

AR and VR Based **FURNITURE STORE**

FINAL PROJECT REPORT

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Prepared for

Human Computer Interaction (CSE4015)

PROJECT COMPONENT

Submitted to

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DECLARATION

I hereby declare that the J Component report entitled “**AR and VR BASED FURNITURE STORE**” submitted by me to *Vellore Institute of Technology, Vellore* in partial fulfilment of the requirement for the award of the degree of **B.Tech in Computer Science and Engineering** is a record of bonafide undertaken by me under the supervision of **Prof. Swarnalatha P.** I further declare that the work reported in this report has not been submitted and will not be submitted, either in part or in full, for the award of any other degree or diploma in this institute or any other institute or university.

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ABSTRACT

The aim of our project is to improve the customer experience for buying furniture from an online furniture store. In some cases, after buying furniture customers realize that the furniture size is not suitable for their house or its design doesn't match with the interior of the house. This project will help the customers visualize that how a particular furniture looks like when kept in their house and will also give the customers an idea if it can be perfectly placed in the desired area of the house. Augmented Reality shall be used to achieve the goal. The customers could also select the furniture they wish to buy by visualizing their demo furniture setup using Virtual Reality.

PROBLEM STATEMENT

- Most of the people do not get the furniture of desired dimension.
- People usually buy furniture on the basis of its quality, comfort, design and size (descending order of priority).
- The people would like to verify how the furniture looks and if it fit in the desired area, they want to keep it in.
- Amidst this pandemic situation people will refrain from going out and visiting the shops.
- So, I intend to cater the above-mentioned problems through an interactive AR and VR app.

INTRODUCTION

Augmented reality (AR) and Virtual Reality (VR) bridge the digital and physical worlds. They allow you to take in information and content visually, in the same way you take in the world. AR dramatically expands the ways our devices can help with everyday activities like searching for information, shopping, and expressing yourself. Over the last few years, we've seen apps that entertain, engage, and help people in different ways – from letting fans interact with their favorite characters, to placing virtual electronics and furniture for the perfect home setup and beyond.

Raw Depth API enables more improved geometry, accurate depth measurements and spatial awareness. In the ARConnect app, these more accurate measurements give users a deeper understanding of their physical surroundings. The AR Furniture Store App utilizes raw depth's spatial awareness to allow users to build realistic virtual 3D furniture around their desired area and allows scene reconstruction.

My android application showcases the following features to solve the trouble faced by the people:

- Shows the accurate dimension of the furniture products.
- Design and color are very similar to the actual store unlike other apps.
- Provides excellent graphics for AR and VR visualization.
- Easy to use and interactive for the amateur users.

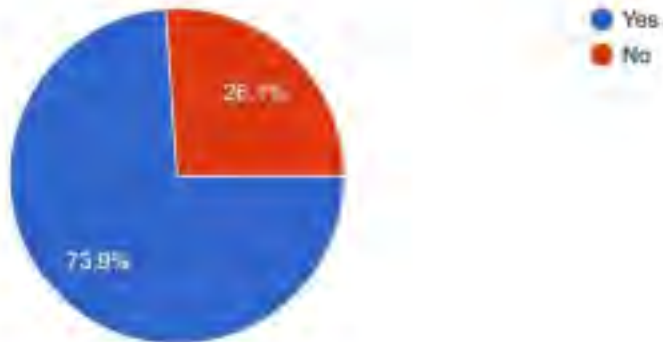
REQUIREMENTS ANALYSIS

A small scaled survey was carried out, in which questions were put up to 25 people regarding the furniture store they would prefer to use. The data collected are visualized below in form of pie charts and bar plots which gives an insight to the user requirements and preferences.

Question 1:

Do you have furniture stores nearby your house?

23 responses



Question 2:

Before buying a new furniture, do you note down the dimensions of the place where it has to be kept?

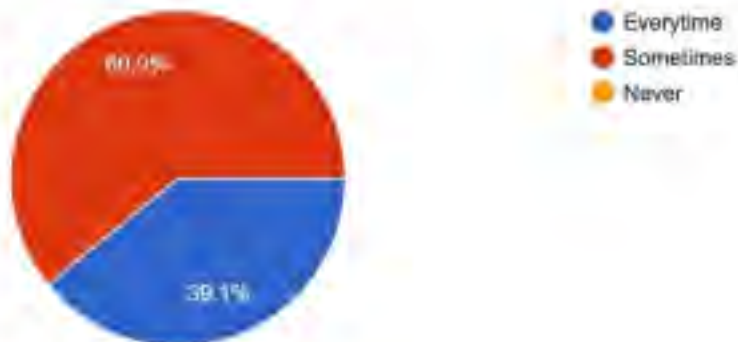
23 responses



Question 3:

How often do you get furniture of desired dimensions (so that it fits exactly in the place you want to keep it)?

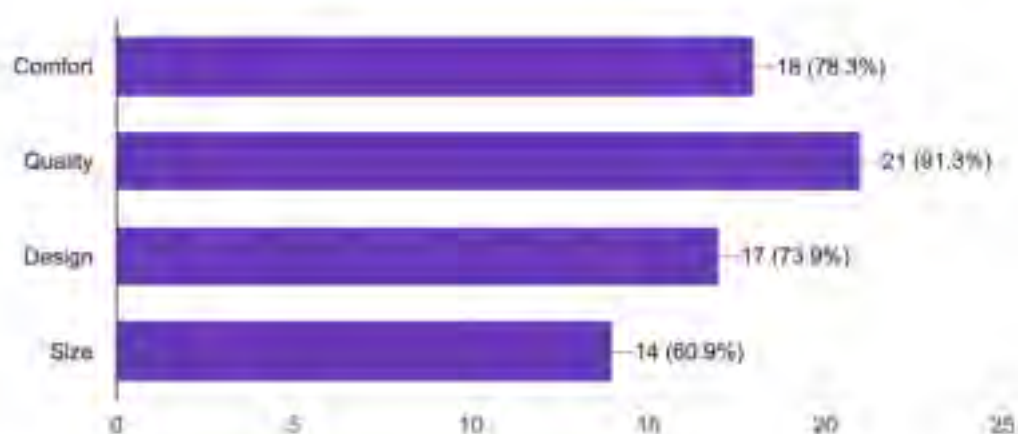
23 responses



Question 4:

What attributes of a furniture do you generally consider before buying?

23 responses



Question 5:

Would you like to verify whether a furniture can fit or how it looks when kept in your house, before buying?

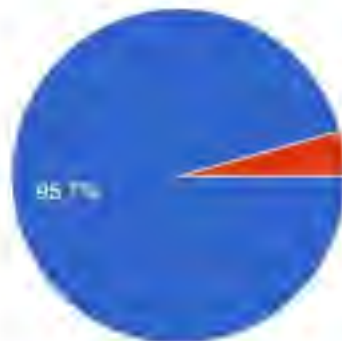
23 responses



Question 6:

Before buying the furniture, which will be more convenient for you?

23 responses



- Virtually place the furniture in the desired place and check for your requirements.
- Bringing the furniture from the shop to your home and check for your requirements.

Question 7:

What do you expect from an app which allows you to visualise how a furniture will look like in your home?

23 responses



HARDWARE & SOFTWARE REQUIREMENTS

****Based on the responses of the people in the survey conducted, the following hardware and software will be adopted to carry out the android app development project work.**

- 1. Google Poly:** To import the 3D Module of the furniture.
 - 2. AR Core:** For adding AR/VR Module to the App.
 - 3. Sceneform SDK:** For adding AR/VR Module to the App.
 - 4. Raw Depth API:** For accurate measurements for Furniture and area.
 - 5. Google Firebase:** To store user database and app info.
 - 6. Google Firestore:** To store the real time database of variety of furniture.
 - 7. Android Studio:** For developing App interface as well as backend. **8.**
- Android Emulator:** For temporarily previewing the App.
- 9. Android Smartphone with Camera:** To run the App.



LITERATURE SURVEY

S. No	Author Names/Year	Title	Methodology	Disadvantages
1.	Khairnar, K., Khairnar, K., Mane, S., & Chaudhari, R. (2015)	Furniture Layout Application Based on Marker Detection and Using Augmented Reality	A system augmented reality conferencing system which uses an overlay of virtual images on the real world was proposed. Remote collaborators are represented on Virtual Monitors which can be freely positioned about a user in space. Users can collaboratively view and interact with virtual objects using a shared virtual whiteboard. This is possible through precise virtual image registration using fast and accurate computer vision techniques and HMD calibration. A method for tracking fiducial markers and a calibration method for optical see-through HMD based on the marker tracking.	Although this system will help buyers who want to buy furniture in a real environment. Customers will use it to determine how to set up furniture in the house. This system proposed the furniture layout augmented reality application based on the visual maker-based tracking methods. Customers will have the exact view of how to set up the office, house and any space which is required for the use. Users can try out multiple combinations virtually, without physical movement of furniture items. In future works, we need to consider the feedback of the user's evaluation as a human interface. In AR studies, not only the estimation of the camera poses and position, the recognition of the real environments, and the Augmented Reality interfaces are necessary for realizing the AR, but also the user's evaluation are a very important issue. This system is to watch over for avoiding dangerous layouts of furniture, considering the space between

2.	Riar, M., Korbel, J. J., Xi, N., Zarnekow, R., & Hamari, J. (2021)	The Use of Augmented Reality in Retail: A Review of Literature	To determine whether AR bears the potential of diffusion in retail, a holistic view on the effects and adoption mechanisms in the extant academic corpus is needed. Hence, the purpose of this paper is to synthesize the current empirical literature on AR in the context of retail in order to investigate how and where AR has been employed in retail, what is known about the effects and criteria for adoption and what potential directions for future research need to be further scrutinized.	This review is limited to literature of empirical nature and studies that investigated AR in the specific context of retail. Therefore, literature that examines AR in other contexts as well as concepts adjacent to AR (e.g. virtual reality) and studies with methodological different approaches (e.g. case studies) are not considered in this review. Moreover, even though we included different possible variations of the search terms, there may be studies that discuss AR under yet other terms, and which may therefore not have found their way into this review.
3.	Gallardo, C., Rodríguez, S. P., Chango, I. E., Quevedo, W. X., Santana, J., Acosta, A. G., ... & Andaluz, V. H. (2018)	Augmented Reality as a New Marketing Strategy	<p>The scheme proposed in the paper can be presented in 3 well-defined blocks: Unity3D AR Screen output functions scripts and input/output. The technology used behind this scheme involves Unity ARkit and Swift4. Unity ARkit is used in developing and rendering the 3D models on the screen, and the backend is handled by Swift4 programming to work with the user interaction.</p> <p>The above-mentioned 3-layer schema involves the connection of local databases with the web server, thus making the application usable both in offline and online modes.</p>	One of the major points that this paper misses is the smooth user experience. The component loading time when it comes to loading Unity 3D models is very high, and the only way to fix this issue is to reduce the size of the model by decreasing the quality of the 3D model. The size of the model also causes problems when one wants to use the application in offline mode, which heavily relies on the device's storage capabilities.
4.	K Wiley - 2017	From Your Phone To Your Home: An	The given thesis focuses on two objectives: the growing need for AR visuals to improve brand experience	Although AR has proven to be a powerful branding tool, there are currently no brand's in the market which

		Augmented Reality Brand Experience for High-End Furniture	and creating an AR prototype for the marketing world. The thesis mentions how AR was used by companies like IBM to promote the technology and implementation of AR in the Pokémon GO game and for the promotions of the show “The Walking Dead” by making AR Zombies. The prototype phase focuses on Knoll - a company which makes designs for office seatings and home settings with new age focus on AR/VR marketing.	successfully follow this strategy. Thus, it becomes difficult to analyze the true market potential of AR/VR solutions without actual usage in the real world. AR/VR world seems handsome but so did the Meta and nobody has been clever enough yet to have generated profit in today’s market.
5.	Viyanon, W., Songsuittipong, T., Piyapaisarn, P., & Sudchid, S. (2017)	AR Furniture: Integrating Augmented Reality Technology to Enhance Interior Design using Marker and Markerless tracking	The purpose of this research is to study and develop an android application called 'AR Furniture' with the use of Augmented Reality technology for design and decoration that will help customers visualize how furniture pieces will look and fit (to scale) in their homes and also can provide details of products to support customer decision. This application is a prototype to find out factors affecting the design and tracking of AR applications.	The results of the experiments indicate that the application needs to be improved in order to perform better. Some of the improvements include creating different marker patterns, such as using barcodes or QR codes as markers, detecting walls or ceilings so that 3D objects can be displayed correctly on them, enhancing light robustness, and creating more realistic 3D models.
6.	Ozturkcan, S. (2021)	Service innovation: Using augmented reality in the IKEA Place app	In this article, IKEA Place App, by the renowned furniture retailer, is explored concerning its service innovation to offer its customers an outstanding digital experience in their shopping. The paper showcases, first, the ready-to-assemble (RTA) furniture market, and IKEA as a company are introduced.	The AR app presented in this article has narrowed down to S-D-logic-based service innovation. According to the traditional view of the G-D logic, business transactions often include some value, which is measured in units of output in manufacturing goods at the end of a production process that utilizes some tangible

			Second, augmented reality (AR) and its use in marketing are presented. Next, follows a section that reviews the IKEA Place app and reflections about it. Finally, concluding remarks are presented within the S-D logic in terms of the service innovation captured by the AR.	physical resources. The S-D logic considers the knowledge and skills as resources used in service interactions where the focus is on co-created value. Yet, the goods and services distinction does not serve as a differentiating factor between the G-D logic and S-D logic.
7.	ALHARBI, B., ALJOJO, N., ALSHUTAYRI, A., BANJAR, A., ZAINOL, A., ALHARBI, A., ... & ALSHEHRI, M. (2021)	The design and implementation of an interactive mobile Augmented Reality application for an improved furniture shopping experience	An augmented reality-based smartphone application for furniture purchasing was suggested in this study. The major goal of the suggested application is to improve the user experience when purchasing furniture. This includes technologies that allow simultaneous interaction with the real world and the virtual world. Users may examine things from various retailers and utilize augmented reality to virtually try them on before making a purchase using the suggested application. This allows consumers to select the ideal color, shape, and size while seated at home.	With the ability to visualize how the space would appear after adding furniture, the suggested mobile application will assist users in trying out furniture in their rooms. Users may digitally test out various furniture configurations using augmented reality without actually moving the furniture. More significantly, it won't be necessary to measure the customer's space or go shopping to see whether the furniture would fit. Therefore, the main drawback of AR is that it requires a very fixed vision, and we cannot anticipate the user to move at all while using it.
8.	Huang, V. C., & Tedjojuwono, S. M. (2020)	Mobile Augmented Reality to Enhance Customer Experience while Purchasing Furniture	The application that is being suggested in this article is made to assist users in getting to the store with the necessary product information and to shorten the time they spend considering making a purchase. On the smartphone application, augmented reality will be employed to allow users to view the colors that go well with the space and to approximately measure sizes. This was accomplished by comparing the intended size to the actual	The study employs static predetermined knowledge of colors instead of a genuine ML technique that is customized to the user's preferences, which is a drawback that can be noticed.

			item size.	
9.	Smink, Anne R. van Reijmersdal, Eva A. van Noort, Guda Neijens, Peter C.	Shopping in augmented reality: The effects of spatial presence, personalization and intrusiveness on app and brand responses	This article broadly evaluated two opposing processes that might add to theoretical explanations of the benefits and drawbacks of augmented reality (AR) applications. The ability for customers to envision things in an environment that is personally relevant thanks to AR is thought to be the fundamental mechanism that underlies perceived personalisation, which can lead to favourable reactions. This real-time view might, however, potentially make the experience seem more invasive and elicit unfavourable reactions. The observation firstly examined the effects of an AR app that depicted virtual make-up on the users' own faces . Then, we examined the findings by using an AR app that showed virtual furniture within the users' surroundings	The study result shown that the underlying mechanisms that favorably influenced attitudes and behavioral intentions toward the AR app were spatial presence and perceived personalisation. More spatial presence was evoked by the AR app than by the non-AR app. Consumers may experience virtual things as if they were actually there thanks to augmented reality (AR), which gives users a better sense of spatial presence than a non-AR app. Users can overlay virtual products onto their physical area in real-time.
10.	Rese, A., Baier, D., Geyer-Schulz, A., & Schreiber, S. (2017)	How augmented reality apps are accepted by consumers: A comparative analysis using scales and opinions	This paper discusses how interactive technologies such as Augmented Reality are generally seen and accepted. A modified technology acceptance model (TAM) is used to measure users' perceptions and experiences. To support the universality of the results, the measurement models, and the measurement approach, four experiments—two using marker-based AR apps and two using markerless AR apps—are described. Based on an intensive research study, 5 hypotheses were listed to be tested. The questionnaires used in the study were based on standard IKEA template.	The study's samples were drawn from classrooms and experimental settings rather than real-world ones. This is a typical weakness of academic TAM research. This also means that the result was obtained for a younger age group and may vary for an older group.

11.	Kurniawan, B., & Fadryan, E. P. (2019)	Furniture Online Shopping using Augmented Reality	<p>The descriptive strategy was adopted in this study. The descriptive technique entails a number of processes, including formulating the problem, choosing the objectives, creating the framework, going through the literature, and others. The two steps of this research's focus are problem formulation and literature analysis using direct interviewing as a method of data collecting.</p> <p>This study focuses on consumer data retrieval applications incorporating augmented reality and leveraging IKEA products. Data is measured against customer satisfaction with application usage, and IKEA incorporated further AR capabilities to help customers choose the furniture they wanted. The level of efficacy is then measured against the application's ability to satisfy users.</p>	<p>The samples taken for the survey were limited, with only 10 people being interviewed. This number is especially less for a study that was heavily reliant on its survey results. Further, the study limits itself to the study of IKEA products and does not venture out to evaluate the furniture products of other stores thereby limiting itself in its possible scope.</p>
12.	Motwani, K., Sharma, S., & Pawar, D. (2017)	Furniture Arrangement Using Augmented Reality	<p>A software development kit (SDK) for augmented reality applications called Vuforia is available for mobile devices. It employs computer vision technology to instantly identify and follow simple 3D objects, including boxes, as well as planar images (Image Targets). We label seams on our 3D mesh in accordance with how the mesh is cut since a seam is where the ends of an image or piece of clothing are stitched together. Cutting the mesh model in accordance with the seams marked leads in a variety of flattened-out mesh bits, which facilitates the development of textures. Mesh is unwrapped in accordance with the seams</p>	<p>In the real world, augmented reality is becoming more prevalent. We have the ability to use augmented reality to an increasing number of applications thanks to the game engine Unity 3D and some AR development platforms. In this paper's application, users can view 3D furniture models in real time. This application's key benefit is that it lowers costs while giving users real-time access to multimedia augmentations of highly realistic simulations.</p> <p>Additionally, it enables the consumer to comprehend the project's concept, enabling them to meet unique requirements and create</p>

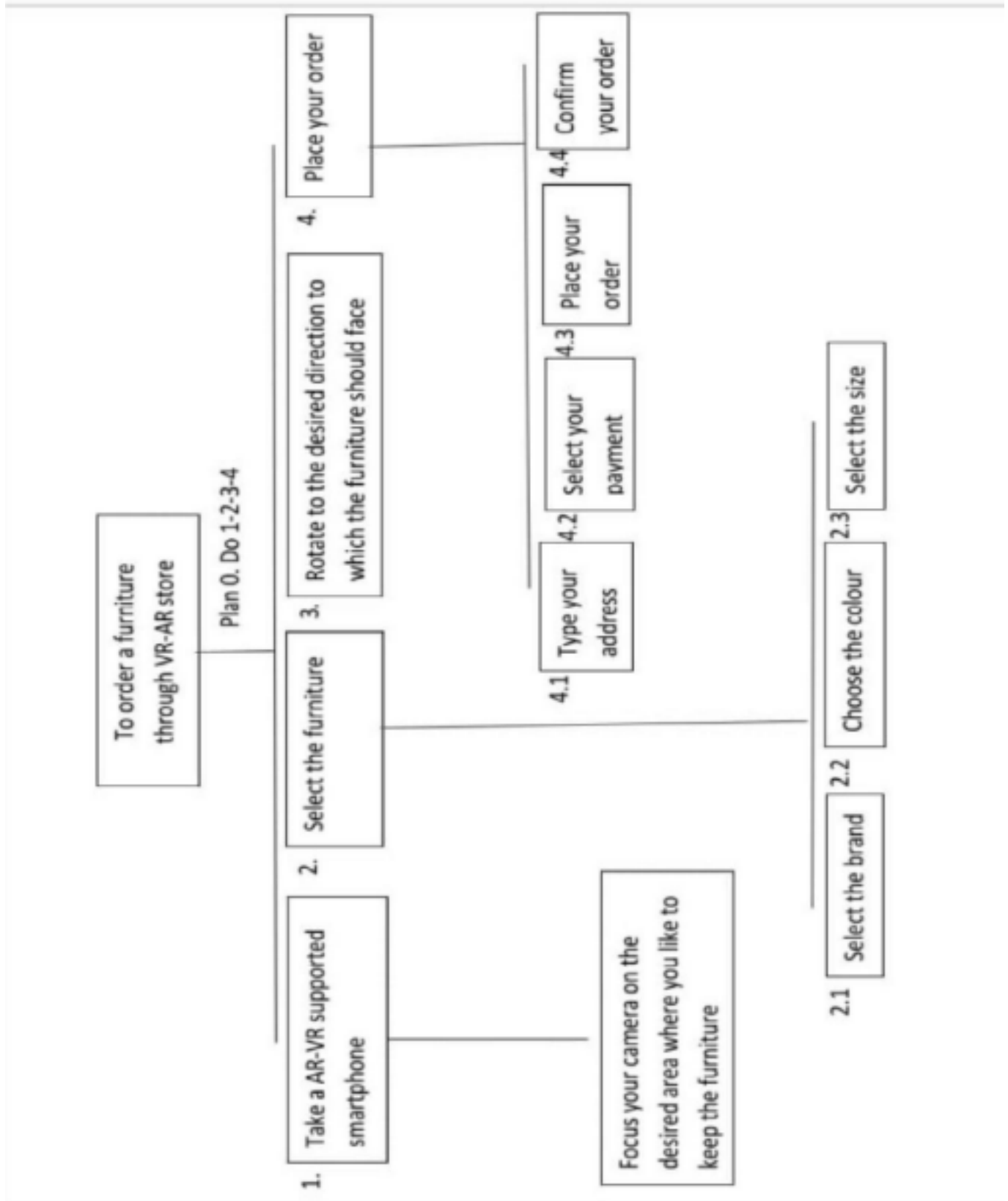
			indicated for texture production. The mesh is then re-projected onto the image plane after the camera has recovered the 3D shape of the furniture from the 2D image.	designs with greater compassion.
13.	Smink, A. R., Frowijn, S., van Reijmersdal, E. A., van Noort, G., & Neijens, P. C. (2019).	Try online before you buy: How does shopping with augmented reality affect brand responses and personal data disclosure	A one-way factorial design was used in an online experiment with three conditions that each had a different online product presentation: augmented reality (AR), a photo of the self (non-AR self), and a photo of a model (non-AR model). Over the course of three weeks in May 2018 in The Netherlands, participants were approached through email and social media using a snowball sampling procedure. Emails and social media platforms were used to disseminate an invitation that included a URL to a Qualtrics survey. The study was only to be conducted on a laptop or computer with a webcam, which was necessary for both the AR and the non-AR selfcondition, according to the invitation. After completing the experimental task, participants were required to indicate which lipstick they preferred and were questioned about any application issues. Participants who reported using the app incorrectly or being unable to complete the experiment were disqualified from future participation. The dependent variables, mediators, and control factors were then measured by having individuals complete out questionnaires. Finally, students completed a manipulation check to see if they had employed the	When interpreting these data, a few restrictions need to be kept in mind. This study explored a prospective user population for AR apps while focusing on an existing make-up application (18–30 years old women). This restricts the generalizability over a more varied user community, including elderly individuals and men who might have had a different impact on the outcomes. Regarding age, studies have found that younger individuals tend to be more digital adept and to experience less technological anxiety. As a result, elderly adults typically struggle more with utilising and embracing new technologies. As a result, it's likely that they find AR applications to be less fun and useful and more obtrusive than younger people do. In terms of gender, studies have indicated that women place more value on direct product experiences than do men, and as a result, they consider online buying to be riskier (because it offers a more indirect product experience).

			designated condition by answering questions about how they had applied the makeup.	
14.	Young, T. C., & Smith, S. (2016, July)	An interactive augmented reality furniture customization system. In International Conference on Virtual, Augmented and Mixed Reality	The interaction event is fired by this study's creation of a cubic event trigger. A larger cube that is 200 mm away from the event trigger was made as a separation detector to increase control stability for virtual objects. An interaction event occurs when users' hands touch or enter the event trigger, and the event trigger appears as a translucent red region. To put the designed AR furniture display system to the test, two tests were conducted. The TF3DM open source was used to source the furniture models. In the test, there were 11 women and 12 men. In the first experiment, participants had to interact with the virtual furniture and position it in the appropriate places. The positions and characteristics of both hands can be retrieved using Kinect's body tracking feature in order to manipulate the virtual objects. One illustration demonstrates how a transparent red area indicating the interaction mode emerges when the user's hands touch the event trigger.	AR applications are growing in popularity as computer technology and software develop. Direct interaction and proper occlusion can increase the realism of an AR scene and aid users in being fully immersed in it. This project created a natural user interface using occlusion for an interactive augmented reality system. The disparity between the infrared image and depth image was fixed. With just their hands, users can interact with the virtual things immediately. The experiment's findings also demonstrate that the majority of participants responded favourably to the AR system. They found the method to be practical, intriguing, realistic, easy to use, and intuitive.
15.	Poushneh, A., & Vasquez, A. Z. (2017)	Customer Present Dissatisfaction and Future Satisfaction with Augmented Reality used in Shopping and Entertainment.	The goal of augmented reality technology is to improve users' experiences while they shop or look for amusement. It may not be because augmented reality (AR) is flawed if improvement is minimal or nonexistent; rather, it may be because AR does not offer enough attributes to please users. This study investigates	Customers anticipated strong interaction, high-quality augmentation (realistic vision and telepresence), high volumes of information, and the availability of essential utilities (search features, narration, quick response, and need for touch). Consumers encountered low levels of involvement and knowledge, as well as fun,

			<p>the degree of happiness or discontent attained by some users of augmented reality in commerce and entertainment based on a study with adult consumers. The findings reveal a substantial gap between what customers anticipated to be provided while using augmented reality for leisure or shopping and what they actually encountered.</p>	<p>pleasure, and connectivity. This difference has significant ramifications for researchers and management.</p>
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HIERARCHICAL TASK ANALYSIS

**Based on the requirements of the people, the goals and subgoals were identified and the following HTA was concluded:



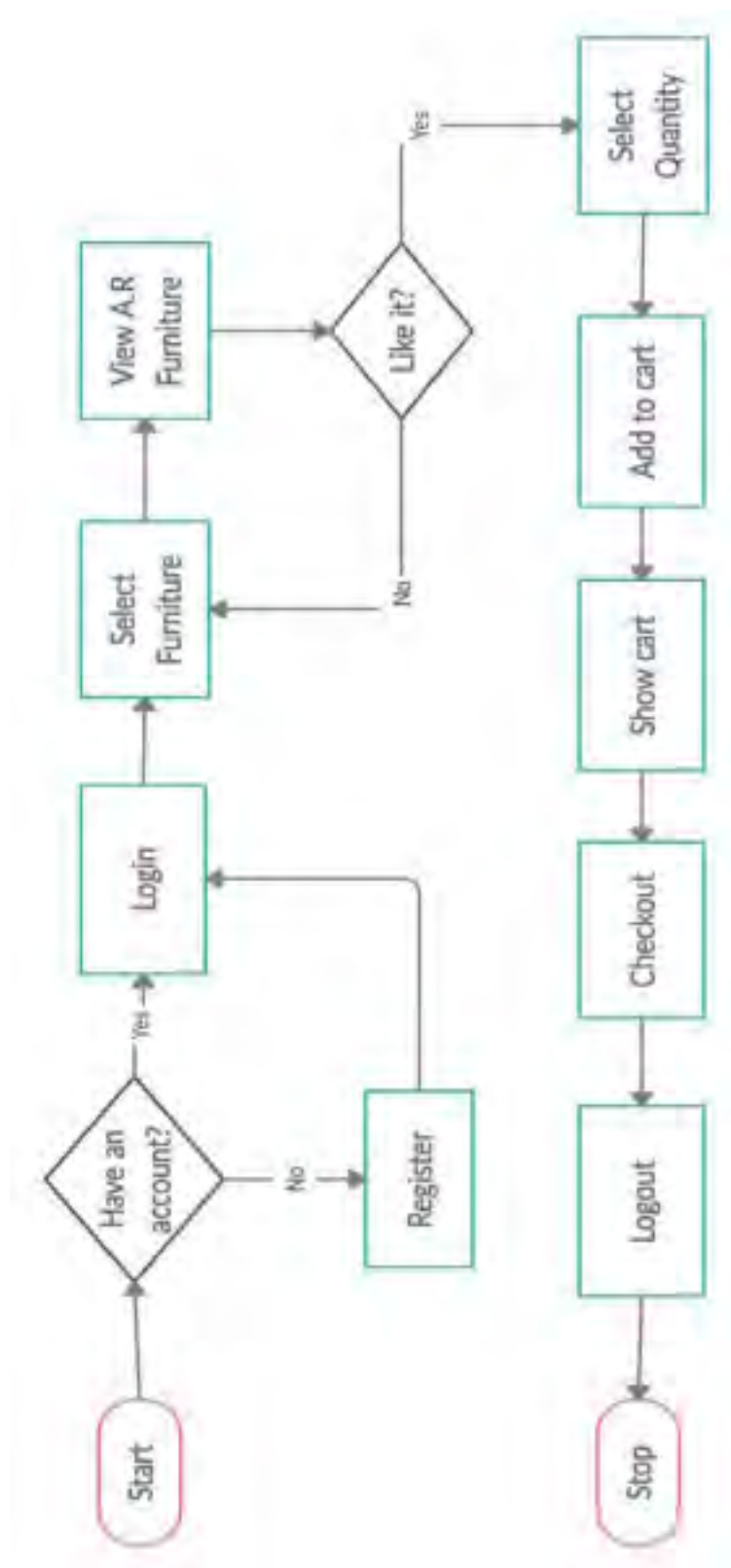
STORYBOARD

APP INTERFACE & WORKING



Flowchart

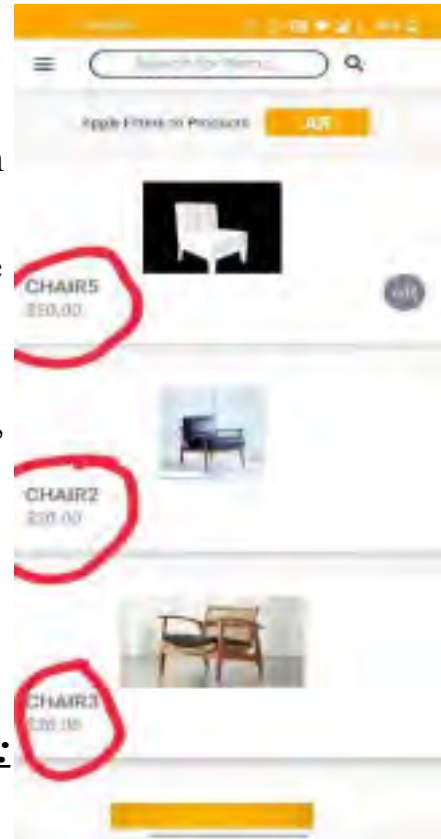
- The below STD shows the flow of control for the application.



COMPATIBILITY WITH SCHNEIDERMAN'S 8 GOLDEN RULES

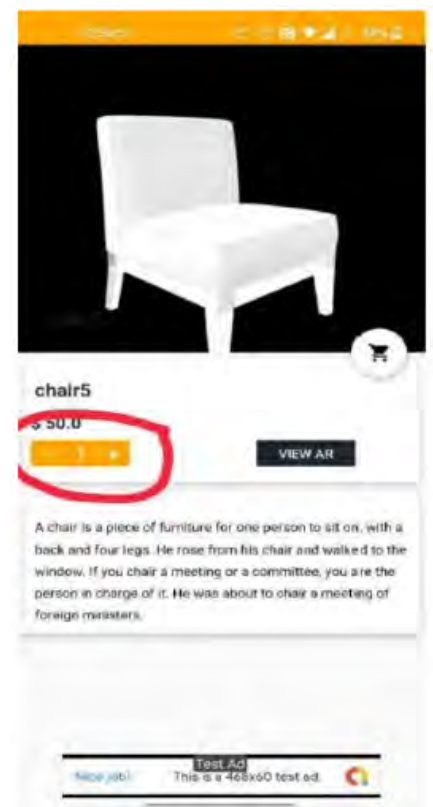
1. Strive for Consistency:

- Collection of different furniture is displayed in similar manner.
- The names and prices of different furniture are displayed in similar font type, size and colour, indicating that they mean the same thing, i.e., name and price of furniture.



2. Enables frequent users to use shortcuts:

- Generally, quantity of a product is selected after adding it to cart. So, to make the usage of the app simpler for frequent users I have added the quantity button beside the description of the furniture.
- The customers could directly select the quantity and add to cart where the quantity will be updated along with the total price accordingly.



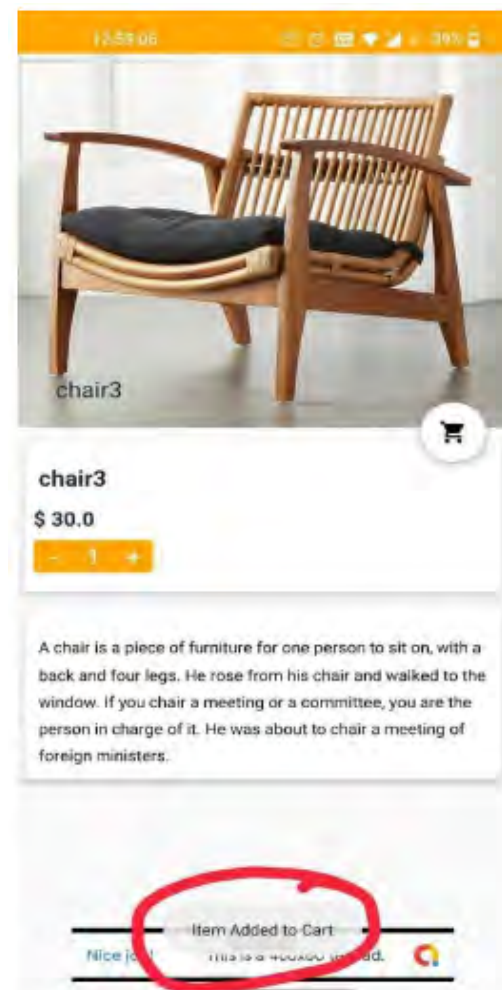
3. Offers informative feedback:

- The icon given in the picture depicts a hand holding the phone.
- This icon rotates before generating the A.R model, informing the users that how they should hold the phone and how to rotate the phone to generate the A.R model of the furniture



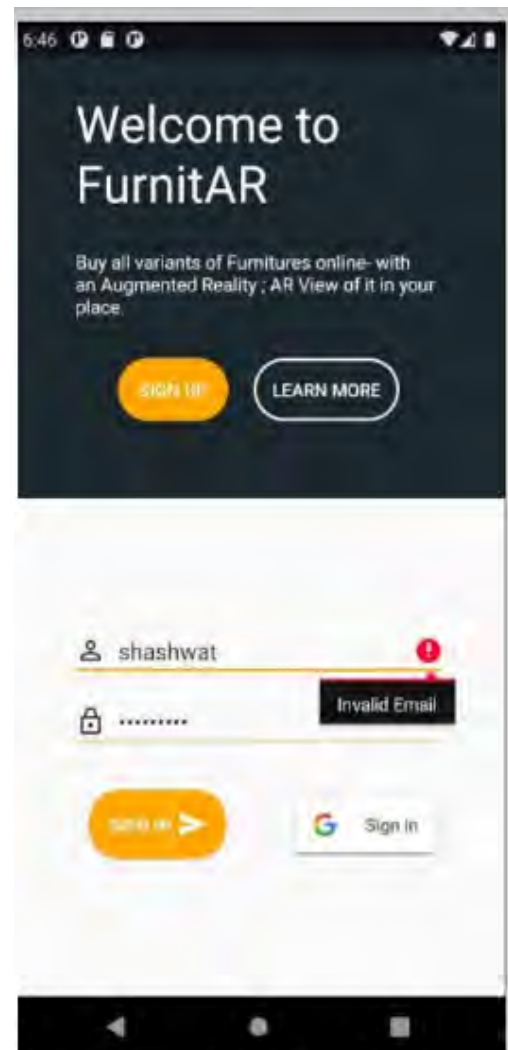
4. Design dialogs to yield closure:

- After the customers selects the quantity and clicks on the cart icon, i.e., when they add items to the cart a dialogue shows up displaying “Item added to cart”.
- This give a peace of mind to the user that the task which they wanted to do is completed successfully.



5. Offers simple error handling:

- If a wrong email id or password is entered by the user, A red colour icon containing exclamation mark displaying the message “Invalid email” or “Invalid Password” pops up beside the text field. This give a peace of mind to the user that the task which they wanted to do is completed successfully.
- This helps the user to correct their error.



6. Permit easy reversal of actions:

- If the user adds a wrong product in the cart by mistake, then the user can easily reverse their action by swiping the product in the card either from left to right to vice versa.
- This feature helps easy reversal of action by the user.



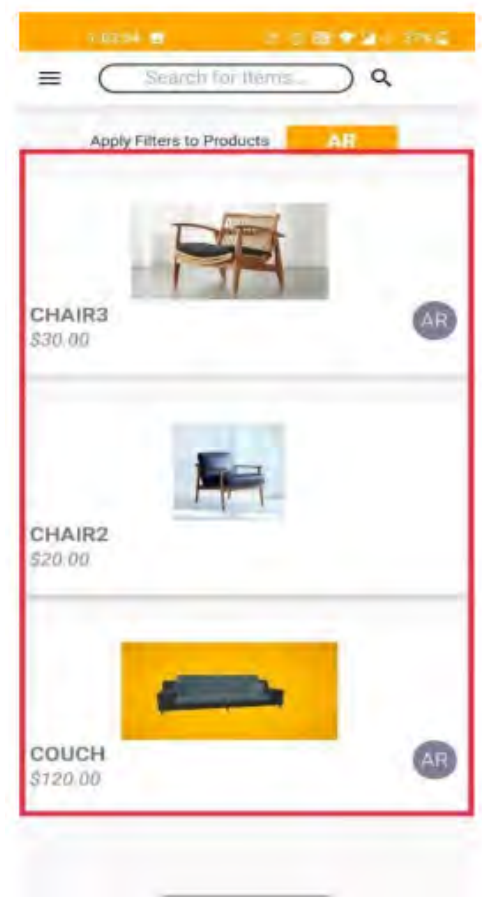
7. Supports internal locus of control:

- There are no interruptions upon opening the app.
- Actions will be performed only when user performs it.
- Anything that is not prompted by the user won't be displayed in the app.



8. Reduces short term memory load:

- The app interface is kept simple and to the point making it easier for users to use the app.
- The list of furniture is consistently displayed with similar patterns and convention.



IMPLEMENTATION

1. Register and Login Module:

- New users will be able to register to the app upon clicking on the “Sign Up” button.
- The user will have to provide their Email-ID and have to create a Password for logging in into the app or they can directly Sign In using their Google Account.
- Existing user can directly Sign In using registered Email-ID and Password.

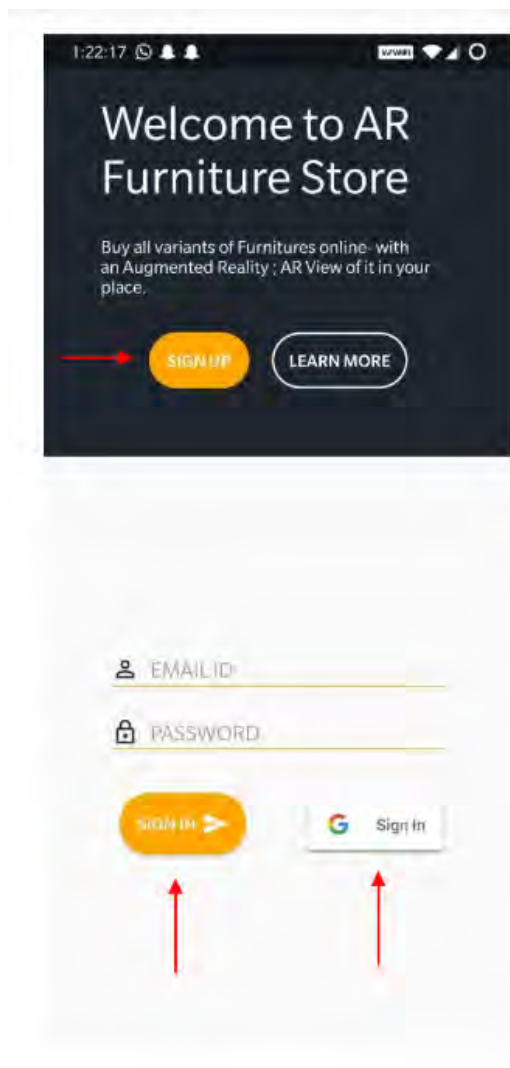


Fig 1.1

Shows the Login Page along with Sign Up button

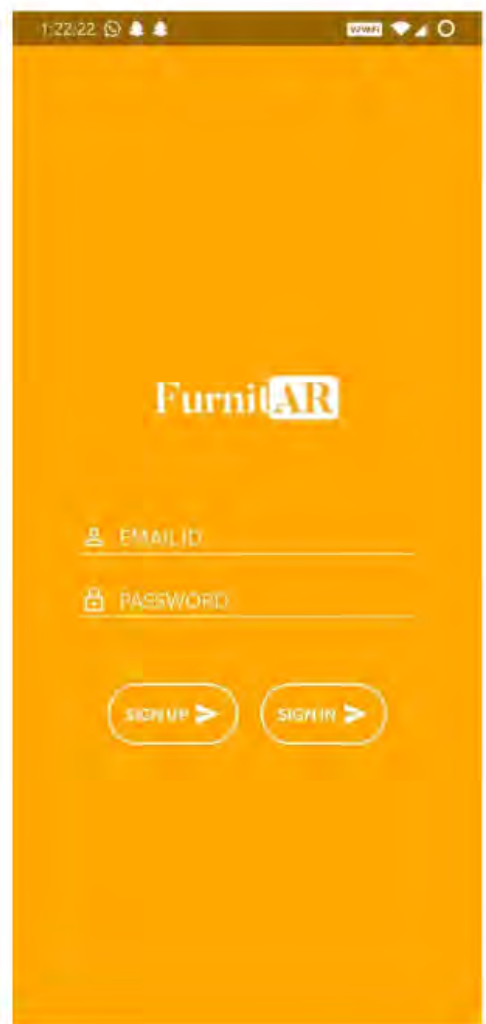
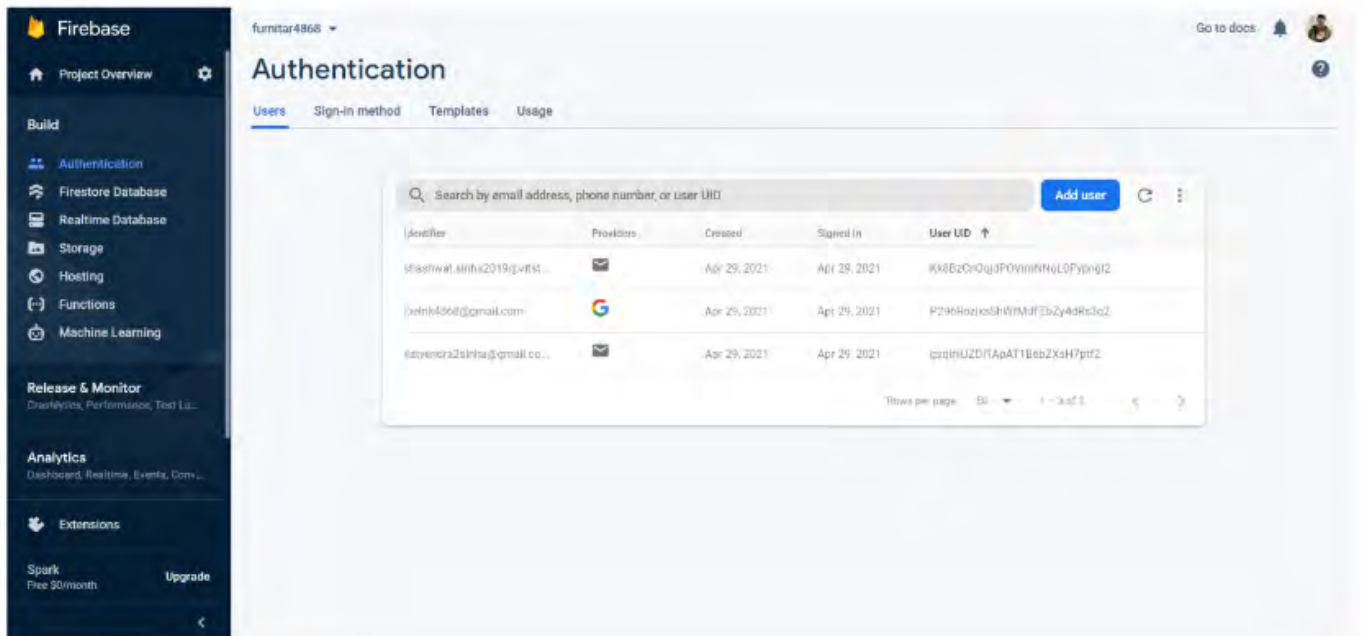


Fig 1.2

Shows the page for Registration of new user.

1.1. Google Firebase Database:

- The app is linked to Google Firebase for authentication services, where the User IDs are stored and Password of the user is encrypted.



2. Products and Filter Module:

- There might be a situation when A.R feature is not available for all furnitures.
- So, the filter button is added above the list of furnitures, clicking upon which, the furnitures in which feature is available are filtered out.

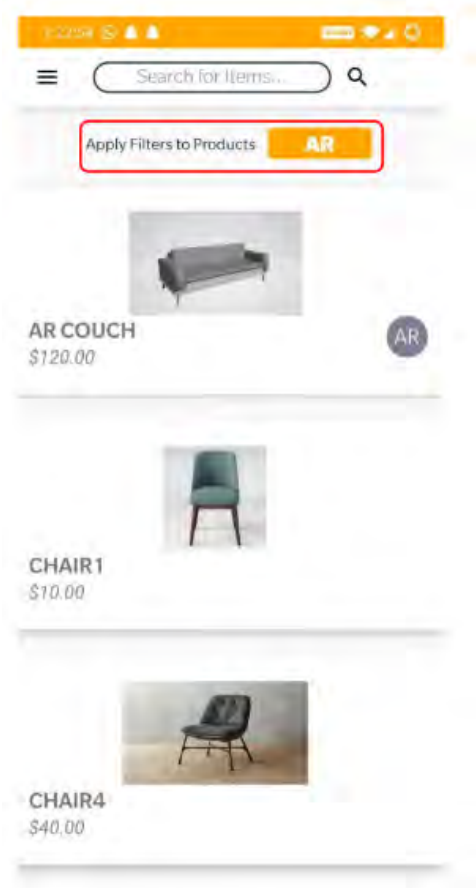


Fig 2.1

Shows the AR filter button is placed above the products

3. Search Module:

- A search bar has been added at the top of the page which display the list of furniture.
- Users will be able to type the name of the furniture in the search bar and the desired furniture will be filtered out.

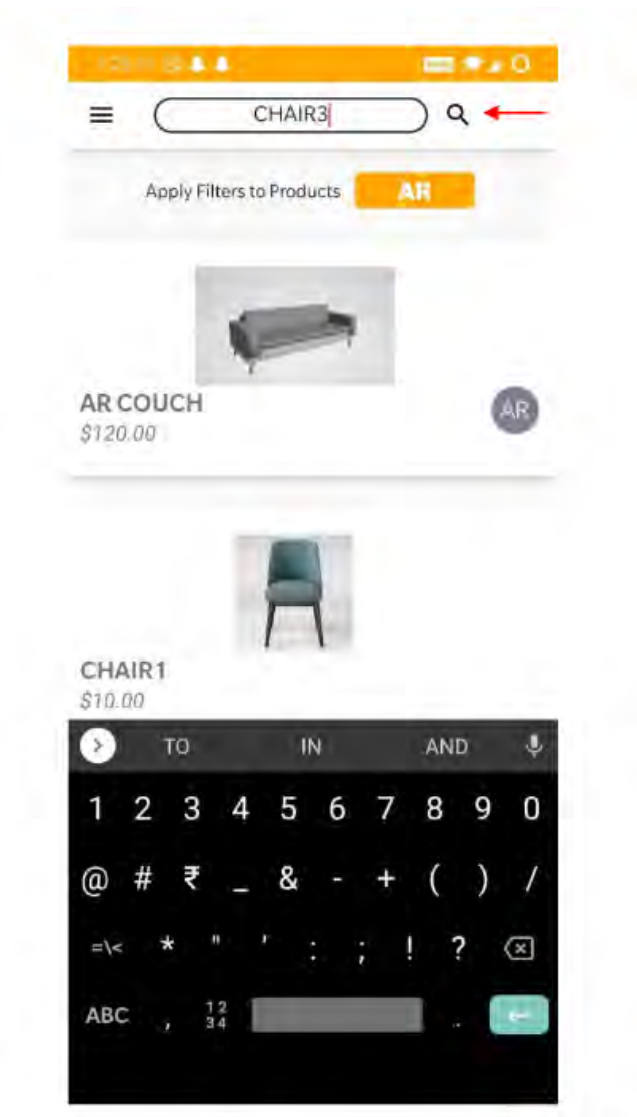


Fig 3.1
“CHAIR3” has been typed
in the search bar

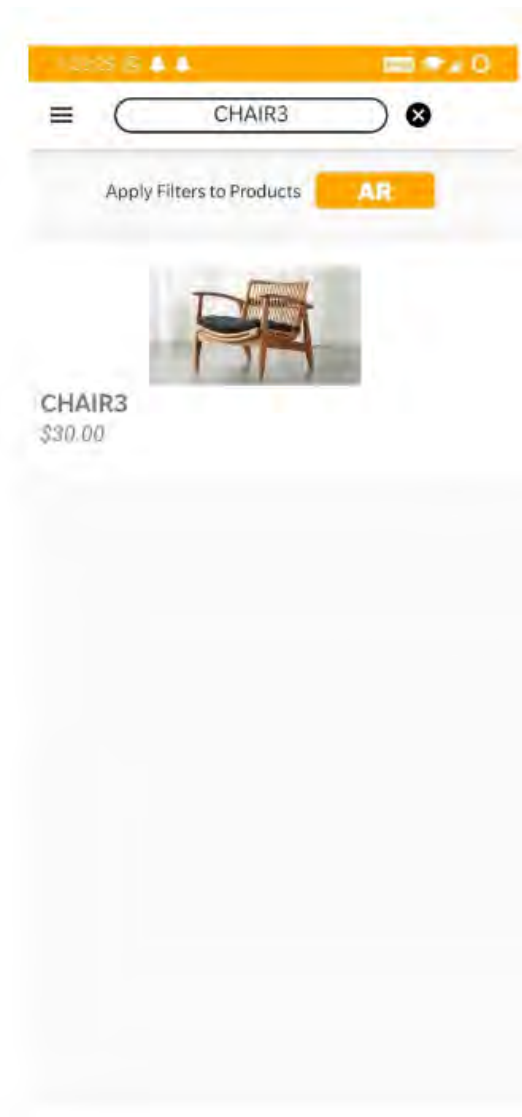


Fig 3.2 Upon clicking the
search icon “CHAIR3”
has been filtered out.

4. AR Module:

- This the defining module of our app.
- On clicking the desired furniture among the list of furnitures “View AR” button will be visible along with description and other features of the app.
- On clicking the “View A.R” button the camera opens and users can place the selected furniture in their desired places to see how it will look.

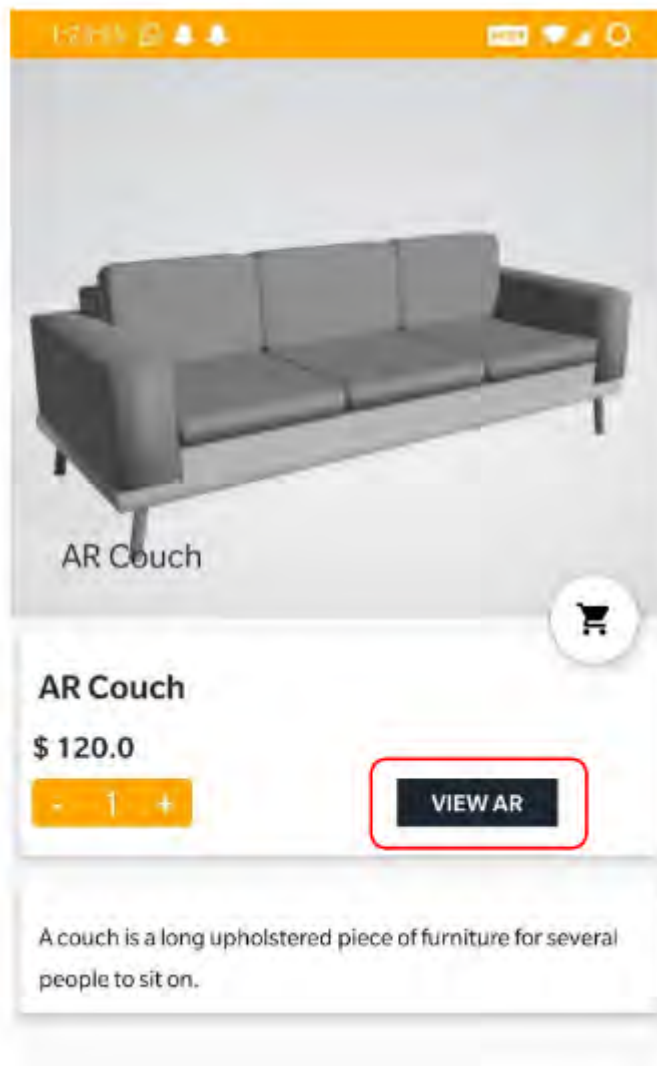


Fig 4.1
View AR button is visible
with selected furniture

5. Quantity and Add to Cart Module:

- Users can select the quantity of feature they wish to order upon clicking the desired furniture.
- Clicking on the plus sign increases the quantity by one and clicking on the minus sign decreases the quantity by one.
- After selecting the quantity, the users can click on the cart icon to add the items in cart.

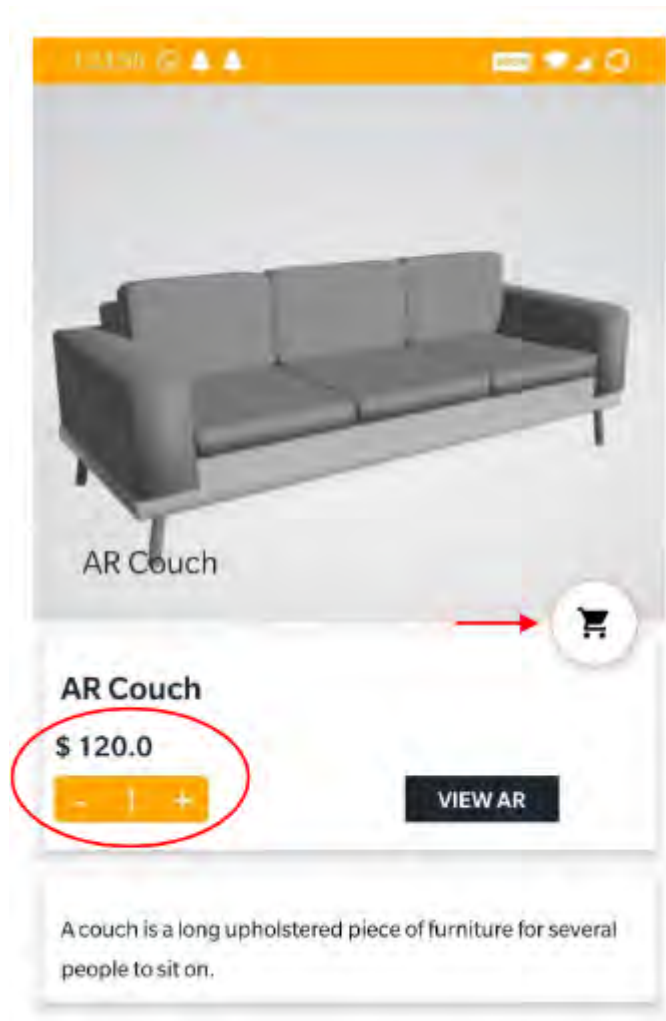


Fig 5.1

Quantity and Add to Cart option is available for selected furniture.

6. Cart and Checkout Module:

- Users can view the item they added in their cart by clicking on the “Show Cart” option.
- The total price and quantity is updated in the cart on the basis of the type of furniture and quantity selected by the user.
- Items in the cart can be deleted by just by swiping the item either left to right or right to left or “Checkout” button can be clicked if user wants to buy.

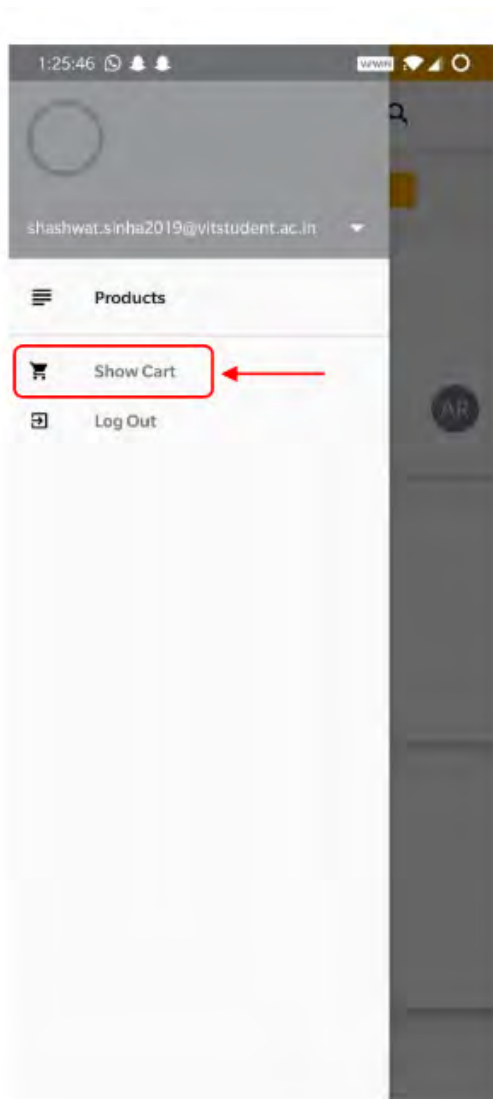


Fig 6.1

User can click on “Show Cart” to view their Cart Items

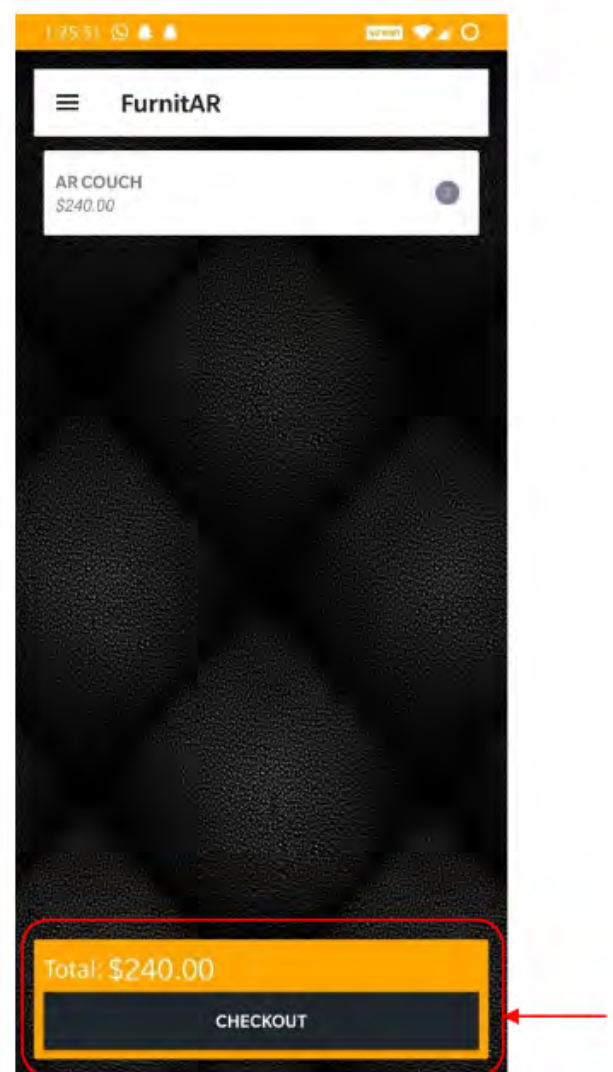
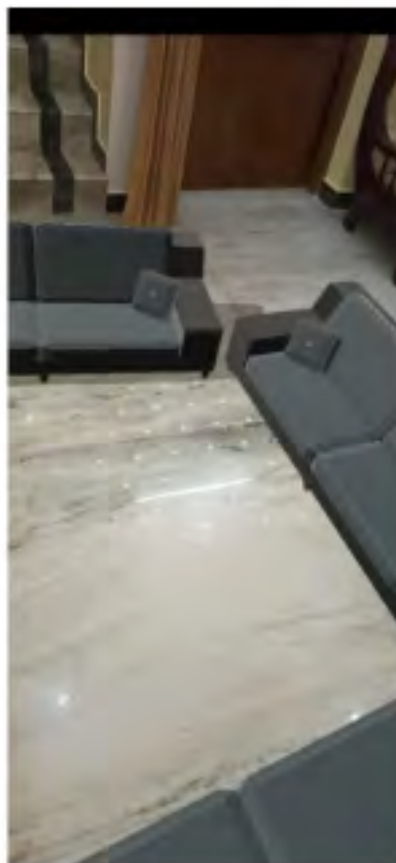


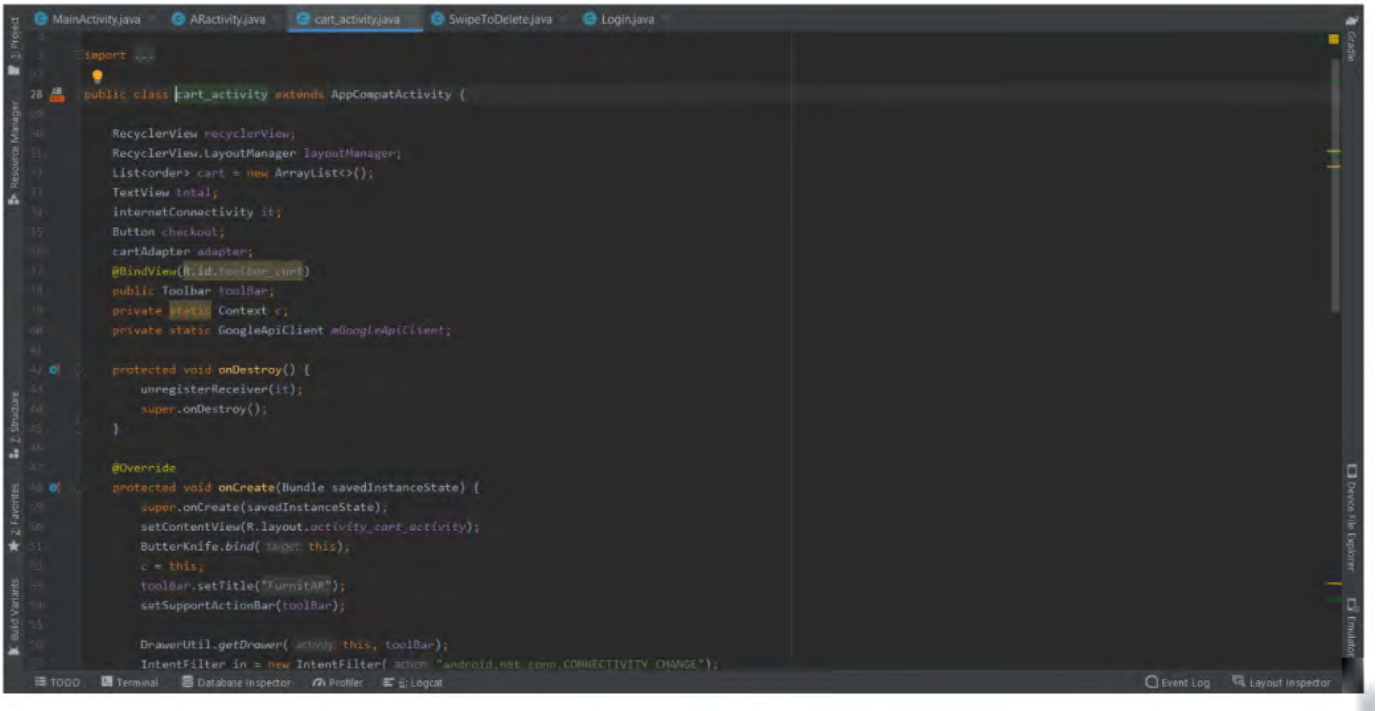
Fig 6.2

The Cart opens up, now user can either delete items or Checkout

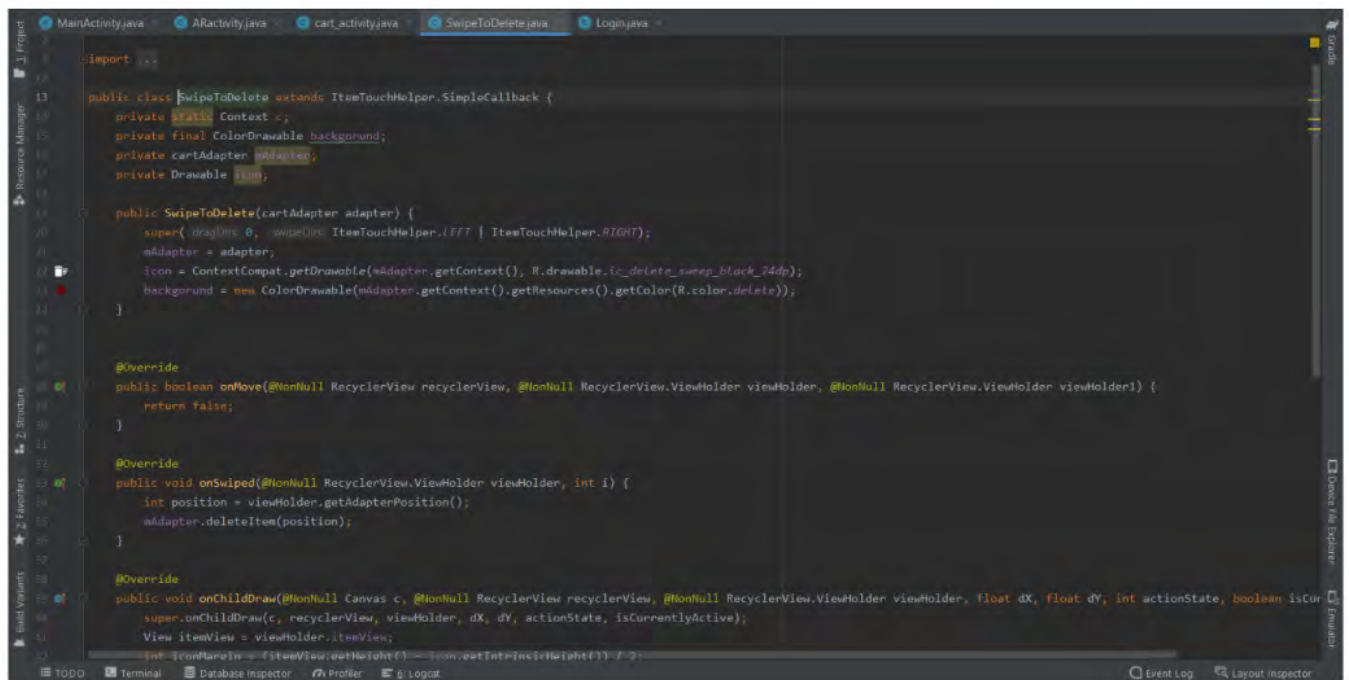
SCREENSHOTS OF AR OUTPUTS



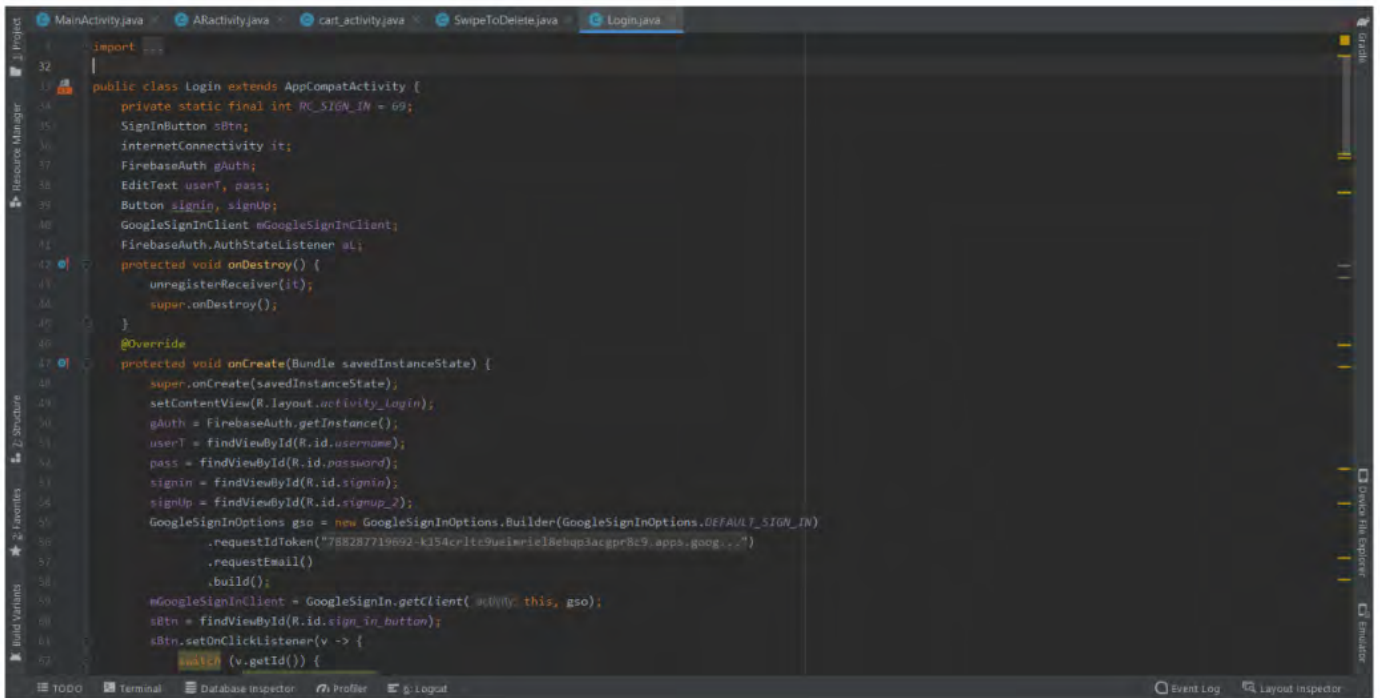
cart_activity.java



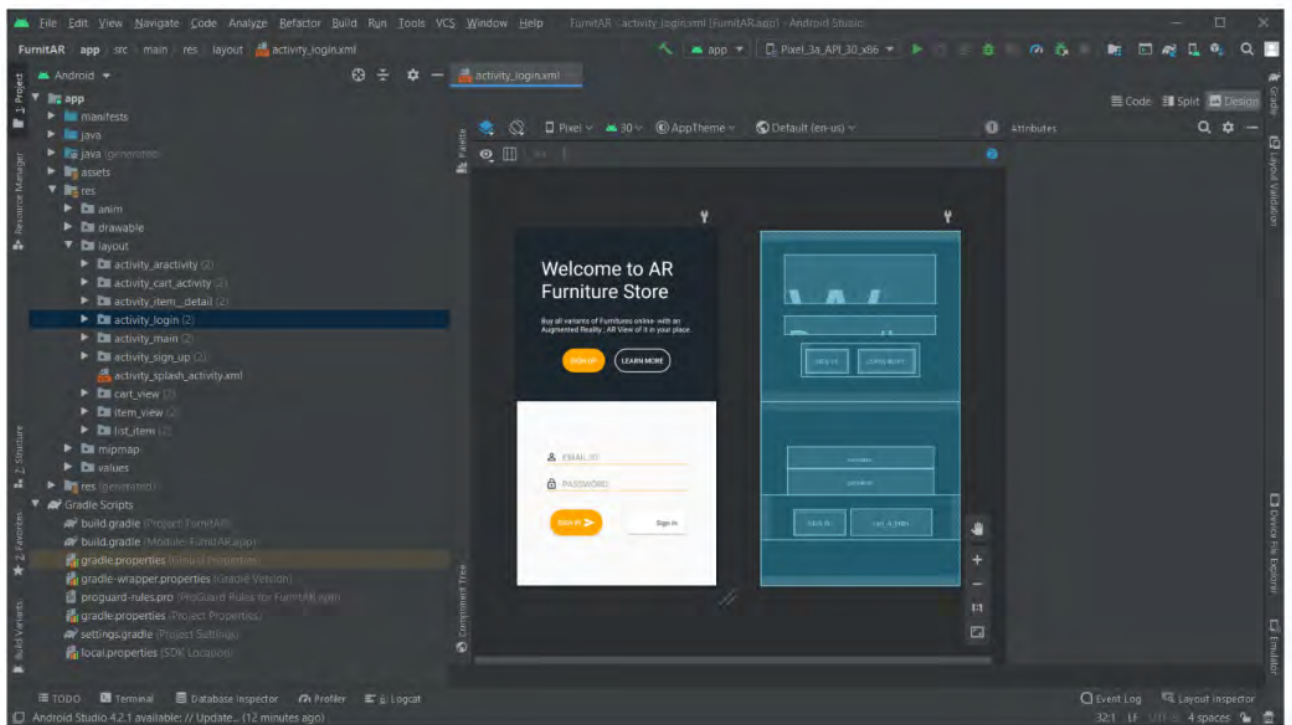
SwipeToDelete.java



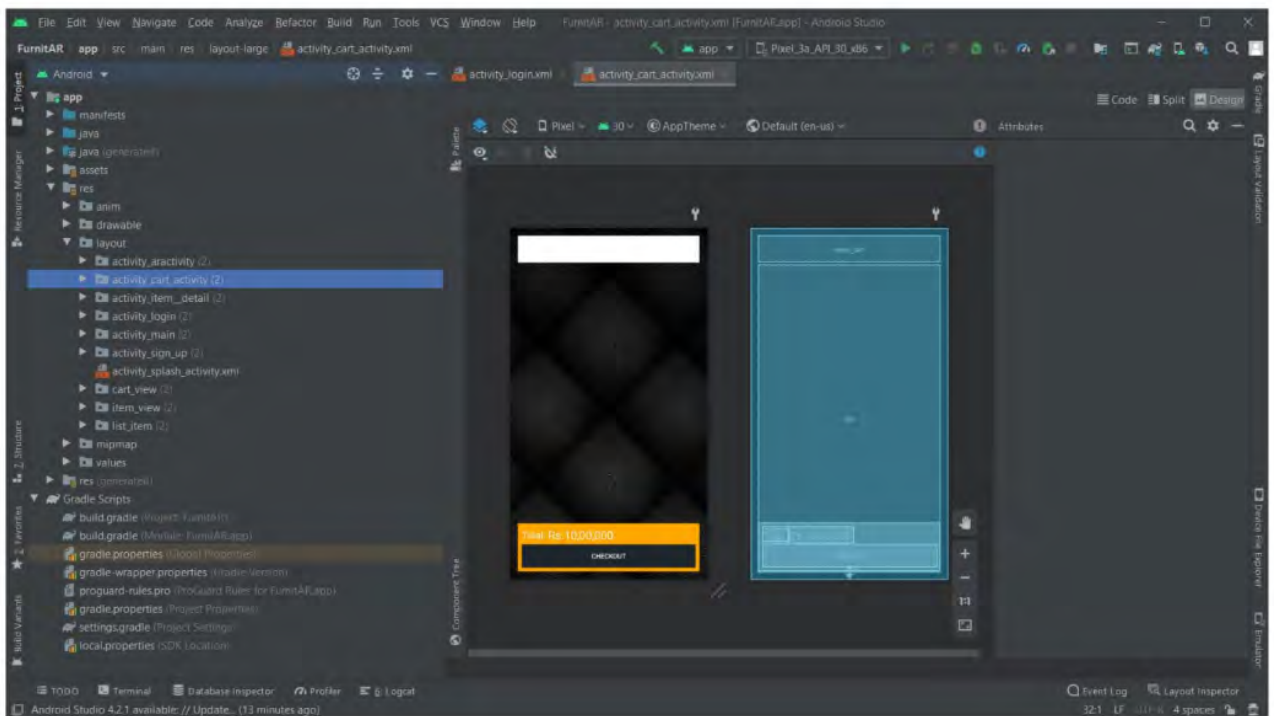
Login.java



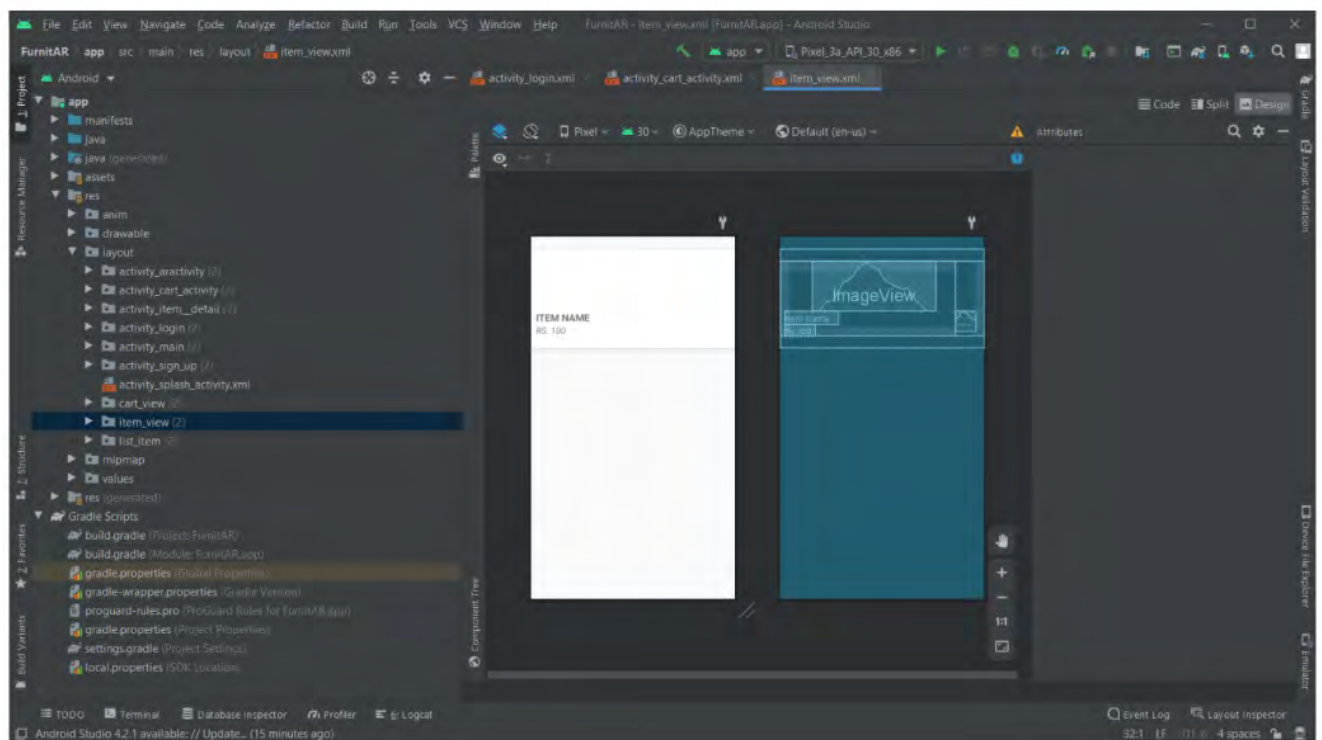
Login UI



Cart UI



Item View UI



SOFTWARE TESTING REPORT

Unit Testing

1. Test if the Email-ID is valid or not.

<i>Test ID</i>	<i>Function</i>	<i>Input</i>	<i>Expected Results</i>	<i>Actual Results</i>	<i>Pass/Fail</i>
1.1	Enter a valid Email ID	shashwat.sinha2019@vitstudent.ac.in	No error	No error	PASS
1.2	Enter invalid Email ID	shashwat.sinha	Show "Invalid Email"	Show "Invalid Email"	PASS

2. Test if Password is valid or not.

<i>Test ID</i>	<i>Function</i>	<i>Input</i>	<i>Expected Results</i>	<i>Actual Results</i>	<i>Pass/Fail</i>
2.1	Enter a valid Password	Password: System@123	Password set and login successful	Password set and login successful	PASS
2.2	Enter invalid Password	Password: sys@123	Password doesn't match.	Password doesn't match.	PASS
2.3	Enter a valid Password	Password: root123	Password set and login successful	Password set and login successful	PASS

3. Products Visibility.

<i>Test ID</i>	<i>Function</i>	<i>Input</i>	<i>Expected Results</i>	<i>Actual Results</i>	<i>Pass/Fail</i>
3.1	Select an item	Click on any item.	Item with description visible	Item with its description visible	PASS
3.2	Select an item	Click on any item.	Item with description visible	Item with its description visible	PASS
3.3	Select an item	Click on any item.	Item with description visible	Item with its description visible	PASS

4. Test the AR filter option.

<i>Test ID</i>	<i>Function</i>	<i>Input</i>	<i>Expected Results</i>	<i>Actual Results</i>	<i>Pass/Fail</i>
4.1	AR items view disable	Click the AR filter button on top.	Items without AR View displayed	Items without AR View displayed	PASS
4.2	AR items view enable	Click the AR filter button on top.	Items with AR View displayed	Items with AR View displayed	PASS

5. Test the Search Bar functionality.

<i>Test ID</i>	<i>Function</i>	<i>Input</i>	<i>Expected Results</i>	<i>Actual Results</i>	<i>Pass/Fail</i>
5.1	Enter an item name	CHAIR1	Only "CHAIR1" visible	Only "CHAIR1" visible	PASS
5.2	Enter an item name	CHAIR3	Only "CHAIR3" visible	Only "CHAIR3" visible	PASS
5.3	Enter an item name	AR COUCH	Only "AR COUCH" visible	Only "AR COUCH" visible	PASS

6. Test the add/drop Quantity.

<i>Test ID</i>	<i>Function</i>	<i>Input</i>	<i>Expected Results</i>	<i>Actual Results</i>	<i>Pass/Fail</i>
6.1	Add the quantity of selected item.	Click on the "+" button	Quantity gets added.	Quantity gets added.	PASS
6.2	Drop the quantity of selected item.	Click on the "-" button	Quantity gets dropped.	Quantity gets dropped.	PASS

7. Test the Cart functionality.

<i>Test ID</i>	<i>Function</i>	<i>Input</i>	<i>Expected Results</i>	<i>Actual Results</i>	<i>Pass/Fail</i>
7.1	Add the selected item to cart.	Click on the cart icon	Item gets added to cart	Item gets added to cart	PASS
7.2	View your cart	Click on Cart button in the profile pane.	Cart opens and view added items	Cart opens and view added items	PASS
7.3	Remove item from cart.	Swipe the item left/right	Cart item deleted	Cart item deleted.	PASS

8. Test the AR View (selected furniture)

<i>Test ID</i>	<i>Function</i>	<i>Input</i>	<i>Expected Results</i>	<i>Actual Results</i>	<i>Pass/Fail</i>
8.1	AR View of the selected furniture – couch	Click on the “ ViewAR ” button	AR View is visible.	AR View is visible.	PASS
8.2	AR View of the selected furniture – chair	Click on the “ ViewAR ” button	AR View is visible	AR View is visible.	PASS

9. Test the Checkout Function

<i>Test ID</i>	<i>Function</i>	<i>Input</i>	<i>Expected Results</i>	<i>Actual Results</i>	<i>Pass/Fail</i>
9.1	To buy the item and refresh the cart.	Click “ Checkout ” button in cart.	Refresh the app and cart items	Refresh the app and cart items	PASS

10. Test if log out is successful.

<i>Test ID</i>	<i>Function</i>	<i>Input</i>	<i>Expected Results</i>	<i>Actual Results</i>	<i>Pass/Fail</i>
10.1	To exit from your profile.	Click “ Log Out ” button in the profile options	Log out of the profile and redirect to home page	Log out of the profile & redirect to home page	PASS

Usability Testing

We carried out the Usability testing with the help of some audience we gave them the information and functions of our app and we asked each one of them to check the all the options in our system if they are working properly or not.

Usability Test Report

S. No.	Test Description	Pass/Failed	How is the interface?
1.	Click to open the app	P1: PASS P2: PASS	
2.	Enter Email-ID and Password to Login	P1: PASS P2: PASS	
3.	Home Page is visible after Logging In	P1: PASS P2: PASS	
4.	Able to select any product from the list	P1: PASS P2: PASS	
5.	Able to use the AR search filter	P1: PASS P2: PASS	
6.	Click on the search bar to enter query	P1: PASS P2: PASS	
7.	Able to search for a particular product through search bar.	P1: PASS P2: PASS	
8.	Able to select quantity after selecting a product	P1: PASS P2: PASS	
9.	Click “AR View” to see the AR View of the furniture	P1: PASS P2: FAIL	
10.	Click on the cart button to add item to cart	P1: PASS P2: PASS	
11.	Click on the top left corner for profile menu	P1: PASS P2: PASS	
12.	Click on “Your Cart” to view products in cart.	P1: PASS P2: PASS	
13.	Able to delete cart items through right/left swipe	P1: PASS P2: PASS	
14.	Click on “Checkout” to refresh your cart	P1: PASS P2: PASS	
15.	Click on Log Out to return to the main login page.	P1: PASS P2: PASS	

TEST REPORT		
EXECUTED	Passed	14
	Failed	1
	Total Test Executed (Passed + Failed)	15
Pending		0
Blocked		0



Exit Questions/User Impression

Q.1) What is overall impression of the app?

Participant 1: The app is working nicely without any bugs and has a good user experience. **Participant 2:** The application is designed very well; I feel that it has followed all the material design concept which makes it easy to find the function user is looking for.

Q.2) Do you think the app is ready to be used by the clients?

Participant 1: It can be used by the clients after adding some extra features such as Views Orders. **Participant 2:** After implementing the Checkout functionality it is ready for the clients.

Q.3) Do you have any suggestion to improve the app?

Participant 1: You can add payment options and order details module to improve the app. **Participant 2:** You have to make sure that the AR Model is featured for each user and Cart UI can also be improved.

Q.4) At any moment did you find it difficult to locate an option you were looking for?

Participant 1: Interface was good, so could find everything easily.
Participant 2: No, there was no difficulty as such.

Q.5) If you have to describe the app in 1 line. What would you say?

Participant 1: An easy to use AR/VR app for deciding the correct furniture for home/office. **Participant 2:** Very well organized app and bought out a very unique concept to visualize before buying.

CONCLUSION

This project was all about making the shopping experience of furniture buyers easier, and we can assert that with the completion of this project, we have created a prototype which can fulfill that purpose. We were able to create an app which contains 3D models of different kinds of furniture which the users can view virtually using the camera of their android smartphone. The 3D model of the furniture can be rotated and placed at any place virtually as desired by the users. If the furniture is suitable to the user, they can also select the quantity of the furniture and add it to the cart and check out subsequently.

This project was a learning curve for us as we did research taking references on the internet as to how to make such an app using Android Studio, ARCore etc. The experience while making this project has even motivated us more to think of more innovative ideas for different projects. The experience gained from this project will surely help us in creating even better projects in the future also.

Various future works are possible in this field including:

- Look into incorporating more furniture options that can be added into the cart or considered for purchase
- Incorporate advanced AR features for better visualization of furniture products
- Show more number of features of furniture items including:

- Material of furniture
- Warranty of material
- Durability
- Nearest Store
- Contact Phone
- Contact Email
- Look at possible applications of Artificial Intelligence to recognize behavioural patterns of user including purchasing patterns to decide a competitive price
- Build a chatbot to assist the user as they use the application

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AR and VR Based FURNITURE STORE

Anirudh Saxena(19BCE2449), NishantDiddigi(19BCE2498), Jeet Bangoria(19BCE0874), Dr Swarnalatha P.

Abstract—The aim of our project is to improve the customer experience for buying furniture from an online furniture store. In some cases, after buying furniture customers realize that the furniture size is not suitable for their house or its design doesn't match with the interior of the house. This project will help the customers visualize that how a particular furniture looks like when kept in their house and will also give the customers an idea if it can be perfectly placed in the desired area of the house. Augmented Reality shall be used to achieve the goal. The customers could also select the furniture they wish to buy by visualizing their demo furniture setup using Virtual Reality.

I. PROBLEM STATEMENT

- Most of the people do not get the furniture of desired dimension.
- People usually buy furniture on the basis of its quality, comfort, design and size (descending order of priority).
- The people would like to verify how the furniture looks and if it fit in the desired area, they want to keep it in.
- Amidst this pandemic situation people will refrain from going out and visiting the shops.
- So, we intend to cater the above-mentioned problems through an interactive AR and VR app.

2. INTRODUCTION

Augmented reality (AR) and Virtual Reality (VR) bridge the digital and physical worlds. They allow you to take in information and content visually, in the same way you take in the world. AR dramatically expands the ways our devices can help with everyday activities like searching for information, shopping, and expressing yourself. Over the last few years, we've seen apps that entertain, engage, and help people in different ways – from letting fans interact with their favorite characters, to placing virtual electronics and furniture for the perfect home setup and beyond.

Raw Depth API enables more improved geometry, accurate depth measurements and spatial awareness. In the ARConnect app, these more accurate measurements give users a deeper understanding of their physical surroundings. The AR Furniture Store App utilizes raw depth's spatial awareness to allow users to build realistic virtual 3D furniture around their desired area and allows scene reconstruction

3. HARDWARE AND SOFTWARE REQUIREMENTS

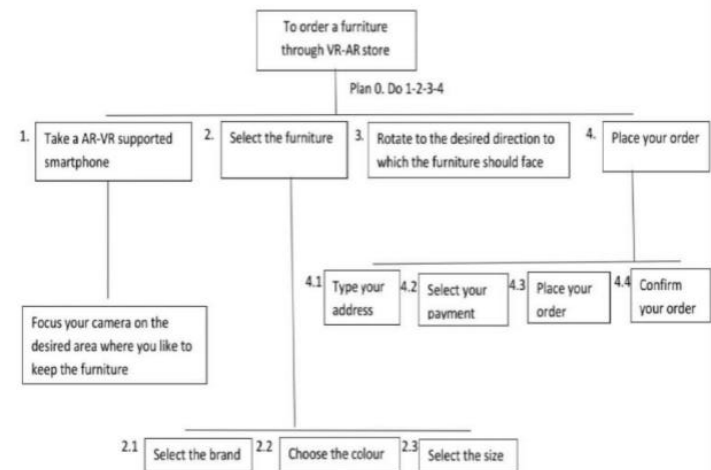
. Based on the responses of the people in the survey conducted, the following hardware and software will be adopted to carry out the android app development project work.

1. Google Poly: To import the 3D Module of the furniture.
2. AR Core: For adding AR/VR Module to the App.
3. Sceneform SDK: For adding AR/VR Module to the App.
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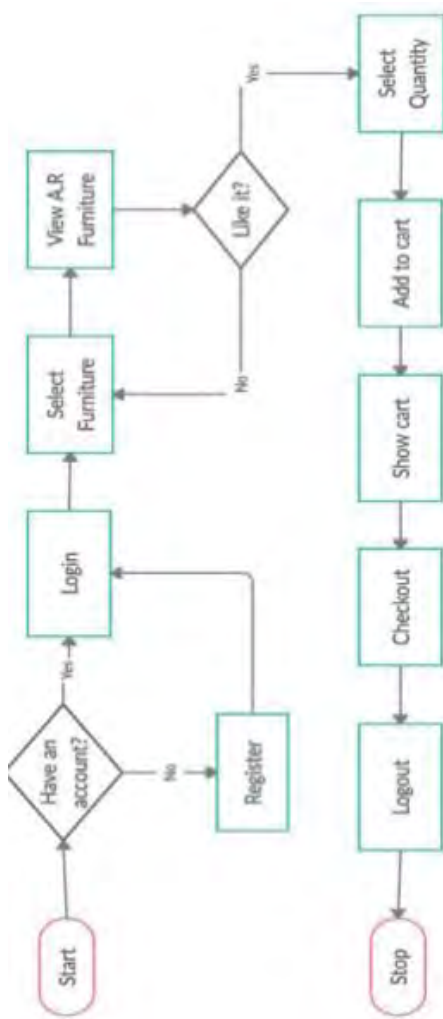
5. Google Firebase: To store user database and app info.
6. Google Firestore: To store the real time database of variety of furniture.
7. Android Studio: For developing App interface as well as backend.
8. Android Emulator: For temporarily previewing the App.
9. Android Smartphone with Camera: To run the App

4.HIERARCHICAL TASK ANALYSIS

Based on the requirements of the people, the goals and subgoals were identified and the following HTA was concluded



5. STATE TRANSITION DIAGRAM



6.COMPATIBILITY WITH SCHNEIDERMAN’S 8 GOLDEN RULES

1. Strive for Consistency:

- Collection of different furniture is displayed in similar manner.

- The names and prices of different furniture are displayed in similar font type, size and colour, indicating that they mean the same thing, i.e., name and price of furniture.

2. Enables frequent users to use shortcuts:

- Generally, quantity of a product is selected after adding it to cart. So, to make the usage of the app simpler for frequent users I have added the quantity button beside the description of the furniture.

- The customers could directly select the quantity and add to cart where the quantity will be updated along with the total price accordingly.

3. Offers informative feedback:

- The icon given in the picture depicts a hand holding the phone.

- This icon rotates before generating the A.R model, informing the users that how they should hold the phone and how to rotate the phone to generate the A.R model of the furniture

4. Design dialogs to yield closure:

- After the customers selects the quantity and clicks on the cart icon, i.e., when they add items to the cart a dialogue shows up displaying “Item added to cart”.

- This give a peace of mind to the user that the task which they wanted to do is completed successfully.

5. Of users simple error handling:

- If a wrong email id or password is entered by the user, A red colour icon containing exclamation mark displaying the message “Invalid email” or “Invalid Password” pops up beside the text field. This give a peace of mind to the user that the task which they wanted to do is completed successfully.

- This helps the user to correct their error.

6. Permit easy reversal of actions:

- If the user adds a wrong product in the cart by mistake, then the user can easily reverse their action by swiping the product in the card either from left to right to vice versa.

- This feature helps easy reversal of action by the user.

7. Supports internal locus of control:

- There are no interruptions upon opening the app.

- Actions will be performed only when user performs it.

- Anything that is not prompted by the user won't be displayed in the app. 8. Reduces short term memory load:

- The app interface is kept simple and to the point making it easier for users to use the app.

- The list of furniture is consistently displayed with similar patterns and convention.

7.IMPLEMENTATION

1. Register and Login Module:

- New users will be able to register to the app upon clicking on the “Sign Up” button.

- The user will have to provide their Email-ID and have to create a Password for logging in into the app or they can directly Sign In using their Google Account.

- Existing user can directly Sign In using registered Email-ID and Password.

1.1. Google Firebase Database:

- The app is linked to Google Firebase for authentication services, where the User IDs are stored and Password of the user is encrypted.

2. Products and Filter Module:

- There might be a situation when A.R feature is not available for all furnitures.

➤ So, the filter button is added above the list of furnitures, clicking upon which, the furnitures in which feature is available are filtered out.

3. Search Module:

➤ A search bar has been added at the top of the page which display the list of furniture.

➤ Users will be able to type the name of the furniture in the search bar and the desired furniture will be filtered out.

4. AR Module:

➤ This the defining module of our app.

➤ On clicking the desired furniture among the list of furnitures “View AR” button will be visible along with description and other features of the app.

➤ On clicking the “View A.R” button the camera opens and users can place the selected furniture in their desired places to see how it will look.

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➤ Users can select the quantity of feature they wish to order upon clicking the desired furniture.

➤ Clicking on the plus sign increases the quantity by one and clicking on the minus sign decreases the quantity by one.

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This project was all about making the shopping experience of furniture buyers easier, and we can assert that with the completion of this project, we have created a prototype which can fulfill that purpose. We were able to create an app which contains 3D models of different kinds furniture which the users can view virtually using the camera of their android

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XXX-X-XXXX-XXXX-X/XX/\$XX.00 ©20XX IEEE AR and VR Based FURNITURE STORE
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Products and Filter Module: There might be a situation when A.R feature is not available for all furnitures. ? So, the filter button is added above the list of furnitures, clicking upon which, the furnitures in which feature is available are filtered out. 3. Search Module: ? A search bar has been added at the top of the page which display the list of furniture. ? Users will be able to type the name of the furniture in the search bar and the desired furniture will be filtered out. 4. AR Module: ? This the defining module of our app.

? On clicking the desired furniture among the list of futur“View bu n will be visible along with description and other features of the app. ? Onclick e A.R” ttonthe os and users can place the selected furniture in their desired places to see how it will look. 5. Quantity and Add to Cart Module: ? Users can select the quantity of feature they wish to order upon clicking the desired furniture. ? Clicking on the plus sign increases the quantity by one and clicking on the minus sign decreases the quantity by one. ? After selecting the quantity, the users can click on the cart icon to add the items in cart. 6.

Cart and Checkout Module: ? Users can view the item they added in their cart by click on e w op. ? The total price and quantity is updated in the cart on the basis of the type of furniture and quantity selected by the user. ? Items in the cart can be deleted by just by swiping the itemeithlefto igor ightto t r eckt” tton can be clicked if user wants to buy 8.CONCLUSIONS This project was all about making the shopping experience of furniture buyers easier, and we can assert that with the completion of this project, we have created a prototype which can fulfill that purpose.

We were able to create an app which contains 3D models of different kinds furniture which the users can view virtually using the camera of their android smartphone. The 3D model of the furniture can be rotated and placed at any place virtually as desired by the users. If the furniture is suitable to the user, they user can also select the quantity of the furniture and add it to the cart and checking out subsequently. This project was a learning curve for us as we did research taking references on the internet as to how to make such an app using Android Studio, ARCore etc.

The experience while making this project has even motivated us more to think of more innovative ideas for different projects. The experience gained from this project will surely help us in creating even better projects in future also. Various future works are possible in this field including: be added into the cart or considered for purchase

visualization of furniture products more number of features of furniture items including recognize behavioural patterns of user including purchasing patterns to decide a competitive price application REFERENCES [1] Khairnar, K., Khairnar, K., Mane, S., & Chaudhari, R. (2015)BFurniture **Layout Application Based on Marker Detection and Using Augmented Reality** [2] Riar, M., Korbel, J. J., Xi, N.,

Zarnekow, R., & Hamari, J. (2021) The Use of Augmented Reality in Retail: A Review of Literature [3] Gallardo, C., Rodríguez, S. P., Chango, I. E., Quevedo, W. X., Santana, J., Acosta, A. G., ... & Andaluz, V. H. (2018). Augmented Reality as a New Marketing Strategy [4] K Wiley 2017. **From Your Phone To Your Home: An Augmented Reality Brand Experience for High-End Furniture** [5] Viyanon, W., Songsuittipong, T., Piyapaisarn, P., & Sudchid, S. (2017). **AR Furniture: Integrating Augmented Reality Technology to Enhance Interior Design using Marker and Markerless tracking** Make sure to remove all placeholder and explanatory text from the template when you add your own text.

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