Grenze International Journal of Engineering and Technology, June Issue

Virtu Decor: Redefining Home Aesthetics through AR

Ajith Kumar BP[1], Nagarjun Patgar[2], Sharat Naik[3], Sriharsha[4] and Joshua Joseph Fernandes[5]
[1-5]Department of Information Science and Engineering, Canara Engineering College, Mangalore, 574219, Karnataka, India
Email: bpajit@canaraengineering.in, arjunpatgar@gmail.com, sharatnaik109@gmail.com, shreeharsha1122@gmail.com, joshuafernandes020@gmail.com

***Abstract*— In the early days, we had to visit a furniture shop to purchase furniture, because it was not possible to determine how the item looks and fit in home construction. At present, our proposed framework says that, users can place furniture objects on a floor just by sitting at home. The main cause for our "VirtuDecor" project is in order to progress an Android application for trying out distinct furniture and wall paint virtually by the use of transportable systems that supports AR cameras. This app will reduce the amount of time that people must spend on traveling to the furniture store, which is a very tiresome task. Additionally, it might be more easier to incorporate this method into online buying so that customers can see how furniture looks in their room and also see if will it fit in the space in the room. All in all, this framework will help the customer with an analysis of furniture objects. With the help of this framework, users may practically experiment with different combinations of articles without having to create furniture pieces themselves. These will assist the buyer in choosing how to set up furniture while building a new home.**

***Index Terms*— Interior design, AI, Augmented reality, Flutter, Google Augmented Reality Core, Three-Dimensional Object, Furniture.**

I. INTRODUCTION

The words "augmented reality" (AR) refers to an enhanced or expanded version of reality. While digitally projected or visually integrated virtual items or contextual information remain visible to the user, their actual surroundings are still perceived. AR is limited by the quality of internal processing of data and virtual content visualization. Users experience no delays because that occurs concurrently. Real-time interaction when using AR application is ensured by doing this. AR systems must provide accurate information about the actual world fast. This is made possible via gyroscopes, cameras, sensors, and other parts. Platforms, applications, and other smart technologies receive this real-world data, which is processed and occasionally augmented by artificial intelligence (AI). It is feasible for customers to acquire furniture items from the comfort of their own homes using our suggested framework in place of going to stores. The main reason for developing our project is to provide users with a tool to try out furniture objects virtually with the help of augmented reality. If a person wants to replace the purchased furniture it will not be cost-efficient, so trying out furniture before purchasing it will be beneficial. also, people can't physically try out different designs because it is not easy to do it easily, it takes a lot of human labour and transport charges. Additionally, it might be easier to incorporate this strategy into online buying so that customers can try out the furniture pieces for their room.

II. RELATED WORKS

[1] Envisioning the interior design of a room before it is built or constructed is such a tough job for any person.

Grenze ID: 01.GIJET.10.2.243

An application of AR technology to interior design is shown by V. T. Phan and S. Y. Choo. In addition, a project on educational interior design is examined. Architectural projects now demand virtual information strategies in addition to the rapidly advancing digital technologies. Therefore, the digital disciplines of building and architectural design may benefit greatly from the emerging technology known as augmented reality.

[2] One of the problems with online purchasing is that buyers sometimes struggle to picture new furniture items looking at home. However, with the growing popularity of Augmented Reality (AR), Paper [2] Sandu M, & Scarlat I S. examines a number of augmented reality applications used for interior design and listed down their benefits and drawback and suggests an AR application that addresses the majority of the present problems with interior space design based on this investigation.

[3] Architecture and urban design depend on a same process that comprises of collection of data, Analyzing, decision in design, imagination, and evaluation. So, in this paper [3], Jishtu, P & A Yadav M. are discussing about AR and VR tools that are created to accompany the global change for saving time. Time is the resource that is very difficult to control or to get back. But it can make our work productive when it is used with automation. Architecture and Designing tools were introduced so that it can help to generate multiple design options and provide many other possibilities.

[4] In paper [4] Gubbala, Sai Bhavan, et al made a application which offers a framework that enables individuals to use application of AR for online shopping. Using Google AR services and Android Studio, this application be improved to have a higher level of performance based on the study's findings. This might be accomplished by identifying surfaces such as walls and ceilings so that the application can reliably show 3D objects on them.

[5] An augmented reality (AR) furniture design tool that lets a user observe and to change size and material of their 3D virtual furnishings in the real world is described in this Paper [5]. Human body movements can be tracked by using Kinect. The occlusion of virtual and actual objects at various levels is taken into consideration to improve the realistic feel of the system. An technique for calibration was created to ascertain the depth, infrared, and RGB picture information of Kinect in order to enhance the quality of images in AR settings. Features for customizing furniture are offered to enhance the user experience. According to user testing, users thought the furniture customization system based on augmented reality was realistic and organic.

[6] The study and development of apps that use augmented reality (AR) in design and production is examined in Paper [6]. It is divided into seven primary sections. The history of manufacturing simulation apps and their early development is covered in the first part. The second section provides an overview of the available AR gear and software. A variety of studies on design and manufacturing operations are included in the third segment, which includes the following: B. Collaborative AR design, robot path planning, maintenance, plant layout, CNC simulation, and assembly using AR tools and methodologies.

[7] In reference paper [7] ,the researchers used 383 valid datasets and empirically tested their results using partial least squares structural equation modelling (PLS-SEM). The outputs show that AR features have a remarkable impact on customer expectations. Furthermore, the attitude toward augmented reality is directly correlated with perceived functional utility and trust in AR, and the intention to embrace AR applications is correlated with these factors indirectly. Therefore, this study shows the business implications of retailers using AR technology as an interactive medium to improve user’s experience when shopping online now and post-pandemic. Additionally, support for user privacy and government control of digital infrastructure is anticipated to facilitate the industry's adoption of AR.. Furthermore, this study also contributes to theoretical developments in the field of AR implementation, interactive marketing, and consumer behaviour.

[8] Recently, AR (augmented reality) has drawn a lot of interest from mobile shopping apps, especially in the furniture and design categories.[8] The relative position of atomic 3D components in a physical world is the main concern of app developers. The composition of complex 3D objects in accordance with user requirements and environmental restrictions is disregarded by this focus. We offer a model-based strategy based on the idea of flexible software product lines to enable AR-assisted product composition in order to overcome these difficulties. Our method divides a product, like a table, into components, such the top, legs, and decorations, each of which has its 3D shape and other information, like the name and price. Feature models hold the goods that can be built using these components.

[9] Technology utilizing augmented reality (AR) generates new immersive experiences for social networking, playing games, education, retail, and entertainment. It can be challenging to obtain AR content non-visually because it is frequently predominantly visual in nature and combines virtual and actual stuff. By examining currently available AR mobile apps for iOS, Authers identify frequent tasks for AR and define the design space of activities that call for accessible alternatives. In order to learn more about the opinions of ten visually impaired participants about accessible augmented reality, they created accessible alternatives for every main task category.

[10] In the modern era of digital transformation, the biggest challenge when selling furniture online is convincing customers whether the furnishings, they select is suitable for different usage circumstances. When purchasing furniture, buyers should ensure that furniture's model, dimensions, colors are suitable & harmonious with the place in which furniture will be arranged. To successfully sell furniture online, you need to solve these problems. This is possible using augmented reality Google AR services and Android Studio will be used to finish this investigation. To attain better performance levels, it is advised to make improvements to this application based on the research findings.
[11] More effective process development is one of the key factors for a company's survival and increases its competitiveness in the market. For decades, industry has sought out computer tools to develop and improve manufacturing processes. augmented reality is the subject of new research and the development of industrial applications. In contrast, its use in this environment is less common. To understand this behavior, this paper proposes a literature review to identify the applications of this technology in industrial settings
[12] Human interaction with virtual and real-world objects is made possible by technological advancements in information and technology. Real-time integration of digital information with the user's surroundings is possible because to technologies like augmented reality (AR). It overlays the user's perception of the actual world with data, artificially created visuals, and other virtual items. This article [12] suggests utilizing the augmented reality-based technology "AR Furniture App" to design and assess his and Android apps. To match AR material to naturally occurring features found in your surroundings, use the Kudan SDK. With the help of this software, users can see how furniture will appear in real life and get a sneak peek at furniture placed in actual settings. Furniture sellers can obtain a competitive edge in the His industry by utilizing this Her application. This system also allows customer to try visualization of furniture placement in his available space before purchase, resulting in loss of sales for business and damage to service provider's brand image. to prevent customer defection and deterioration of stakeholder interests.
[13] An overview of the Tinmith-Metro simulation system's features is provided in this article [13]. The system is built on outdoor mobile augmented reality technology. A new user interface for the system is implemented using tracked pinch gloves in conjunction with a set of methods known as "remote design" to capture and generate 3D geometry. Users use hand and head movements to control the modeling process and achieve modeling accuracy according to user requirements. Tinmith-Metro allows users to model external geometries depicting structures and landscape elements in a naturalistic way.
[14] Technology, ARpm (Augmented Reality for polygonal modeling), is a prototype. It was designed to be a front end for his commercially accessible 3D animation application, 3D Studio Max, and doesn't need to be altered by locked software.[14] A head-mounted display (HMD) allows the user to view the modeled object as a three-dimensional extension of user's physical surroundings. Like the modeling toolset in 3D Studio Max, this item can be managed using a tangible interface consisting of a wireless pointing device and marker box. This technology uses a variety of sophisticated 3D geometrical modeling tools that are supplied by the user's 3D Studio Max to place his 3D model in the client's world as opposed to virtual reality, which immerses the client in a virtual world.
[15] With the use of furniture geometric form extraction, model feature space creation, model information hierarchy research, and product image simulation quantity theory, this paper [15] addresses the ambiguity and complexity of information about design in furniture modeling. Semantic feature analysis in furniture modeling, investigating mapping relationships between visual images and model elements, and developing quantitative representations of furniture style attributes based on semantic features, mapping relationships, and modeling features.
[16] In reference Paper [16], work is on a mobile augmented reality model system which can create on-the-spot augmented reality model 3D virtual objects is proposed. The suggested system differs from the current ones in that it uses an interaction technique to produce and modify primitives and adds features like a multi-freezing mode and a shadow to effectively construct realistic augmented reality contents.

III. System Requirements

The furniture application requires the Android smartphone to exceed its minimum requirements for operation. Authorization for local storage is necessary for saving images or videos within the application. Although the application can run on smartphone that do not exceed the system requirements, it is advisable to meet the minimum hardware and software requirements to prevent crashes and overheating. The mentioned requirements are essential for executing the project as the flutter, which utilizes the Dart language, undergoes change in syntax with version updates.

TABLE I APPLICATION REQUIREMENTS

S. No.	Software/Hardware	Version/Disk Space
1.	Random Access Memory	8GB
2.	Read-Only Memory	30GB
3.	Operating System	Windows 11/MAC OS Catalina or higher
4.	Android Studio Version	4.1 or higher
5.	Android Emulator	7.0 or higher
6.	Flutter SDK	2.2.3 or higher
7.	Kotlin	1.7.2.0
8.	iOS	13.3 OR higher

IV. SYSTEM ARCHITECTURE

Once the application is launched, users can browse through the furniture catalog and select the desired item. Using the AR mode, users can preview the furniture and use the controls to customize its placement, size, and orientation. After customizing the product, users have the option to capture a video or photo.
The architectural diagram provides an overview of the application's design and Fig 1 Shows the Architecture Diagram of proposed system

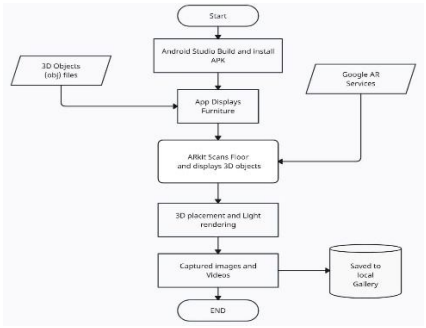

Fig. 1: Architecture Mapping

V. PROPOSED SOLUTION

The "VirtuDecor : Redefining Home Aesthetics Through AR" project aims to revolutionize the furniture shopping the core feature of our proposed solution is the integration of AR cameras within the mobile application. This allows users to superimpose virtual furniture objects onto their actual living spaces, enabling them to see how each piece fits and complements their existing home construction. Users can experiment with different furniture arrangements virtually, gaining insights into optimal placements without the need for physical movement of furniture items. This feature empowers users to make informed decisions about the layout and design of their living spaces. Our proposed framework seamlessly integrates with online furniture shopping platforms. Users can preview potential purchases within the app, ensuring that selected items not only suit their style but also fit harmoniously within their homes

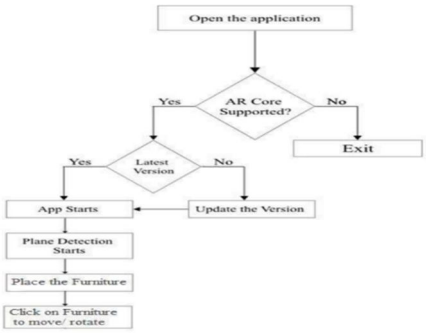

Fig 2: Use Case Diagram

Use case diagram for the system as follows in Fig 2. This diagram shows the flow of activity while using the application. AR Core support is necessary for using application.
To enhance interior using Augmented Reality (AR), follow these steps:
1. Scan Environment: Use AR technology to scan the interior space.
2. Digital Overlay: Overlay digital elements like furniture or decor onto the real-world view.

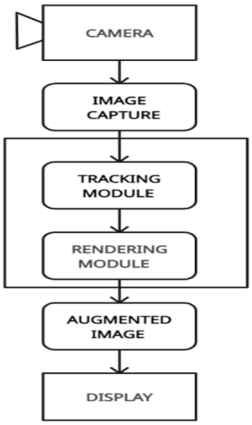

Fig. 3: Block Diagram

3. Interaction Design: Implement interactive features for users to customize and place virtual items.
4. Real-time Rendering: Ensure real-time rendering for a seamless integration of virtual and real elements.
5. User Interface (UI): Design an intuitive UI for users to navigate and control the ARenhanced interior.
6. Compatibility: Ensure compatibility with AR devices or mobile apps for widespread accessibility.
We wanted to create a prototype for furniture placement using Unity along with AR core but it presented more disadvantages than advantages in comparison to the Flutter. The application built in Unity lacked the ability to scan and project objects in real-time as well as needed a pre scanned map of the surrounding environment. On the other hand, Flutter utilized the Dart, which facilitated UI development with pre-built widgets. During the development process, challenges arose due to outdated Java development kit versions, high power usage, and cache limitations in memory. By enhancing the source code with Kotlin and optimizing cache management, we were able to address compatibility issues, reduce device overheating, and improve object placement on LiDAR-enabled devices.

VI. METHODOLOGY

Stage 1: During the initial stage,3D models and required data are collected for program. To display each item in the catalogue, the program requires a 3D model in GLFT file format. These models were obtained from halorenders.com, a website that offers models in different formats. Although the application does not have a physical store for experimental purposes yet, the acquisition of models was still necessary. Various types of furniture, including chairs, dining sets, and coffee tables, were acquired to explore a wide range of options.
Stage-2: The GUI of the application is composed of numerous pages, such as a homepage, a class page, and a product information page. During the development process, the primary focus was on ensuring that the interface is user-friendly, while also incorporating modern design principles. Throughout the creation of the Interface, great emphasis was placed on maximizing user-friendliness and adhering to contemporary design concepts.
Stage-3: Following the collection of product data, a user-friendly interface was made to enhance the process of showcasing the three-dimensional model. The software's utilization of GLB models resulted in an exceptional level of quality, evident in both the vibrant colours and realistic textures. The accuracy of the lighting estimation is reflected in the AR fragment, which accurately portrays the chair's reflections and shadows. Thanks to the implementation of Physically Based Rendering (PBR), the furniture’s leather material exudes a glossy appearance. Considering that the model was created in real-time, its complexity level can be deemed as average. With more powerful equipment it will be possible to create models with even greater complexity.
Stage 4: Augmented Reality Core, an essential component for our project, remains inaccessible. This feature utilizes the built-in camera of device and is compatible with all Google smart devices, enabling the execution of programs. By leveraging the camera's capabilities to display furniture in augmented reality, a tangible device can be employed to address this issue.

Stage 5: The AR Core services efficiently display 3D images on compatible devices, utilizing minimal system resources. Additionally, user can save images or videos in a locally stored gallery accessible at any time. The Augmented Reality Core services efficiently showcase 3D images on compatible devices, using minimal system resources. Furthermore, users can save captured images or videos in a locally stored gallery that is always accessible.

VII. Result And Discussion

The proposed system does the following

- Better User Experience, An easy-to-use, Time and Effort Savings, Making Informed Decisions

The program's outputs, as well as the colours and textures used, are excellent because it uses OBJ models. A realistic chair with shadows and reflections, thanks to the sophisticated lighting modelling, is included in the augmented reality fragment. The leather of the chair has been treated with PBR to brighten it. The complexity density of the completed model is approximately average compared to other models with similar characteristics, because it was built through dynamic processes.

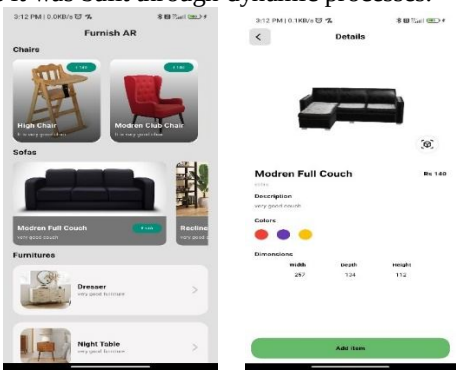

Fig. 4: Home page of application and Product page.

Fig 5 Augmented Couch and Wooden Bed on Floor.

As demonstrated in the image above, the augmented image appears realistic, allowing users to search for the specific furnishings they need. This function can be implemented in online shopping websites so that customers can try on the furniture they intend to buy.

V. Conclusions

This project is poised to bring a transformative shift to the world of interior design. By harnessing the power of augmented reality, this innovative endeavor empowers users to become the architects of their living spaces. It simplifies the complexities of arranging furniture, rendering the process accessible and enjoyable. Users can visualize their design visions in stunning realism, resulting in informed decisions, potential cost savings, and enhanced creativity. Moreover, in a world increasingly embracing technology, the project holds significant market potential, offering a dynamic solution for homeowners and design enthusiasts. As an educational tool, it also imparts design knowledge and skills to users. With the promise of high user satisfaction and the potential to reshape the interior design landscape, the " VirtuDecor : Redefining Home Aesthetics Through AR" project embodies the future of personalized, innovative, and user-driven interior design.

References

[1] V. T. Phan and S. Y. Choo, “Interior design in augmented reality environment,” Int. J. Comput. Appl., vol. 5, no. 5, pp. 16-21, 2010 [doi:10.5120/912-1290].

[2] M. Sandu and I. S. Scarlat, “Augmented reality uses in interior design,” Inform. Econ., vol. 22, no. 3/2018, p. 5-13, 2018 [doi:10.12948/issn14531305/22.3.2018.01].

[3] P. Jishtu and M. A. Yadav, “Futuristic technology in architecture & planning-augmented and virtual reality: An overview,” Int. J. Soft Comput. Artif. Intell. Appl., p. 10.1, 2021.

[4] S. B. Gubbala, et al., “Augmented Reality based Furniture Application” 2nd International Conference on Applied Artificial Intelligence and Computing (ICAAIC). IEEE, 2023 [doi:10.1109/ICAAIC56838.2023.10140655].

[5] T.-C. Young and S. Smith, “An interactive augmented reality furniture customization system,” Virtual, Augmented and Mixed Reality, Proc. 8: 8th International Conference, VAMR 2016, Held as Part of HCI International. Canada: Toronto, July 17-22, 2016. Springer International Publishing, 2016, p. 2016.
[6] Y. C. Nee, et al., “Augmented reality applications in design and manufacturing,” CIRP Ann., vol. 61, no. 2, pp. 657-679, 2012 [doi:10.1016/j.cirp.2012.05.010].
[7] M. A. Ramdani, et al., “Consumer perception and the evaluation to adopt augmented reality in furniture retail mobile application,” Binus Bus. Rev., vol. 13, no. 1, pp. 41-56, 2022 [doi:10.21512/bbr.v13i1.7801].
[8] E. Yigitbas, et al., “GaMoVR: Gamification-based UML learning environment in virtual reality,” Sci. Comput. Program., vol. 231, p. 103029, 2024 [doi:10.1016/j.scico.2023.103029].
[9] D. Wagner and D. Schmalstieg, “Making augmented reality practical on mobile phones, part 1,” IEEE Comput. Graph. Appl., vol. 29, no. 3, pp. 12-15, 2009 [doi:10.1109/mcg.2009.46].
[10] S. B. Gubbala, et al., “Augmented Reality based Furniture Application” 2nd International Conference on Applied Artificial Intelligence and Computing (ICAAIC). IEEE, 2023 [doi:10.1109/ICAAIC56838.2023.10140655].
[11] L. Fernando et al.. "A survey of industrial augmented reality.", “de Souza Cardoso,” Comput. Ind. Eng., vol. 139, p. 106159, 2020.
[12] M. N. A. Musthofa and I. Handayani, “Developed Jepara 3D augmented reality furniture catalog application based on android,” Int. J. Softw., vol. 3, no. 3, pp. 252-260, 2023 [doi:10.35870/ijsecs.v3i3.1734].
[13] W. Piekarski, “3D modeling with the tinmith mobile outdoor augmented reality system,” IEEE Comput. Graph. Appl., vol. 26, no. 1, pp. 14-17, 2006 [doi:10.1109/mcg.2006.3].
[14] C.-H. Teng and S.-S. Peng, “Augmented-reality-based 3D modeling system using tangible interface,” Sens. Mater., vol. 29, no. 11, pp. 1545-1554, 2017.
[15] H. Zhang and W.-J. Liu, “Analysis on the quantitative model construction of furniture modeling characteristics.” International Conference on Intelligent System Design and Engineering Application, vol. 1. IEEE, 2010 [doi:10.1109/ISDEA.2010.444].
[16] H. K. Yoo and J. W. Lee, “Mobile augmented reality system for in-situ 3D modeling and authoring.” International Conference on Big Data and Smart Computing (BIGCOMP). IEEE, 2014.