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Interior and Product Design Using Augmented Reality

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Abstract: This paper introduces the design and creation of an Augmented Reality(AR) system that helps with visualizing interiors and Products. The platform lets users use their mobile devices to place furniture and design items in real life spaces virtually. By using AR Technology, 3D models, and real-time graphics, the system helps people make better design choices through engaging and interactive experiences. The app lets users see different Layouts, adjust where objects go, and check how things look before they actually build them, which helps save time, money, and reduces mistakes in the design process.

Keywords: *Augmented Reality (AR), Interior Visualization, Product Design, 3D Models, Real-Time Graphics, Mobile Applications, Virtual Object Placement, User Interaction, Spatial Visualization, Design Optimization.*

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I. INTRODUCTION

➢ *AR-based Interior and Product Design Systems*

Augmented Reality (AR) has become a powerful tool in design and visualization. It lets digital objects appear on top of the real world, letting users interact with virtual items as if they were real, right there and then.

In areas like interior and product design, AR systems offer users the ability to:

- See how furniture and decorations would look in their own space
- Change layouts on the fly
- Decide on purchases with more confidence

Older design methods depend a lot on imagination or flat 2D images, which can create a big difference between what people expect and what they actually get. AR helps close that gap by showing a more realistic view of the designs before they're built.

- *Need for AR in Interior Design*

Interior design includes arranging spaces, making them look good, and ensuring they work well. Mistakes in the design can cause problems like:

Higher expenses

✓ Inefficient use of space
✓ Unpleasant experience for the people using the space

Using augmented reality systems helps by offering:

✓ Seeing the design as it would look in real time
✓ Correctly sized and positioned elements
✓ The ability to make changes to the design interactively

- *Interactive Visualization and User Experience*

Modern AR applications focus on:

✓ Gesture-based interaction (move, rotate, scale)
✓ Real-world plane detection
✓ Real-time rendering of 3D models

These features enhance user engagement and usability, making the system appropriate for both professionals and regular users.

II. LITERATURE REVIEW

Even though Augmented Reality (AR) technology has made big progress, there are still several problems that researchers have pointed out. These include things like limited device capabilities, slow rendering performance, difficult-to-use interfaces, and the challenge of smoothly combining AR with real-world situations. Many studies stress the importance of creating easy-to-use interfaces, precise spatial awareness, and real-time interactions to improve the overall experience when using AR for design tasks. This research builds on those earlier studies by focusing on combining engaging visual experiences with simple and effective ways for users to interact, making it

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easier to design interiors and products in real-life settings. Azuma (1997) first explained the basic ideas of Augmented Reality, describing it as a system that mixes real and virtual environments, works in real time, and is positioned in 3D space. This work set the stage for future uses of AR in many areas, including visualizing interiors [1].

Houzz Inc. (2019) created AR tools for interior design that let users see how furniture would look in real spaces using their mobile devices.

Their study showed that this improved users' confidence when making buying decisions and lowered the number of returned products because they could better imagine how things would fit [2].

IKEA (2017) launched the IKEA Place app, which uses AR to let users place realistic 3D furniture models in their homes.

The app showed how AR can improve the customer experience and help people understand how furniture will fit in their spaces [3].

Peddie (2017) looked into how AR affects visualization technologies, stressing its ability to increase user engagement and interaction.

The study showed that AR can help bring ideas to life more effectively in design projects [4].

Kim et al. (2020) studied how users interact with mobile AR environments, focusing on how they can move, rotate, and change the size of virtual objects using gestures. Their research found that simple and intuitive controls make AR apps easier to use and more satisfying for users [5].

Billinghurst et al. (2015) looked at collaborative AR systems and discussed how AR can help multiple people work together on design projects.

Their work suggests that AR can be used for group design tasks where people can make decisions together [6].

Unity Technologies (2021) offered tools for real-time 3D rendering and AR development, allowing developers to build interactive apps that run smoothly. These tools have become a standard in AR design systems [7].

Google (ARCore, 2022) introduced features like plane detection, light estimation, and motion tracking, which help place virtual objects more accurately in real spaces.

These improvements made AR apps more realistic and stable [8].

Zhou et al. (2018) reviewed trends in AR systems and identified major challenges such as tracking accuracy, delays, and hardware limitations.

They stressed the importance of finding ways to improve performance in mobile AR apps [9].

Wang et al. (2021) studied how AR is used in e-commerce and product visualization.

Their research found that AR helps customers engage more with products and feel more confident about their purchases by allowing them to see how items look in real life [10].

In short, current research shows that AR has a lot of potential to change how we design interiors and products by offering immersive, interactive, and realistic visualizations.

However, there are still challenges like usability, performance, and how well AR works in real-world situations. Right now, the main focus is on creating efficient, easy-to-use AR systems that provide accurate visualizations and smooth interactions, so they can be used in everyday design processes.

III. METHODOLOGY

The system for augmented reality (AR)-based interior and product design is built with several parts that work together to let users see and interact with virtual items in real time. It starts by using a mobile device's camera to capture the actual space. This data is then processed with AR tools to find surfaces and understand the space's shape. These surfaces act as a guide for putting in virtual objects like furniture and design items.

At the heart of the system, AR technology and 3D rendering tools help place and show objects accurately in the real world.

The system uses well-optimized 3D models and rendering methods to keep things running smoothly and look realistic. Users can move, turn, and resize objects using simple gestures.

The processed data is shown through an easy-to-use interface where users can pick products, change layouts, and see their designs as they would look in real life.

The system is also built to grow, render efficiently, and work on different devices, making it easy to add new models and features later on.

- *Environment Detection*

The system uses ARCore to identify flat and vertical surfaces in the real world.

It constantly analyzes the camera feed to find suitable areas where virtual objects can be placed with precision.

- *3D Model Integration*

Furniture and product models are either created or imported in FBX format.

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These models are adjusted for better performance on mobile devices and include textures and materials to make them look realistic. Once ready, they are added into the Unity engine.

- *Object Placement and Interaction Users can put virtual objects on the detected surfaces.*

The system allows them to:

- Move objects around
- Rotate them to change their direction
- Resize them as needed

- *Rendering and Visualization*

The system uses Unity's rendering engine to display things in real time.

It adds lighting and shadow effects to make the virtual objects look more natural and blend in with the real environment.

- *User Interface & Deployment*

The app has a user-friendly interface that lets users:

- Choose furniture items
- Place and adjust objects
- Reset or change the layout

Fig 1 User Interface and Deployment

IV. EXPERIMENTAL SETUP & RESULTS

It is well worth making the hardware and software requirements necessary for the system to function at its best before utilizing the system. The requirements are shown in table 1 and 2.

Table 1 Hardware Requirements

Components	Specifications
Processor	Snapdragon 845 or higher
Memory RAM	4GB or more
Storage	64GB or more
Camera	Required for AR functionality
Display Resolution	720p or Higher

Table 2 Software Requirements

Software Component	Unity 2021 or above
AR Framework	ARCore
Programming Language	C#
3D Model Format	FBX
Operating System	Android

The technologies chosen ensure effective training and inference and easy implementation of the same. Streamlit has a simple user interface, so even non-technological users can utilize the system.

V. CONCLUSION

This work presents the design and development of an Augmented Reality (AR)-based system for interior and product visualization. The proposed system enables users to place and interact with virtual furniture and design elements in real-world environments using mobile devices. By integrating AR technology with real-time rendering and intuitive user interaction, the system enhances design accuracy and user experience.

The application allows users to visualize layouts, adjust object placement, and evaluate aesthetics before actual implementation. This significantly reduces design errors, saves time, and minimizes overall costs. The system also improves decision-making by providing a realistic preview of interior spaces, bridging the gap between conceptual design and real-world execution.

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➢ *System Performance Summary*

Table 3 System Performance Metrics

Metric	Observation
Surface Detection Accuracy	High
Rendering Performance	Smooth (Real-time)
User Interaction	Responsive and intuitive
Usability	User-friendly interface

The system uses Unity and ARCore to make rendering efficient and plane detection accurate. It uses optimized 3D models to ensure smooth performance, even on mobile devices. Features like scaling, rotating, and moving objects help create a smooth and enjoyable user experience.

➢ *Future Work*

The system could be improved in the future by adding:

- Using AI to give design suggestions
- Support for multiple users working together in AR Advanced interaction through voice and gestures Connecting with e-commerce sites for buying products directly
- Making the AR experience more realistic with better lighting and physics effects.

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