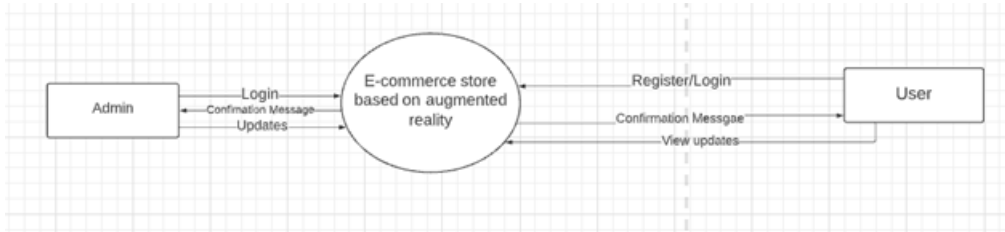
Figure 3.7: DFD 0 Diagram

3.2.2   DFD Level 1
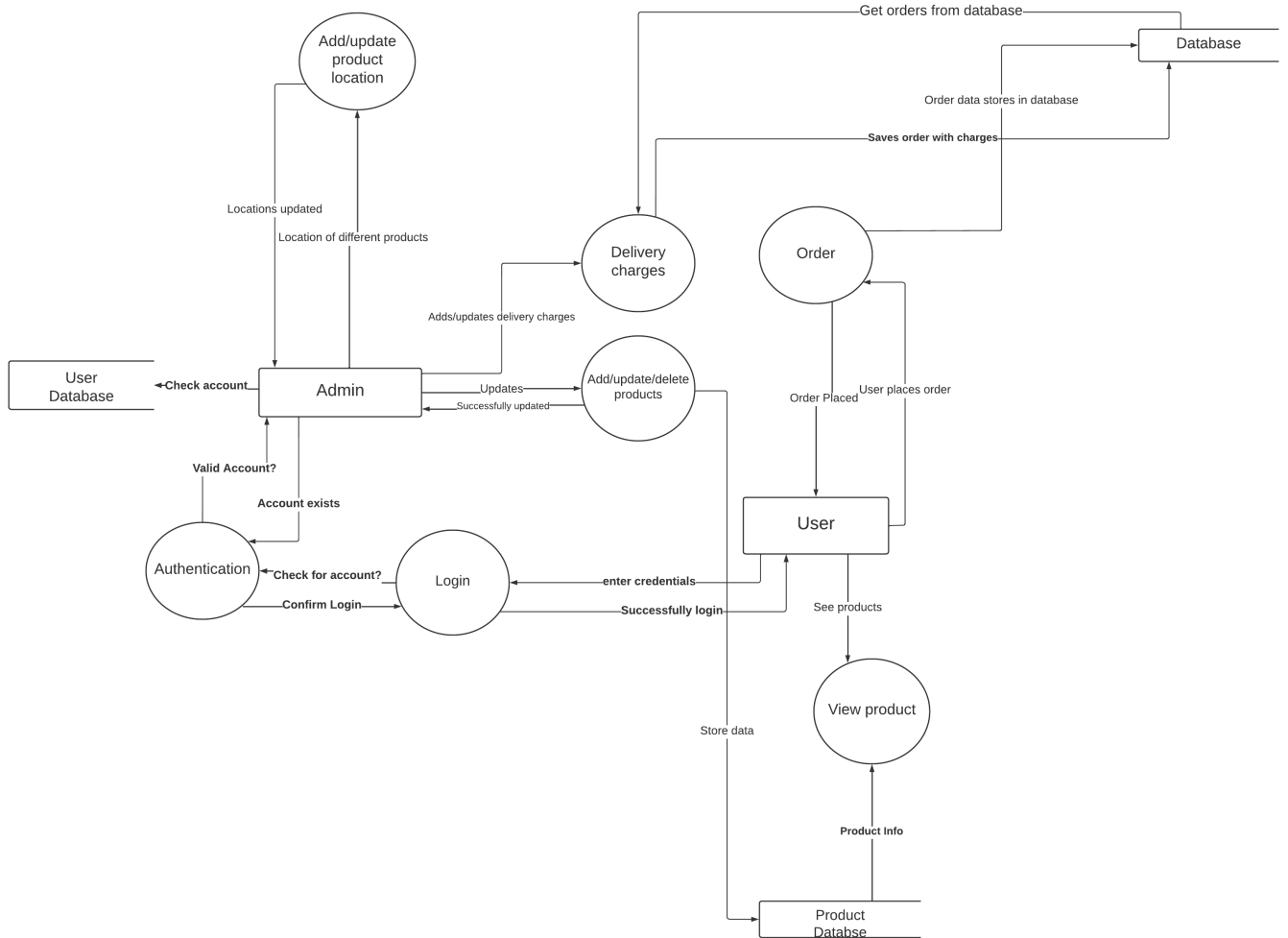
Figure 3.8: DFD 1 Diagram

3.2.3   DFD Level 2

In level 2, order placement method is decomposed into several sub-processes, you cannot directly place the order, first you try the products then add them to cart after that you confirm the order and at last the user checks out

Figure 3.9: DFD 2 Diagram

3.3   Sequence Diagram

Figure 3.10: Sequence Diagram

3.4   Class Diagram

Figure 3.11: Class Diagram

3.5 Activity Diagram

3.5.1 Admin

Figure 3.12: Admin Activity Diagram

3.5.2 User

Figure 3.13: User Activity Diagram

Chapter 4

Design

Using this application users can feel like they are shopping in person as it helps in personalizing their online shopping experience. Users can see how the products are looking before they buy them. As previously, we are talking about the Covid pandemic, so some people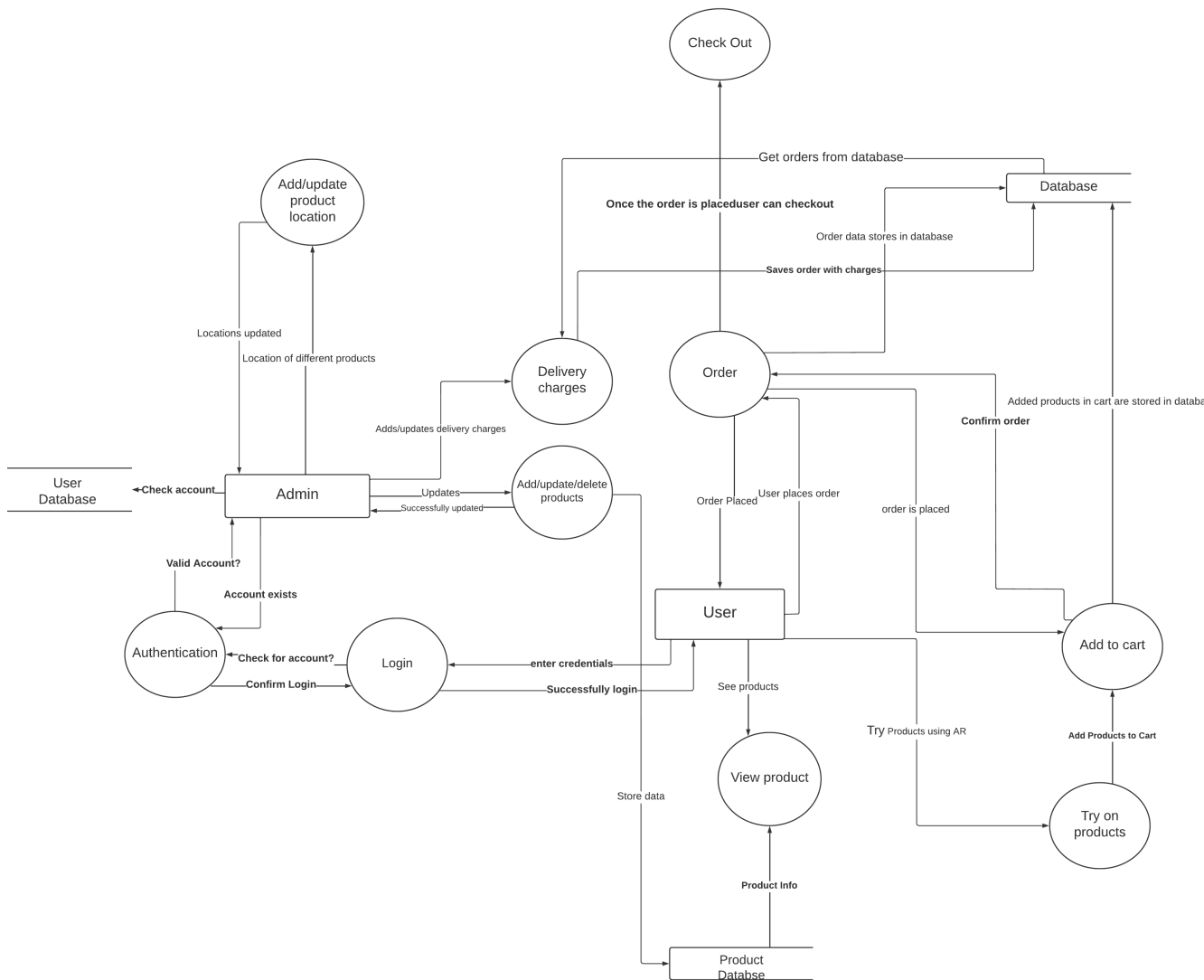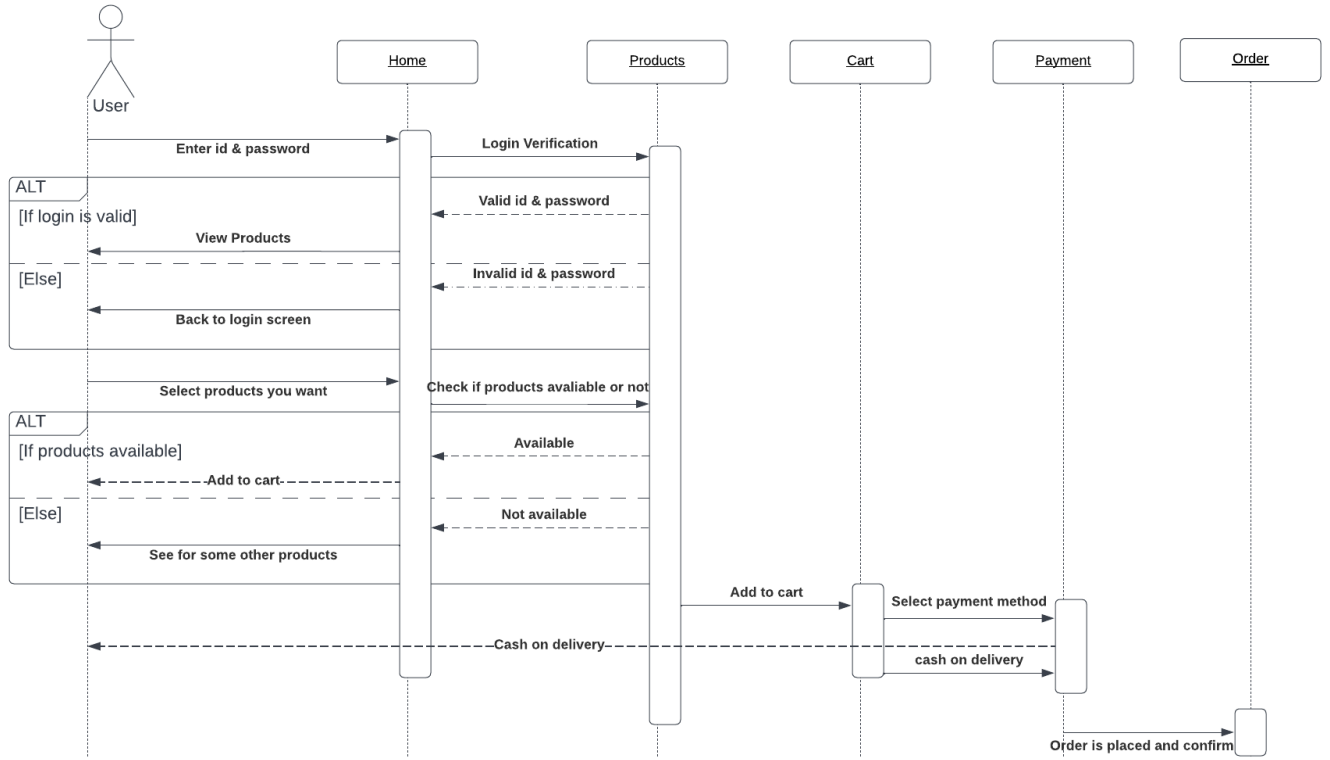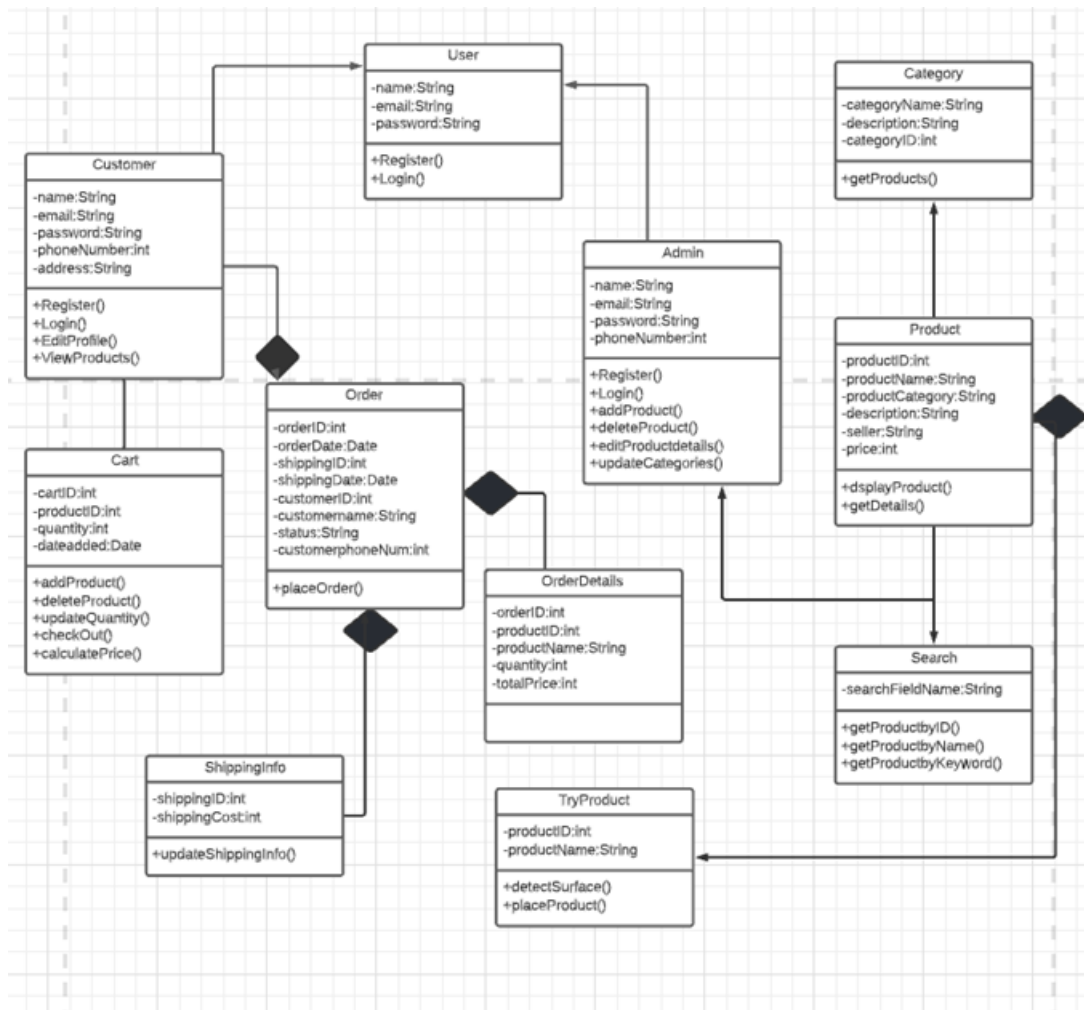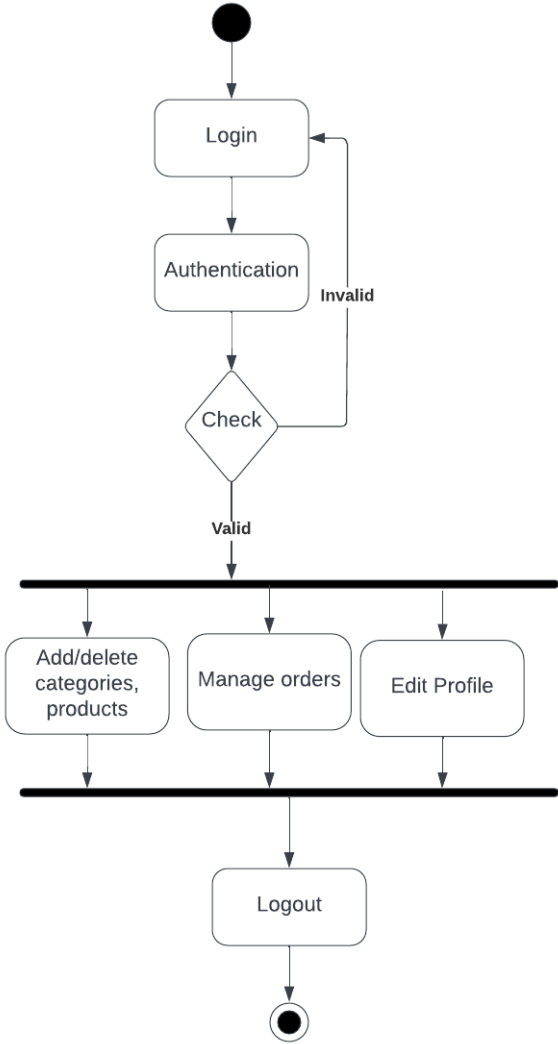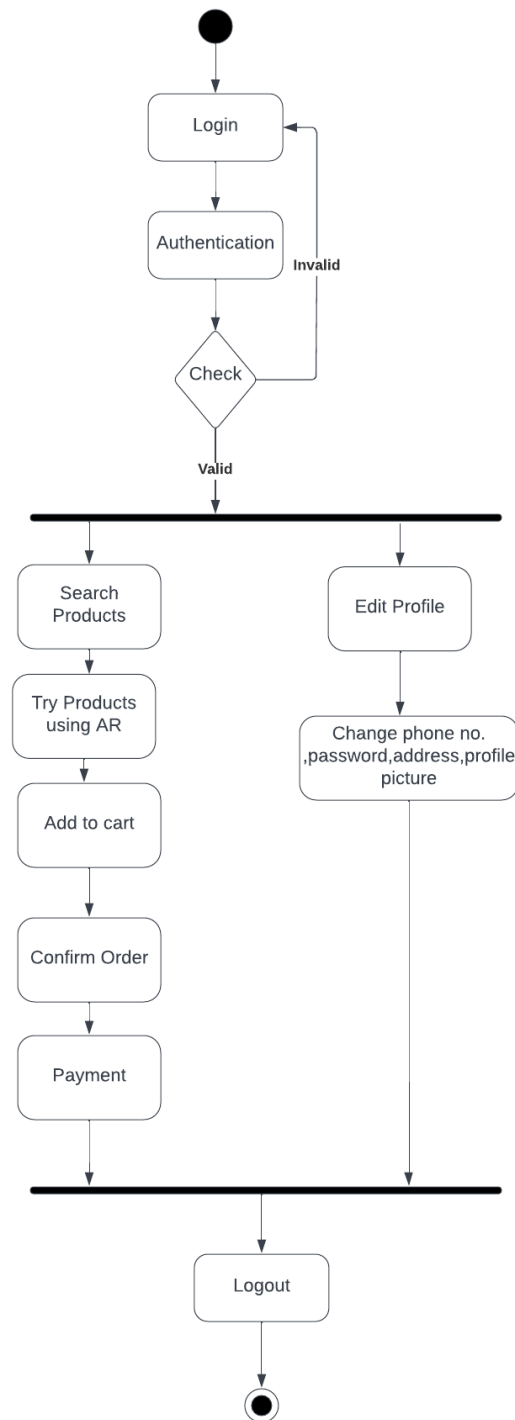 are not sure if they want to buy the shirt they like unless they try it on and see how it looks so in online shopping it's not possible and they have a fear of buying a wrong item, so this app makes it possible for them to try on the shirts they like and gives them an experience same as of in-person shopping.

Augmented Reality-based E-Commerce is an android application of its kind targeting a specific domain that is customers.

The applications are available for all users. Two actors (Admin, User) are able to use all the functions available. There is database for saving the data about all the users. The mobile application communicates with the database, however, according to its functionalities. Users are expected to be able to read and understand English, as well as be familiar with the operation of the Application's core Graphical User Interface (GUI) components. This system is mainly interacted with by two users.

4.1   User

User/Customer can Sign up the account that is created by the user, which is stored in the database. User Logged in to the account can select different products after selecting the product Users can experience the product on their own. User can add product to the cart and pay through different payment methods. By supplying information about Products, Admin can be interested in the system's smooth operation. The application is completely under the control of the administrator. A database can be maintained by an administrator.

Admins have complete control over account access. Admins can create new Products for users in the application database.

4.2 Operating Environment

As android applications need different environments in which the software operates.This mobile application can only be used on android mobiles

4.3 Design and Implementation Constraints

The proposed Android system runs on the version of Android 4.0.3 (Ice Cream Sandwich) or latest. Because the android applications must retrieve data from a database over the internet, it requires an internet connection. The limited screen size and resolution of mobile phones can make it difficult to examine a large number of search results while using Android applications.

4.4 Assumptions and Dependencies

It is assumed that the user should be familiar with the Android Phone. The performance of the mobile phone application is reliant on the phone's capabilities. There may be circumstances where the application does not perform as intended if the phone does not have enough hardware resources available for it or if the user has allocated them with other applications. Since the user interface is in English, so the users must be familiar with the language.

4.5 Features

4.5.1 Administration Section

- Administrator Authentication

- System allows administrators to change the details of users.

- System allows administrators to view existing profiles of users.

- Mobile Application Section

- System allows users to send a sign up request to the administrator by filling an online form with personal details.

- System allows users to sign in to their account once their verified account.

- System allows the users to view their profile, by which they are able to see their given information

- System allows the users to edit their profile.

- System allows the users to delete their profile.

Chapter 5

System Implementation

5.1 User Interface

5.1.1 Splash Screen

Whenever we open the application, this screen pops up.
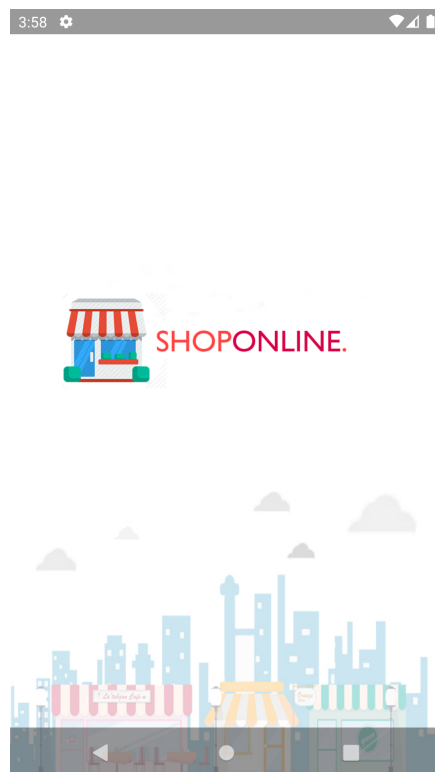
Figure 5.1: Splash Screen

5.1.2   Sign Up/Sign In

If you already have an account, then just enter your phone number and password and you log into your account and if you are new to this app first get yourself registered and then login into the app.

Figure 5.2: Sign Up/Sign In

5.1.3 Home

After successful login, you are now able to see home page.
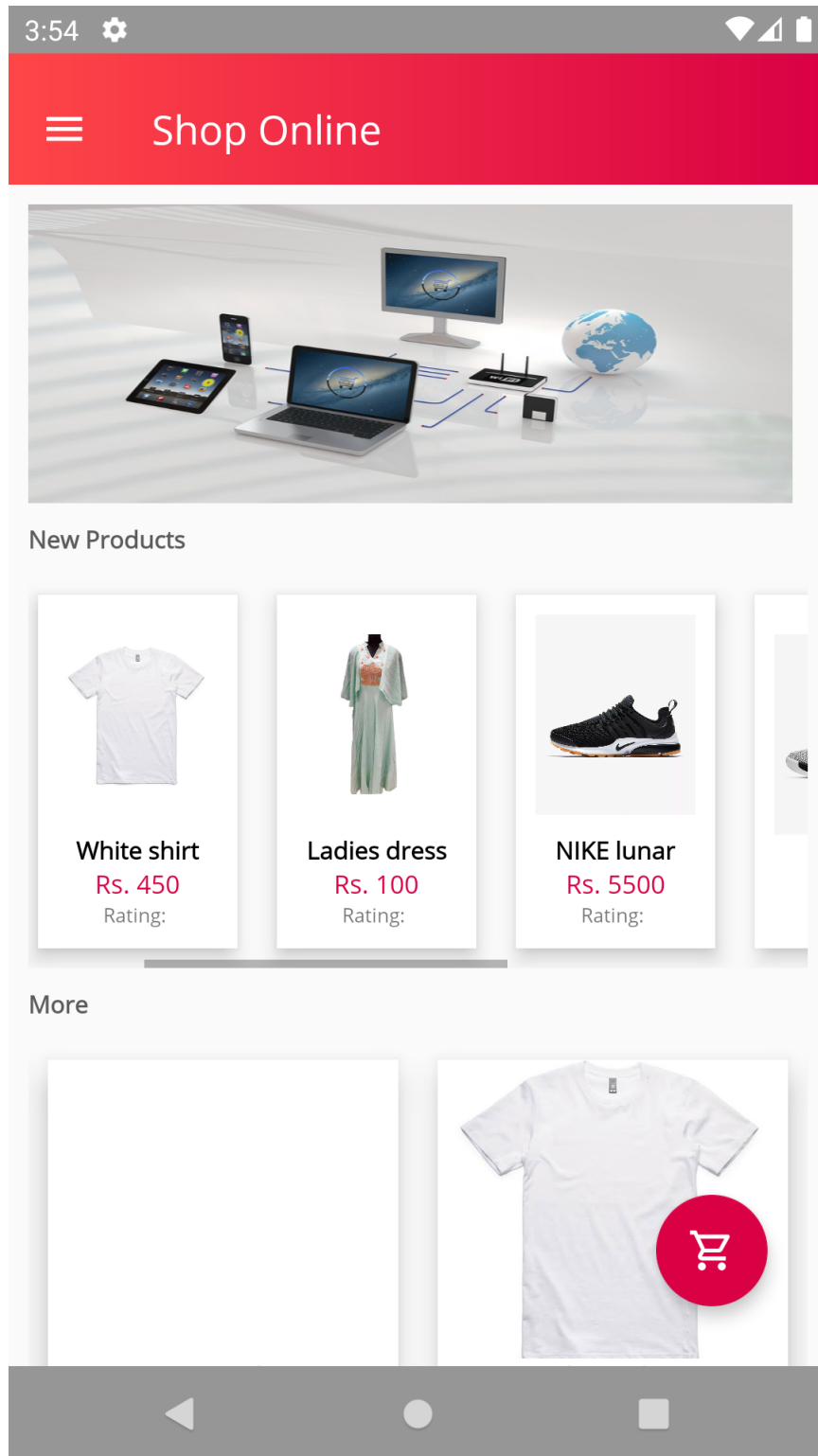
Figure 5.3: Home

You are now able to see multiple products, and theirs details.
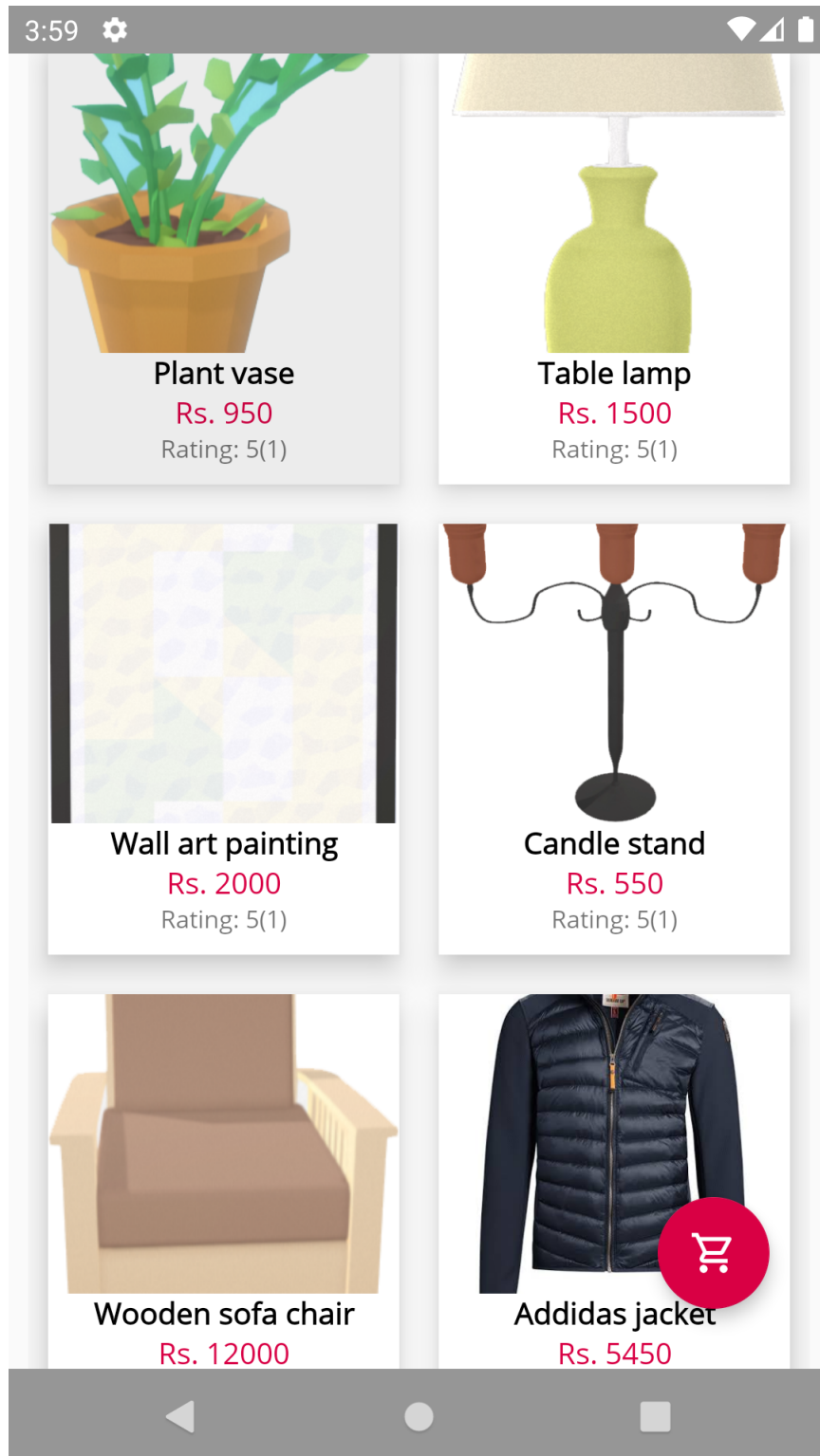
Figure 5.4: Home1

5.1.4 Navigation Drawer

Navigation drawer helps you to choose any option to see them in more detail.As an admin you are able to see your customers orders, or you can also go to categories to add new items (category) or to delete any category or to update it, and multiple other options are also available.
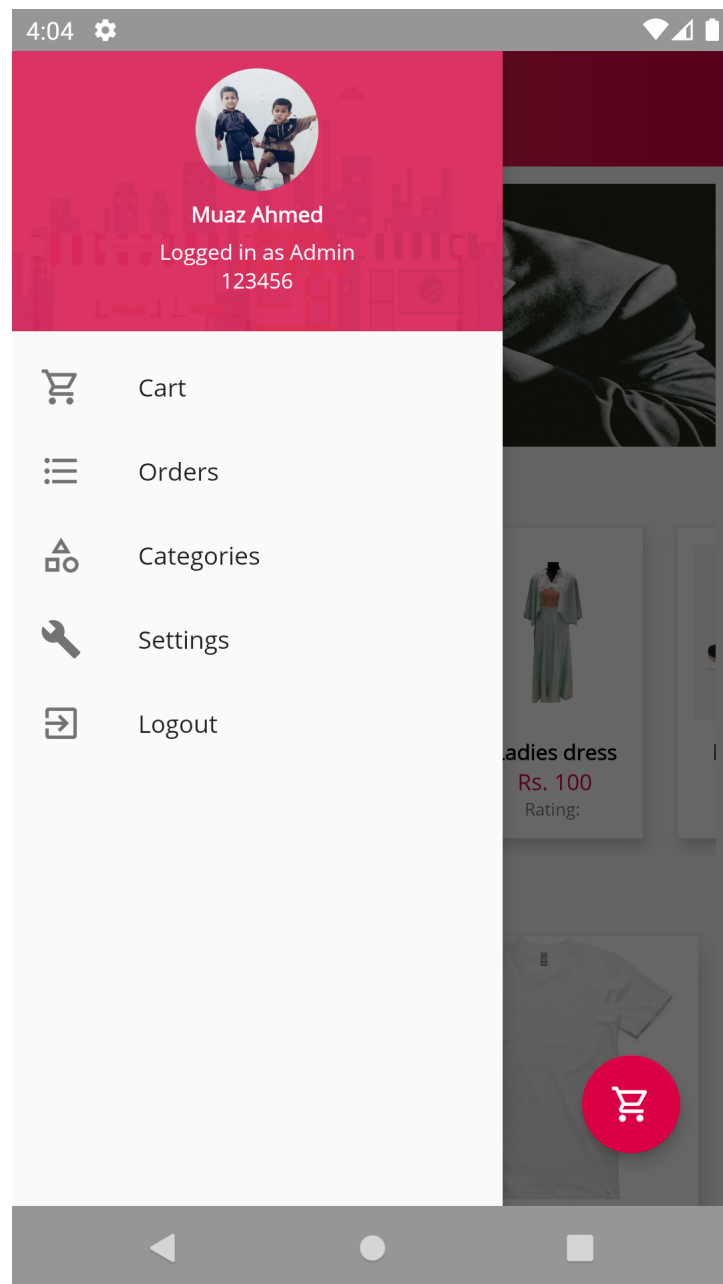
Figure 5.5: Navigation Drawer

5.1.5   Product Detail

At home page only products images and their prices are available to see more details about
the products, you can click on any product and it shows you the more detail about that
product.
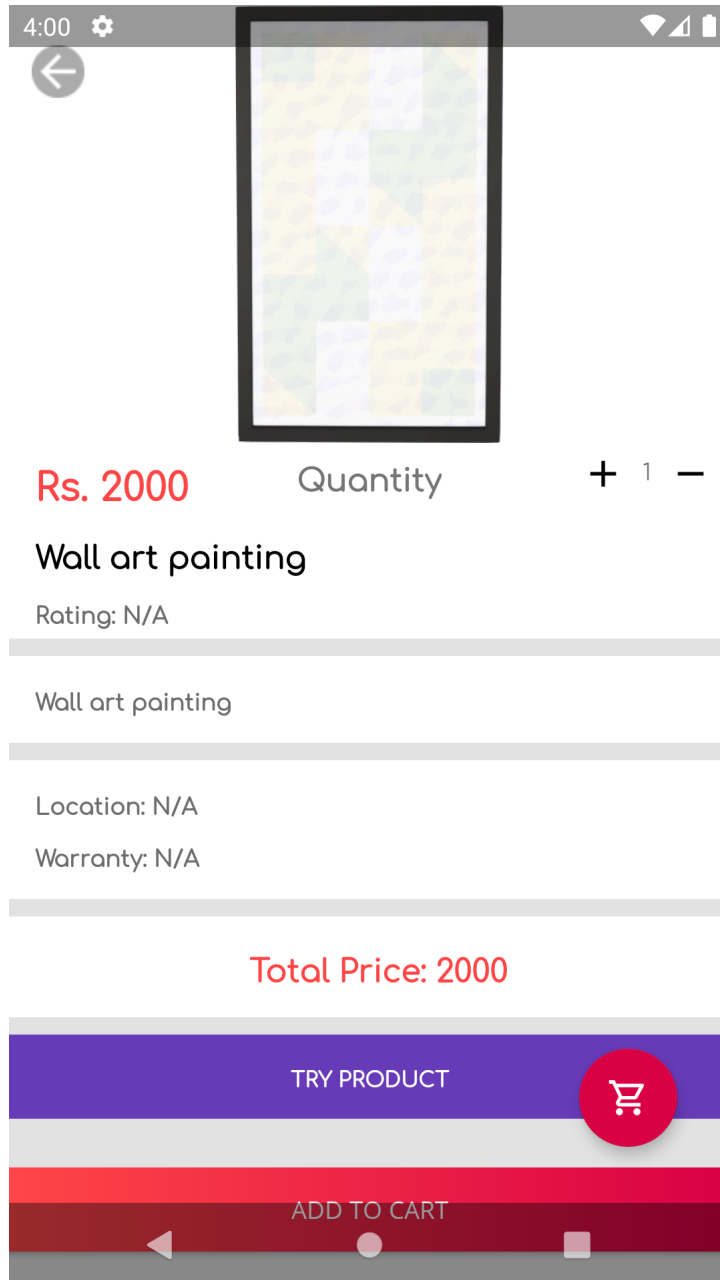
Figure 5.6: Product Detail

5.1.6 Cart Activity

After adding to the cart, you can also delete any product if later on you do not want to buy that product otherwise click on check out.
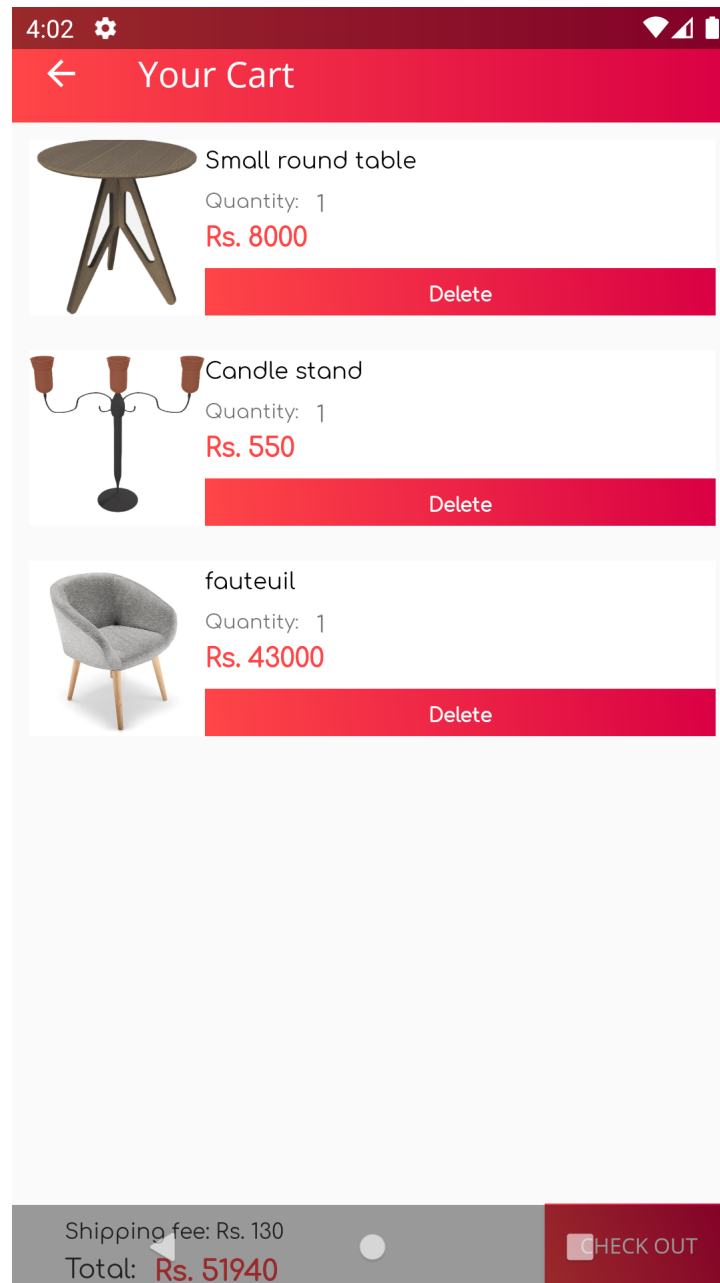
Figure 5.7: Cart Activity

5.1.7   Product Categories for Admin

Different product categories are available for admin, from where they can easily add new categories, also if they want to delete any product category they can also delete that as well.
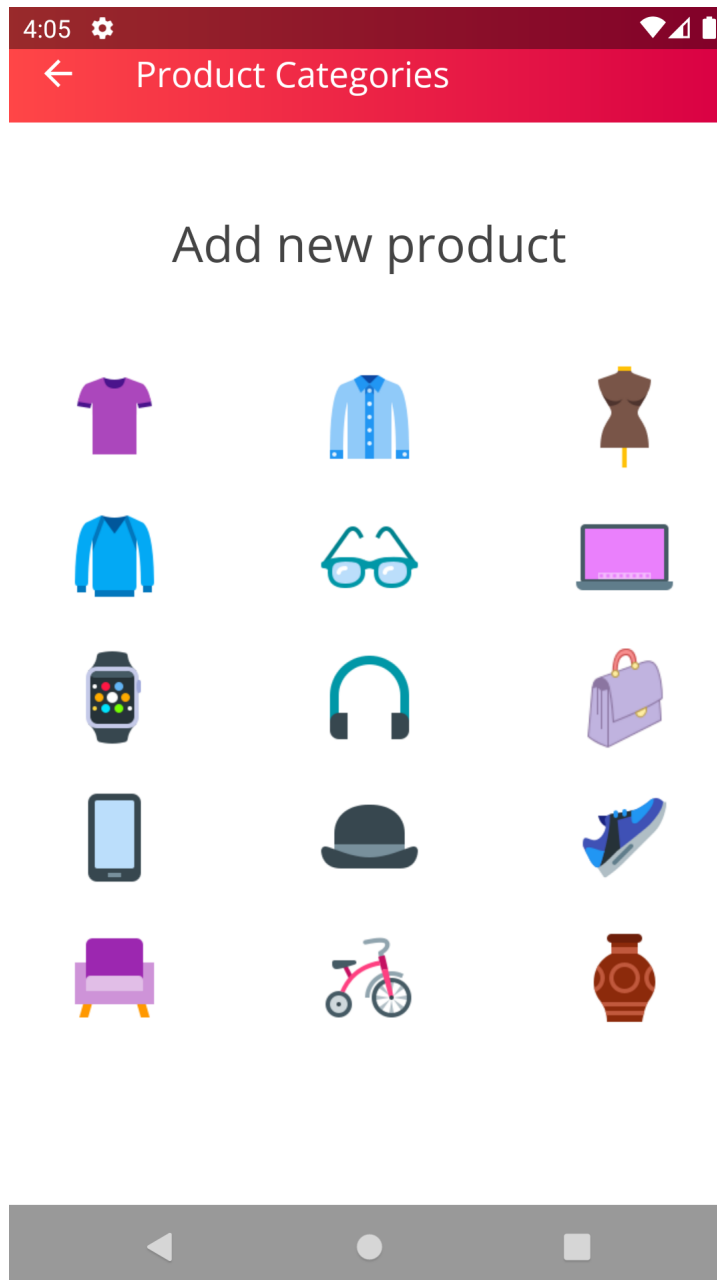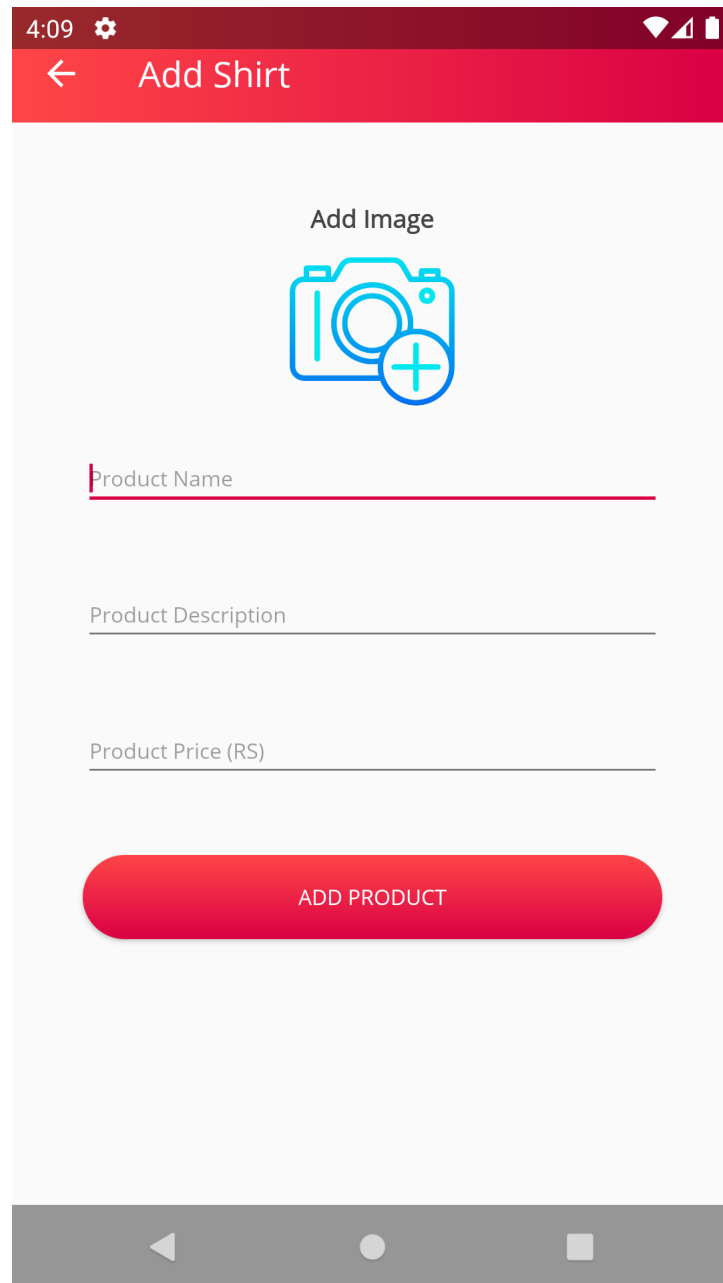
Figure 5.8: Product Categories for Admin

5.1.8 Add Product

To add any new product, you need to fill product details i.e. you need to product image, name, description, and price.

Figure 5.9: Add Product

5.1.9   Try Product

After it successfully search the surface where we need to place that object it then shows that virtual object in our own environment.

Figure 5.10: Product Display

Figure 5.11: Product Display

Figure 5.12: Product Display

Figure 5.13: Product Display

5.2   Database

5.2.1   Database

This is our Firebase database, where we have admins,cart,orders,products, and users.

Figure 5.14: Firebase Database

5.2.2 Admin

This database shows the registered admins for our application.

Figure 5.15: Admins in Application

5.2.3   Cart

Whenever any user adds products to their cart, it get stored in database.

Figure 5.16: Products in Cart

5.2.4 Orders

All the orders and order related details also get stored in database.
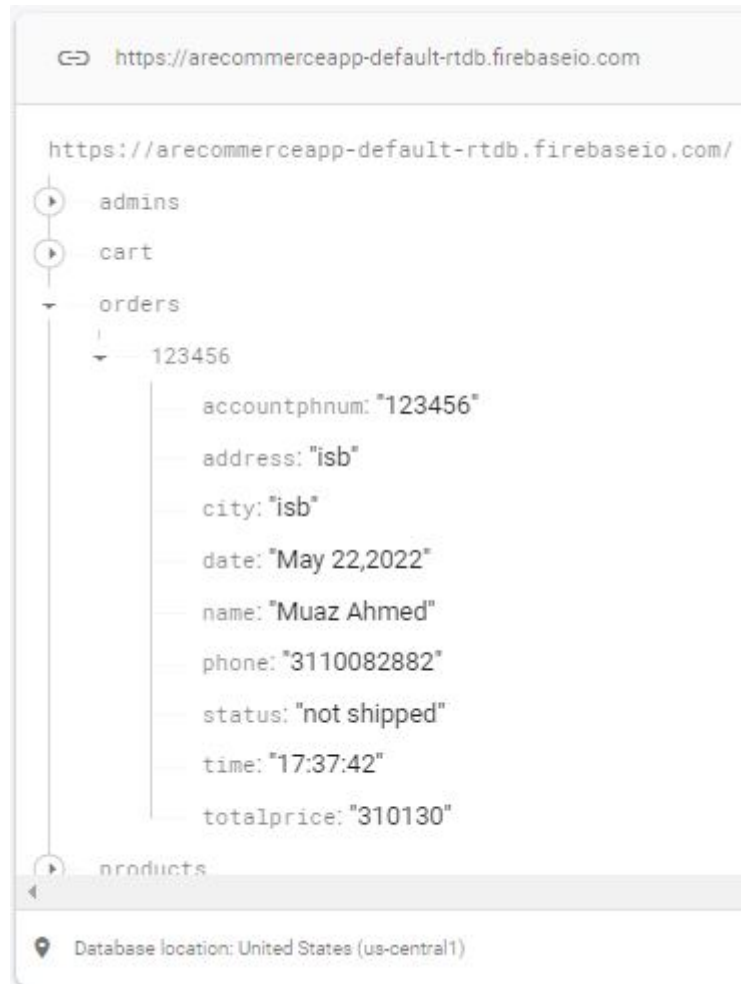
Figure 5.17: List of Orders

5.2.5   Products

Number of products our application have, all are stored with their details in database as well.
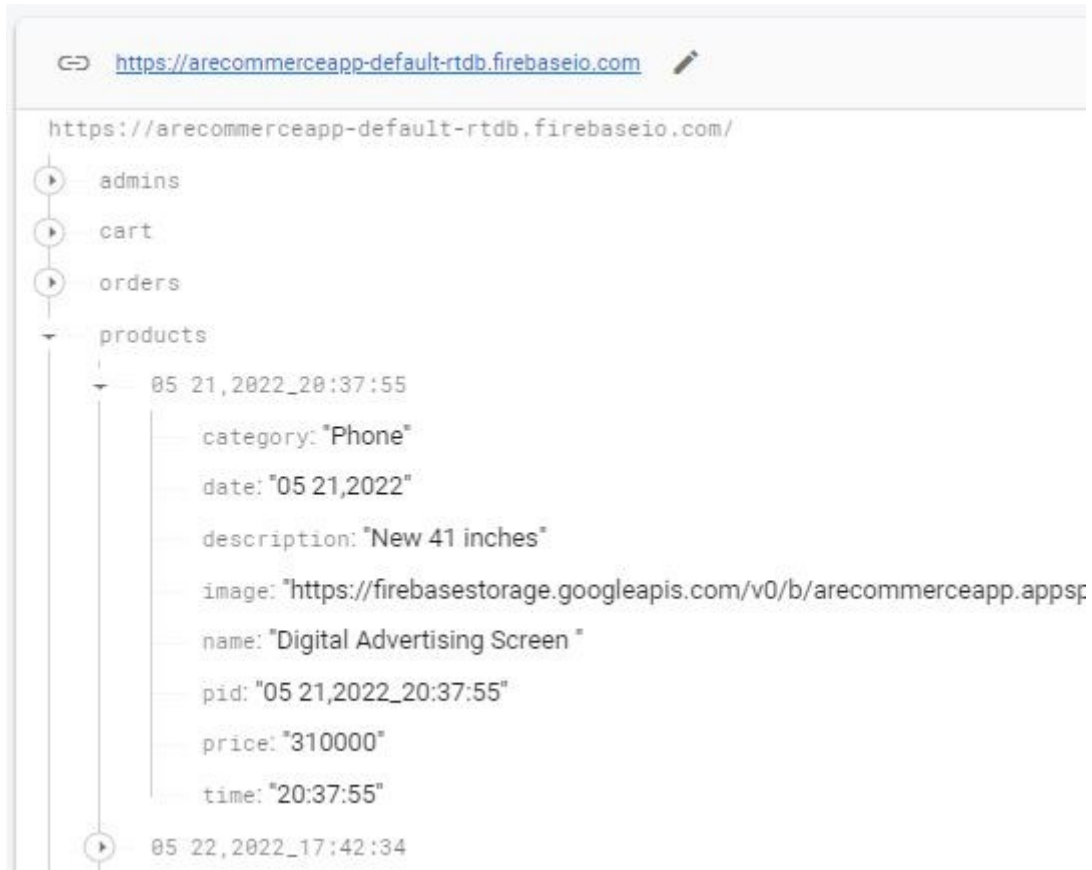
Figure 5.18: List of Products

5.2.6 Users

Users also have a database, when a user get registered their data is also kept in database.
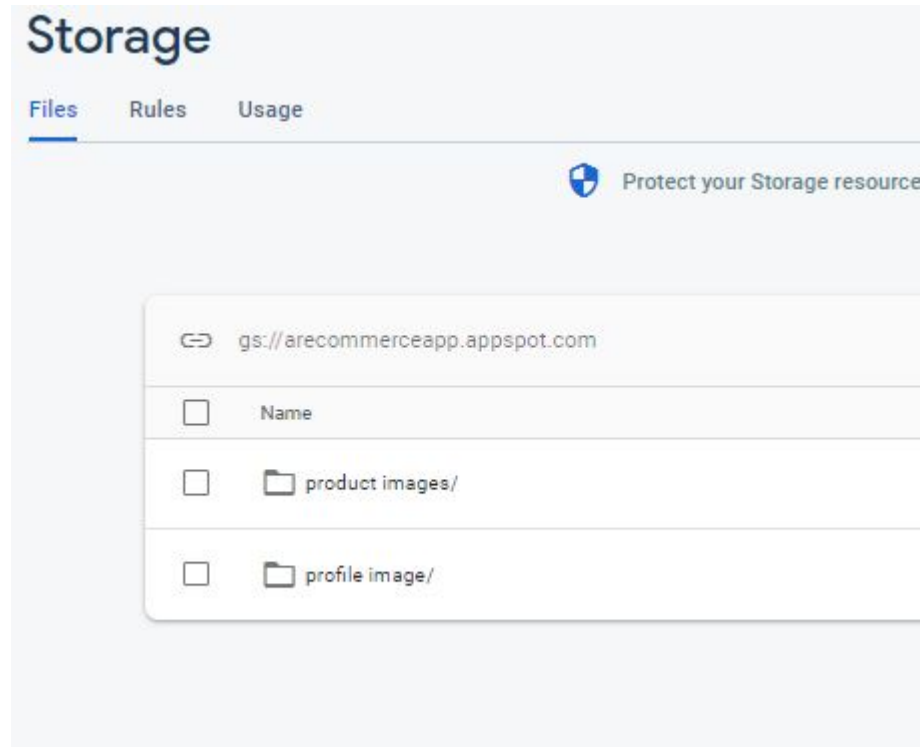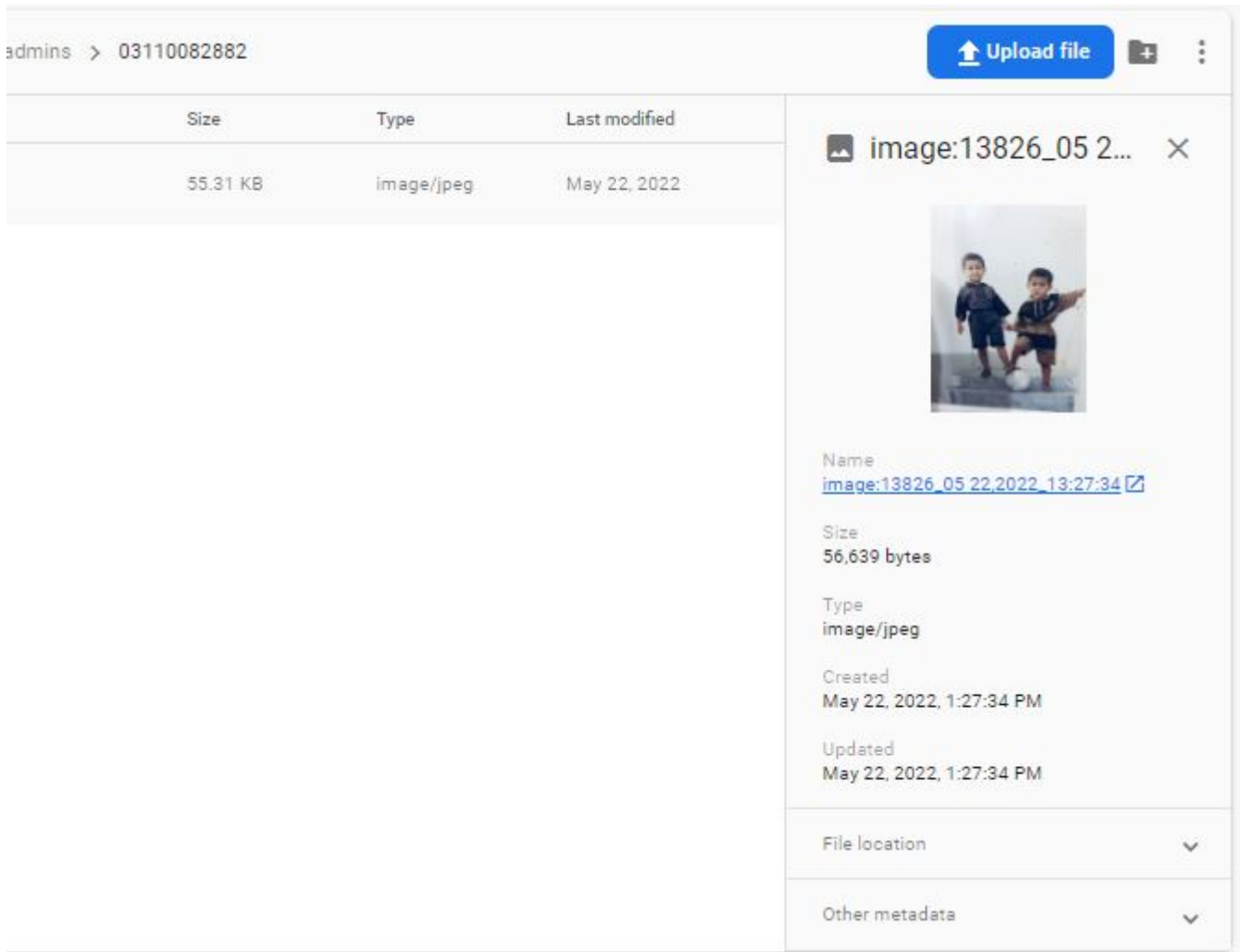
Figure 5.19: Storage in Firebase-Database

5.2.7   Profile Images

Either its a user profile or admin, profile images are kept in the database.

Figure 5.20: Profile Images in Database

5.2.8 Product Images

No matter how many products we have, images of every single product is stored in database.

Figure 5.21: Product Images in Database

Chapter 6

System Testing and Evaluation

6.1 Tabular Description of Use Cases

6.1.0.1 LOGIN

The table given below is the tabular description of login use case which shows that who the actors are, what actions are they going to perform, also what are their pre and post conditions.

Use Case ID	UC-01
Use Case Name	Login
Actors	User(Registered or Unregistered)
Description	When a user wants to login to a system if they are already registered, they can enter their username and password, and if a new user wants to login, they first need to register themselves. Because the system is only be used by registered users.
Trigger	The use case can be triggered when user click at the create account button. Then registered user enters his log-in details and clicks on log-in button.
Pre-Condition	Have access to the internet The actors should not be registered before using same information (e.g., phone number/username). Users have a verified account.
Post-condition	Actors shall receive a confirmation message after successful registration The user successfully log-in to the account
Normal flow	After getting to the application users gets the normal flow of registration as: User clicks on create account button, user log-in to the account, system displays added products to the users, user see the products, user able to live experience the products, after successful registration user get the confirmation message.

Alternative flow	When the user opens the application he enters the log-in details, then he clicks on login button, and he enters to his account as a user.
Exceptions	If the user enters incorrect/ incomplete information for the registration: The system shows a message to re-enter the information, the user enters the correct information and normal flow resumes. If the user entered the registration information which is already used for another account The system displays the message that an account with the same information already exists, then the user needs to make an account with unique information. When the user enters incorrect log-in details: the system displays a message that an incorrect phone number or password has been entered. Also, the system asks the user to enter the phone number and password again The user enters correct log-in details and clicks on the log-in button it leads them to their accounts.
Special-Requirements	The information provided by the users must be accurately saved in the system database.

Table 6.1: Tabular Description of Login as user Activity

6.1.0.2   VIEW PRODUCT

The table given below is the tabular description of view product use case which shows that who the actors are, what actions are they going to perform, also what are their pre and post conditions.

Use Case ID	UC-02
Use Case Name	View Product
Actors	User
Description	Users can view the Products user can browse the products that are added by the admin also user can search the product that he or she wants to buy also user can Live Experience of the product using Augmented Reality After selection of the Product that the user wants to buy user can add the product into the cart to store the products.
Trigger	Use case shall be triggered by the users when they click the View Products button.
Pre-condition	Internet Connection is working. The user is signed into their verified account.
Post-condition	Admin receives the information of product and user that which user and which product ordered from the system. The database gets updated.
Normal flow	After getting to the application the user have the following normal flow to access the View option. Log In, User views the Products, User Browses the Products, User Searches the Products, User Lives Experience of the Product by pointing camera using AR, User After Selecting the product adds it to the cart.
Alternative flow	None
Exceptions	If the user's Mobile does not support the Augmented Reality feature AR Core, then System can not show the Live Experience of the Product.
Special Requirements	None
Assumptions	Internet should be working; the user should be aware of how to use this system. the user should know the English language.

Table 6.2: Tabular Description of View Product Activity

6.1.0.3 CHECKOUT

The tabular description of checkout activity is shown.

Use Case Id	UC-03
Use Case Name	Checkout
Actors	User
Description	Users checks out the account through database, customer authentication is checked before logging out from the account, user can view the shopping cart and if the user wants to buy the product, he or she can update the shopping cart by adding the product into the cart.
Trigger	When the user clicks on the checkout button use case is triggered.
Pre-condition	The users must have access to the internet. The users are logged in to their verified accounts.
Post-condition	After selecting products user can log out from the account.
Normal flow	After getting to the application, firstly the user Log In to their account. Secondly, the user can view the Checkout option. The system can authenticate the customer through the database. The user can update the shopping cart. The user can pay for the selected products by cash on delivery. At last, the users can Logout from the account.
Alternative flow	None
Exceptions	None
Special-Requirements	None
Assumptions	Internet should be working; the user should be aware of how to use this system. the user should know the English language.

Table 6.3: Tabular Description of Check-Out Activity

6.1.0.4 LOGOUT

The tabular description of logout activity which shows that who the actors are, what actions are they going to perform, also what are their pre and post conditions is shown.

Use Case Id	UC-04
Use Case Name	Log Out
Actors	User
Description	When the user clicks on the logout button, the system logs off the user's account. So, if they want to use the app again, they need to login to the account.
Trigger	Clicking log out button or closing the application.
Pre-Condition	The users are logged in to their verified accounts.
Post-condition	After clicking log out button, user can log out from the account.
Normal Flow	First user needs to login to their accounts, they perform some actions and at the end they logged out from their accounts.
Alternative Flow	None
Exceptions	None
Special-Requirements	None
Assumptions	Internet should be working; the user should be aware of how to use this system. the user should know the English language.

Table 6.4: Tabular Description of Logout Activity

6.1.0.5 LOGIN

The table given below is the tabular description of login activity for admin which shows
what actions admin perform for logging in, also what are their pre and post conditions and
what are any special requirements if needed.

Use Case ID	UC-05
Use Case Name	Login
Actors	Admin
Description	When an admin wants to login to a system, they can enter their phone number and password.
Trigger	The use case is triggered when admin clicks on log-in button.
Pre-condition	Have access to the internet The actor should not be registered before using same information (e.g., phone number).
Post-condition	The admin can successfully log-in to the account
Normal flow	After getting to the application, the admin log-in to the account, he can add/delete/update products, product locations, product categories and delivery charges.
Alternative flow	None
Exceptions	If the admin enters incorrect log-in details: the system displays a message that an incorrect phone number or password has been entered. Also, the system asks the admin to enter the phone number and password again. When the admin enters the correct log-in details and clicks on the log-in button it leads him to their account.
Special-requirement	The admin login information must be accurately saved in the system database.
Assumptions	The admin must be able to use system and internet, also able to understand English language.

Table 6.5: Tabular Description of Login as Admin Activity

6.1.0.6 ADD/DELETE/UPDATE CATEGORY

The tabular description of add/update/delete category activity that the admin can perform is mentioned.

Use Case ID	UC-06
Use Case Name	Add/update/delete category
Actors	Admin
Description	This allows the admin to Add, Update and Delete information about different categories which allows the users to view different new categories, or they can view the latest updated category.
Trigger	Only Admin can use this function.
Pre-condition	The system requires internet. Admin is signed into his account.
Post-condition	The administrator shall have reviewed the categories.
Normal flow	To view, the information administrator shall follow these steps: first, the administrator shall add the new category, update category and Delete category. Second, the system shall display a list of newly added categories for the users to view. Third, the administrator shall update any category so that users can view newly updated products. Fourth, the administrator shall delete any category.
Alternative flow	None
Exceptions	If the administrator wants to click the "Add category" option. The administrator shall click the "Add category" option. The system shall send a message to the user that a new category has been added to the application.
Special-requirement	None
Assumptions	The administrator must be able to use system and internet, also able to understand English language.

Table 6.6: Tabular Description of Category Activity

6.1.0.7 ADD PRODUCT LOCATION

The table given below is the tabular description of add product location activity which in details explains that how the admin can add product location, also what are their pre and post conditions.

Use Case ID	UC-07
Use Case Name	Add Product Location
Actors	Admin
Description	Admin can add the Product Location so that it can be easy for the user to buy the product that he wants to buy.
Trigger	When the admin clicks on the "Add Product Location" button, the use case is triggered.
Pre-condition	The system requires internet. Admin is signed into his verified account.
Post-condition	Product information can be added to the system and the information of existing Products in the system can also be updated. The updated information is available to the users. The database is also be updated.
Normal flow	To access Add Product Location option, firstly you need to Log In, then Admin can go to the Products categories and add the Location of each Product.
Alternative flow	None
Exceptions	None
Special-requirement	None
Assumptions	The administrator must be able to use system and internet, also able to understand English language.

Table 6.7: Tabular Description of Add Product Location Activity

6.1.0.8   ADD/UPDATE DELIVERY CHARGES

The tabular description of add/update delivery charges activity that the admin can perform is mentioned.

Use Case ID	UC-08
Use Case Name	Add/Update Delivery Charges
Actors	Admin
Description	Admin can add charges on delivery and can update delivery charges with different products.
Trigger	The use case is triggered when the admin clicks on the Add Delivery charges buttons.
Pre-condition	The system requires internet.Admin is signed into his account.
Post-condition	Delivery charges are updated.
Normal flow	The normal flow: The user can sign-in to the account. The user can open the Add Delivery charges option.The system displays delivery charges.The database is maintained by admin whenever charges increase or decrease.
Alternative flow	None
Exceptions	None
Special-requirement	None
Assumptions	The user must be able to use system and internet, also able to understand English language.

Table 6.8: Tabular Description of Delivery Charges Activity

6.1.0.9 LOGOUT

The tabular description of logout activity for an admin is mentioned in detail in this table.

Use Case ID	UC-9
Use Case Name	Log out
Actors	Admin
Description	When the admin clicks on the logout button, the system logs off the admin's account. So, if they want to use the app again, they need to login to the account.
Trigger	Clicking log out button triggers this use case.
Pre-condition	The admins are logged in to their verified accounts.
Post-condition	After clicking log out button, admin can log out from the account.
Normal flow	First admin needs to login to their accounts, they perform some actions like (add/update/delete products, product categories or product locations etc.) and at the end they logged out from their accounts.
Alternative flow	None
Exceptions	None
Special-requirement	None
Assumptions	Internet should be working; the user should be aware of how to use this system. the user should know the English language.

Table 6.9: Tabular Description of Logout as Admin Activity

6.2   Testing

Testing is the process of assessing a system or its components with the goal of identifying software errors and comparing them to requirements specified. Testing is the process of running a system to look for flaws, faults, or requirements that aren't being met.

We are computer science students who adhere to IEEE standards and ideals. A procedure of analyzing a software item to detect the discrepancy between existing and necessary conditions and to evaluate the features of software item, according to the IEEE definition.

6.2.1   Testing's Roles

The roles in software testing are entirely dependent on the needs of project stakeholders. Large corporations have a dedicated staff with specific tasks for assessing the presented needs. Unit testing is another type of testing done by developers. The jobs involved in testing are as follows:

- End user

- Software Developer

- Configuration Manager

- Project Lead/ Manager

- Software Tester

Roles and their nomenclature may differ from one company to another. The following are some software testing designations.

- SQA Engineer

- QA Analyst and Lead

6.3   Testing Levels

6.3.1   Unit Testing

Before the software is handed over to the testing team, which formally executes test cases, developers undertake this type of testing. The goal is to isolate each component of the software and demonstrate that each component is correct in terms of requirements.

6.3.2   Integration Testing

Integration testing is the process of determining whether or not the various components of an application work together appropriately. Bottom-up integration testing and top-down integration testing are two approaches to integration testing.

6.4 Test Cases

6.4.1 Test Case for Existing Phone number

The table given below is the test case for checking the authenticity of the users. Whether their phone numbers are valid or not.

Test Case ID	TC-01
Test Case Name	Test for Existing Phone Number
Tested by: Manal Khalid	Date: April 5,2022
Test Data	User Information
Pre-Condition	The user must on registration page
Test Verification	The Test verifies that the user cannot make another profile with the same phone number twice.
Actions	System Response
Sign up, enter data, invalid phone number	System shall show an error of invalid email.
Result	Pass The system do not let users to sign up with invalid data.

Table 6.10: Test Case 1

6.4.2 Test Case for Register User Tries to Login with Wrong Data

The table given below is the test case for checking that user is logging in with wrong log in details.

Test Case ID	TC-02
Test Case Name	Register User tries to login with wrong data.
Tested by: Manal Khalid	Date: April 5,2022
Test Data	User Information
Pre-Condition	The user must have been registered.
Test Verification	The test verifies that the user cannot login with wrong phone no or password.
Actions Sign up, log in, invalid phone number/password	System Response System shall show an error of invalid email/password.
Result	Pass The System don't let users to sign in with invalid data

Table 6.11: Test Case 2

6.4.3 Test Case Delete Profile

The table given below is the test case for verifying that can admin delete the customers profile or not.

Test Case ID	TC-03
Test Case Name	Test for delete profile.
Tested by: Muaz Ahmed	Date: April 1,2022
Test Data	User Information
Pre-Condition	The user must login.
Test Verification	The Test verifies that whether Admin can delete user profile.
Actions log in,account setting,delete profile	System Response System delete the profile.
Result	Pass The System allows the user to delete profile.

Table 6.12: Test Case 3

6.4.4   Test Case for Logout

The table given below is the test case for checking that whether the user able to successfully logout from the app.

Test Case ID	TC-04
Test Case Name	Test for Logout.
Tested by: Muaz Ahmed	Date: April 1,2022
Test Data	User Information
Pre-Condition	The user must login.
Test Verification	The Test verifies that whether user can logout from system.
Actions log in,view pro-file,click logout	System Response System shall logout the user.
Result	Pass The System allows the user to logout.

Table 6.13: Test Case 4

6.4.5   Test Case for Change Password

The table given below is the test case for verifying that if users want to change their accounts password is it possible for them or not.

Test Case ID	TC-05
Test Case Name	Test for change the password.
Tested by: Muaz Ahmed	Date: April 1,2022
Test Data	The user must put the old password then new password and clicks change button
Pre-Condition	The user must login.
Test Verification	The Test verifies that whether the password is changed or not.
Actions log in,account set-tings,change password	System Response System changed the password
Result	Pass The System allows the user to change password

Table 6.14: Test Case 5

6.4.6 Test Case for View Products

The table given below is the test case for checking that if all the products are available for the users or not.

Test Case ID	TC-06
Test Case Name	Test for View Products
Tested by: Muaz Ahmed	Date: April 8,2022
Test Data	The user must login to the account type view products
Pre-Condition	The user must login.
Test Verification	The Test verifies that whether the Products are available for user and can see the products or not.
Actions log in,view products,live experience of product by Augmented Reality	System Response User view the products and live Experience of product by Augmented Reality
Result	Pass The System allows the user to Experience Live view of a Product.

Table 6.15: Test Case 6

Chapter 7

Conclusions

Our project "E-Commerce Store Based on Augmented Reality" is described in depth in this document. The document provides a thorough examination of the proposed system. The report shows the solutions and how to put it into action. The document contains a full description of the system's features and functions. The document also shows how the system's interfaces work. It offers a variety of functionalities that may be accessible through an Android app.

Working on this project with the supervisor and partner has become a real pleasure. We've had a big learning curve as a result of the project. Experiencing various challenges and finding solutions teaches us that there are numerous approaches to a given problem. The project was unique, and we had our reservations, but with the support of our supervisor and our determination, we were able to meet our objectives to a large extent.

Work in the Future

In response to customer demands, we want to enhance the capabilities of our system and try to make it more advanced in the future. We're ecstatic to be working on new features that can make the app better for everyone. 3D models can be added to every product, as well as online payment options.

Appendix A

User Manual

- Existing users may access the application through a login page, while new users can register for an account.

- If you're a new user, you may join up using the registration form choosing an option whether as a Buyer or Seller . if you're an existing one, you can log in and go to the home screen.

- Buyer : is divided into three sections: the home page, the shopping cart, and the user profile. The user may see and pick categories on the Home page. The stores in this category have names that are linked to the category, and you can browse their items and see where they are located on a map. By viewing items, putting them to the shopping basket, and checking out, the user may make a purchase by adding shipment details.

- Augmented Reality : User has option to see the product using augmented reality. Where he/she can place camera and display the products

- Admin : Admin have to sign-in and add new changes about products.

- User can Sign out by sign out option in the profile tab

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