

AR App for visualizing interior design changes in real-world Environment

Muskan^a, Gargi Ghosh^b, Sudip Kumar Mahato^c, Kirti^d

^{a, b, c, d} Computer Science and Engineering Department, Chandigarh University, Mohali, Punjab

^a Corresponding author: muskansangwan2003@gmail.com

Abstract— *This study introduces an augmented reality application for interior design. The field of architecture requires virtual information techniques with the expansion of digital technology. People these days are too busy at work to take the time to visit different stores and purchase furnishings for their daily needs. It is challenging to satisfy client desires for a room they have decorated without providing them with an accurate virtual representation of the space. A printed furniture catalog is a paper-based resource that contains text and photographs without any user input. We have used a new interior design methodology using marker-based augmented reality. Users can select furniture options in an AR environment and view them projected in a real-world setting. To save consumers time and effort, this will streamline the interior design process and offer a better view of furniture arrangement.*

Keywords— Space recognition, 3D Modelling, Visualization, interaction design, lighting simulation, interior design, augmented reality (AR), and collaboration

I. INTRODUCTION

Augmented Reality (AR) is a cutting-edge field that combines the real and virtual world to create a revolutionary way to imagine changes to interior design. This introduction explores the development of conventional design methods, emphasizes the role of augmented reality (AR) technology, and describes the goal and possible outcomes of an AR application that is specifically designed to visualize changes in interior design in a real-world setting.

The intended AR app aims to reinvent interior design by putting the user at the center of creative discovery and decision-making. The application seeks to go above the limitations of conventional design representations by providing a three-dimensional, enhanced view of suggested modifications in the user's actual surroundings. Users may see spatial changes, try out different color schemes, and arrange furniture virtually- all streamlined by this revolutionary experience, which also gives users more confidence in the selected design because they can see its effects immediately.

The introduction of an augmented reality application, that allows users to visualize changes to interior design in a physical setting, has transformed the way people approach the process of creating their own homes. This revolutionary technology not only bridges the gap between idea and reality, but it also democratizes the design process by empowering people to make precise and confident changes to their surroundings. As we embark on this journey at the intersection of design and technology, our living spaces become infinitely more innovative and creative.

II. LITERATURE REVIEW

The field of architectural interior design is experiencing a gradual shift towards the use of virtual tools, mainly due to the rapid advancement of virtual technology. This paper aims to focus on how the interior design industry is adapting to these technological changes, particularly to use the augmented reality (AR) applications in the real world. The field of architectural interior design is experiencing a gradual shift towards the use of virtual tools, mainly due to the rapid advancement of virtual technology. This paper aims to focus on how the interior design industry is adapting to these technological changes, particularly in the use of augmented reality (AR) applications in the real world. The modeling process is streamlined to a great extent by using semantically annotated 3D models instead of general-purpose tools, which greatly reduces the time needed to construct the first room model[1]. In a poll, 81% of participants said AR helped streamline the design process, especially when it came to creating spatial layouts. Most of the students who took part reported that by improving both 2D and 3D perception, utilizing the AR program improved their capacity to optimize spatial arrangements[2]. The foundation of their automated interior design system relied on a hierarchical implementation of procedural rules governing object placement. To introduce variability in the designs generated, the execution tree offered multiple pathways to reach endpoints. This means that a given rule may have multiple child rules, which can be executed either concurrently or individually. Concurrent execution in their approach adhered to three primary principles: To clarify the rules, if two rules are on the same level and have the same parent, they cannot be executed together unless they belong to a concurrency group.

However, if the rules are present in the same concurrent, they can be executed together, except if they are part of the same avoidance group. The last principle involved using avoidance groups to prevent the simultaneous execution of rules, regardless of whether belonging to the same concurrency group. This principle aims to prevent an excessive proliferation of concurrency groups. To develop augmented reality applications in interior design, it is crucial to understand user perception [3][4]. The use of virtual reality provides a deeply immersive experience, but it often falls short in terms of realism as it mainly consists of digital data intended to simulate the real world. On the other hand, augmented reality (AR) has the potential to deliver a more realistic experience by integrating digital elements into a built-in background. Current AR HMD devices face limits in delivering immersive experiences because of elements like limited field of view (FoV) or reliance on specific locations for optimal functionality. These limitations can hinder the ability of AR HMDs to deliver a truly realistic experience[5]. During the final phase of the assessment, the ability to complete each task was measured by determining the time-on-task. It was performed during the COVID-19 time period so few people were tested remotely, while others underwent in-person evaluations. Remote persons had to submit screen recordings to analyze the time taken to complete every task. After the testing phase, participants made several suggestions to improve the user experience of the application. Many of them recommended adding extra options also buttons on the main user interface screen. While a certain party recommended creating a clickable button, another suggested integrating an undo option. This study designed and examined a system for AR 3D/virtual furniture interior design using two user studies. Metrics like the System Usability Scale (SUS), Handheld Augmented Reality Usability Scale (HARUS), job finish time, and the frequency of blunders were taken into consideration while determining the preliminary iteration of the solution across five tasks [6][7][8]. The authors' system offered many tools for managing photos, scaling models, and adjusting threshold values and marker attributes for object manipulation. From the item list on the left, the user may pick various virtual furniture items, change, remove, or modify their attributes, and then conceal them as needed. Every picture and virtual model is continuously added to the system. Additionally, if the user chooses to continue working on their design, they may store their virtual furniture design in a project file and import it at a later time[9]. The main goal of the paper was to address the shortcomings of traditional systems and provide a solution that encourages the innovation of a 3D model of a room that can be used repeatedly by both interior designers and customers[10]. The outcome of the application design explained how the augmented reality (AR) software was created, which included designing the front page of the home screen and determining how those 3D objects would appear. Additionally, technical testing was conducted to ensure the application can be installed and used seamlessly on various smartphone devices. This was all part of the application design result[11]. This project aimed to reduce the time and effort required for the interior design of homes. They created an

augmented reality catalog that showcased a variety of home design products. Moreover, they allowed customers to customize the listed products in the catalog according to their preferences. These changes could be made to the size, texture, color, or orientation of the product. The expected cost of product setup was also calculated to ensure that users stayed within their budget. Previously, customers had to wait until interior designers arrived at the location to provide product samples, among other issues related to interior design[12]. The article explored augmented reality technologies and 3D interior models for various interior designs. A framework for hard decoration modeling has been created to help users perceive each aspect of the design project, to achieve the balance between geometry and function. Specialized stereoscopic technology was simulated for content and sensory information about various furnishings, appliances, and ornamental materials for soft décor to improve clients' understanding and involvement with personalized interior design projects. In the ARID framework, this generates an AR3D interior prototype [13]. The article proposes an improved user experience and perception of objects using marker-less augmented reality. They used a marker-less tracking technique that tracked an object's position and orientation by utilizing positional tracking[14].

III. EXISTING SYSTEM

Since many details are left up to the imagination of the user, it can be challenging to picture how any piece of furniture would appear in space. The technology known as augmented reality allows computer-generated pictures to be superimposed over the actual world. It has been used in engineering and architecture to solve real-world problems. Thanks to advancements in technology, people can now perceive reality more accurately. Previously known as "mediated reality," augmented reality alters one's vision of reality by using a computer. Head-mounted displays (HMDs), eyeglasses, contact optics, and trackers are some of the devices that have built-in augmented reality, which professionals use frequently. Non-professionals or regular individuals can also use elements of augmented reality to solve problems in their daily lives. The size, color, and degree of harmony with the environment are some of the factors to consider when using augmented reality.

The accurate visualization of furniture in a space is made possible by augmented reality, which projects computer-generated visuals onto the actual world. By modifying what we see, it improves our understanding of reality. Professionals employ augmented reality in many different ways through devices like head-mounted displays, contact lenses, eyeglasses, and monitors. Yet augmented reality can help regular people too, by providing solutions to common issues.

Currently, available augmented reality (AR) systems for interior design often utilize AR frameworks, 3D model tools, and mobile applications. Numerous platforms and businesses offer solutions that enhance the representation of interior design

changes in actual scenarios. These systems typically contain the following parts:

A. AR Platform and SDKs:

The ARKit for iOS and ARCore on Android are highly popular platforms that provide developers with a comprehensive set of tools to create AR applications. These frameworks facilitate the adjustment of virtual objects according to the user's surroundings and enable the tracking of real-world surfaces.

B. Interior Design Apps:

With an emphasis on interior design and décor, some currently in use applications incorporate augmented reality features to produce a more immersive experience. Before purchasing, users can now preview furniture and decor in their homes.

C. Furniture Retail AR Apps:

Furniture stores have introduced a new way for their customers to visualize how furniture would look in their homes. This feature is made possible by augmented reality apps, which can be accessed via tablets or smartphones. These apps display a catalog of products in 3D models, allowing customers to virtually arrange furniture in their homes.

D. Customizable 3D Model Libraries:

Augmented reality software can provide clients with a vast selection of virtual placement options by utilizing large libraries of 3D models that showcase design elements, furniture, and accessories.

IV. METHODOLOGY USED

The project employs a meticulous approach to crafting Augmented Reality (AR) software for visualizing interior design modifications in real-world settings.

The following attributes are included in the methodology used:

A. Requirement Analysis

When developing Augmented Reality (AR) software for visualizing changes to interior design, it is vital to conduct a thorough requirement analysis. This involves closely examining the needs, objectives, and target audience of the client and engaging in insightful discussions to understand the project's objectives. This process helps to outline critical features and ensures intuitive interactions for selecting, adjusting, and positioning virtual elements in physical spaces. A well-defined project scope and goals are crucial for successful implementation. Careful planning and alignment of objectives ensure that the AR software meets the client's requirements and provides an engaging user experience.



Fig. 1 Requirement Analysis

B. Research and Inspiration

During the research and inspiration phase, developers analyze the latest technologies and available AR interior design applications to gain insights into emerging trends and industry best practices. They dive into the world of interior design, taking cues from user interfaces and furniture catalogs to understand the tastes of their target market. To ensure the seamless integration of AR features into the app, developers also explore AR development tools such as ARKit and ARCore. By conducting thorough research and seeking inspiration, developers lay the foundation for innovative and user-focused augmented reality interior design software that exceeds customer expectations.



Fig.2 Research and Inspiration

C. Conceptualization and Design

During the design phase, developers use their creativity to imagine the user interface and experience of an augmented reality (AR) interior design app. They focus on simplicity and user involvement through brainstorming sessions. Wireframes and prototypes are used to transform ideas into visual concepts, enabling an iterative development process. The development team prioritizes AR features and gesture-based interactions, along with user-friendly controls for selecting and organizing virtual items. By keeping the user's needs in mind and utilizing modern design tools, developers create aesthetically pleasing and user-friendly AR interior design software.

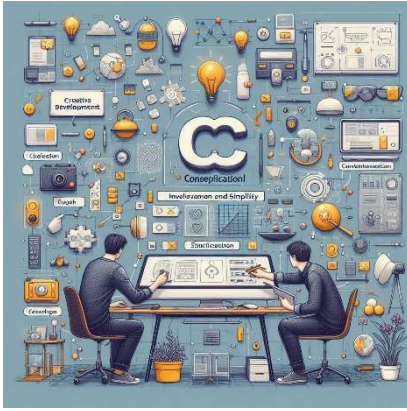


Fig. 3 Conceptualization and Design

D. Development

Developers strive to create a fully functional AR interior design software by choosing the appropriate AR development framework such as ARKit or ARCore. They integrate essential AR features like surface mapping and object tracking for seamless interaction. To enhance user experience, they include high-quality 3D models of furniture and décor. They also enable manipulation and customization of virtual objects. By giving priority to sound development processes and leveraging advanced AR technologies, developers ensure the delivery of an exceptional AR interior design app.



Fig. 4 Development

E. Testing and Feedback

During the testing phase, developers assess the AR interior design app to ensure it functions properly and meets user expectations. Beta testers provide valuable feedback on navigation and usability to identify and resolve issues. The app undergoes rigorous testing to ensure consistent performance and compatibility across various devices and AR scenarios. To offer users a seamless experience, developers give priority to fixing any bugs and continuously improve the app based on user feedback. During the testing phase, developers assess the AR interior design app to ensure it functions properly and meets user expectations. Beta testers provide valuable feedback on navigation and usability to identify and resolve issues. The app undergoes rigorous testing to ensure consistent performance and

compatibility across various devices and AR scenarios. To offer users a seamless experience, developers give priority to fixing any bugs and continuously improve the app based on user feedback.



Fig. 5 Testing and Feedback

V. PROPOSED SYSTEM

Introducing our advanced augmented reality app that enables you to visualize changes to interior design in real spaces. This cutting-edge solution ensures seamless integration with design services by offering personalized design options and sophisticated tracking capabilities without the need for markers. With the help of cloud storage services, customers can view their designs from anywhere, and the offline mode ensures that the functionality will continue to work even when there is no internet connection. Our technology is optimized for performance and provides a user-friendly interface that revolutionizes how people interact with interior design.

The proposed system developed for the AR app consists of the following features:

(a) Personalisation Choices :

Our augmented reality interior design app offers a range of customization options that allow customers to personalize their virtual furniture according to their preferences. You can create spaces that truly reflect your style by experimenting with different designs, colors, textures, and sizes. We have streamlined the customization interface while retaining its functionality to ensure ease of use and convenience. This approach enhances the overall design experience by enabling users to easily add unique touches to their living spaces.

(b) Tracking without Markers :

Our augmented reality interior design app boasts sophisticated tracking algorithms that enable reliable and accurate marker-less tracking across various settings. Our team's top priority is to develop strong algorithms that ensure seamless operation across diverse environments, allowing users to position virtual objects precisely in their real environment. We also prioritize optimizing the tracking speed to enhance the overall augmented

reality experience. By equally focusing on speed and stability, our program offers a smooth and immersive augmented reality experience that enables users to visualize and interact with virtual items efficiently and precisely in real time.

(c) Combining Design Services with Integration :

Our interior design app that uses augmented reality technology is equipped with robust tracking algorithms that can accomplish precise and reliable marker-less tracking in various environments. With our app, you will experience the smooth augmented reality that guarantees virtual objects seamlessly blend with their surroundings in real time. Our application prioritizes tracking speed improvement, which ultimately enhances user satisfaction and usability, creating a more seamless and engaging design visualization process.

(d) Offline Mode :

Our AR interior design app offers essential offline features that allow users to manipulate and examine simple designs even when they are not connected to the internet. With our offline capabilities, users can seamlessly continue their design process regardless of connectivity. We also use data caching and synchronization strategies to ensure smooth transitions between online and offline modes. This guarantees a continuous design experience, enabling users to switch between modes without any disruptions. Our software empowers users to access and modify their designs quickly and efficiently, whether they are online or offline.

(e) Optimizing Performance :

Our program has been optimized for faster performance on all kinds of devices, including lower-end ones. We have implemented performance optimization techniques such as texture reduction and level-of-detail rendering to streamline the rendering process and improve performance. This helps to reduce the burden on device resources and ensure a consistent user experience.

We strive to identify and fix performance bottlenecks by taking user feedback into account and conducting thorough testing. This allows us to allocate resources effectively and prioritize the optimization of key regions to improve the overall user experience. Our approach ensures that our program performs well on a variety of devices with different hardware specifications, while still providing a responsive and reliable user experience.

(f) Designing User Experience :

It is crucial to conduct regular user testing and make iterative changes to improve the user interface and interaction design. By continuously improving and refining the interface in response to user feedback, this iterative method guarantees that the interface satisfies user preferences and expectations. To maximize usability and user satisfaction, it is important to prioritize accessibility, consistency, and simplicity. By emphasizing these factors during the software design phase, it becomes easier to create an intuitive user experience, easy for

navigate and consistently meets the needs of the target audience. This approach not only fosters positive user interactions but also contributes to the overall success and adoption of the software product.

VI. RESULTS AND DISCUSSIONS

Our development of an augmented reality (AR) app for visualizing interior design within real-world environments highlights its effectiveness across diverse demographics and professional fields.

Below are the characteristics of the AR app that we have developed:

(I) SIGN-UP PAGE INTEGRATION:

To enhance user interaction and security in AR applications, it is crucial to include a sign-up page that requires password and login authentication. By doing so, users can create personalized accounts, which fosters a sense of ownership and makes it easier for them to access unique design projects and preferences.

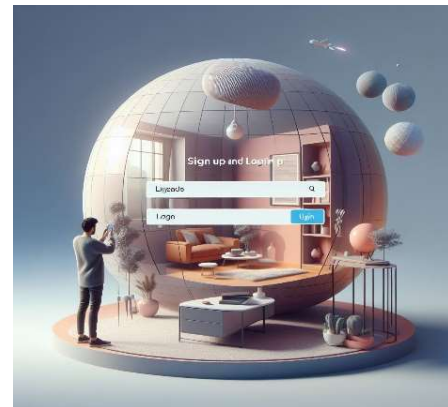


Fig.6 Sign-up Integration

(II) VISUALIZATION FOR VARIED AGE GROUPS:

Based on our analysis, it seems that augmented reality software can be useful for users of various age groups, ranging from young adults to the elderly. The participants in our study found the interface design to be age- and gender-neutral, which improved their involvement with the interior design visualization process. Additionally, the user-friendly navigation further enhanced their experience with the software.



Fig.7 Visualization for Varied Age Groups

(III) USER EXPERIENCE AND ACCESSIBILITY:

We found that adding the sign-up page was positively correlated with increased user satisfaction based on qualitative feedback and usability tests. Along with the ease of accessing individual design portfolios and collaboration features, participants valued the shortened account setup procedure.



Fig.8 User Experience and Accessibility

(IV) COMPREHENSIVE 3D LIBRARIES REALISTIC VISUALIZATION:

To enhance the realism and augmented reality immersion of interior design visualization, extensive 3D libraries are combined. With the help of an enormous library of meticulously curated high-fidelity models of clothing, furnishings, lighting, and architectural details, users of the augmented reality program can visualize their design concepts with an unparalleled level of accuracy and detail.

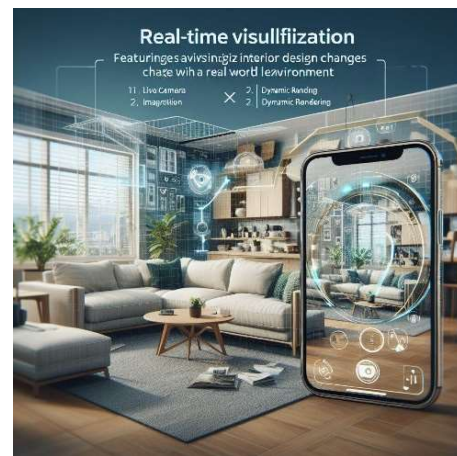


Fig.9 Comprehensive 3D Libraries Realistic Visualization

(v) COLLABORATIVE FEATURES WITH ONLINE RETAILERS:

Users can explore, choose, and see furniture, decor, and accessories from a wide range of collaborating merchants immediately within their design projects thanks to the AR application's integration of online retailer collaboration. Users can access a vast product inventory through agreements with top e-commerce platforms or individual stores, which expedites the procurement process and improves design customization.

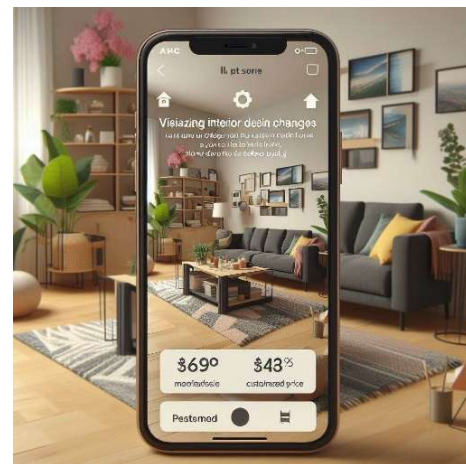


Fig. 10 Collaborative Features with Online Retailers

(VI) SEAMLESS ACCESS TO CLOUD STORAGE:

The integration of cloud storage features in the AR application allows users to access their design files, project layouts, and customization preferences easily from different devices and locations. Our research has shown that customers benefit greatly from the convenience of saving and retrieving their design files from online repositories such as Dropbox, Google Drive, or exclusive cloud solutions.



Fig. 11 Seamless Access to Cloud Storage

VII. CONCLUSION

Our experience creating augmented reality software that enables users to visualize interior design in real-world settings shows that the app is adaptable to a wide range of age groups and professional backgrounds. The inclusion of a sign-up page that requires a login and password for authentication not only increases user engagement and accessibility but also underscores the importance of safeguarding user privacy and data within AR application ecosystems.

Moreover, accessibility, collaboration, and personalization in interior design visualization have improved significantly with the integration of cloud storage and online store collaboration into the AR app ecosystem. These features enable users to create immersive and customized creative experiences, foster teamwork, and streamline the procurement process by providing easy access to design files and product catalogs.

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