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AR Based Furniture Placement and Measurement App

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Abstract

Traditional furniture shopping, whether in-store or online, presents significant challenges for consumers, as they can't decide how it will look in their space. This research investigates the role of an Augmented Reality furniture placement app as a solution to these types of problems and its impact on consumer purchase. By integrating a virtual, interactive solution into the real-world environment, these applications offer consumers a way to visualise and interact with the listed products. This study used a mixed-methods approach, combining a comprehensive literature review of AR in e-commerce with a quantitative survey of users of prominent AR furniture apps and customer interviews. The research focused on determining the extent to which AR visualisation influences consumers' decision-making, confidence, and overall satisfaction. The research indicates that the use of AR furniture apps significantly increases consumer confidence in product-space compatibility, leading to a notable reduction in perceived purchasing risk. A majority of survey respondents reported that the AR feature was a primary factor in their decision to purchase, and retailers with AR capabilities were realized as more innovative and trustworthy. In conclusion, this paper demonstrates that AR furniture placement technology is not just a marketing gimmick but a transformative tool that addresses core pain points in the industry. Its successful implementation leads to improved consumer experience, higher conversion rates, and lower product returns. This research provides valuable insights for retailers and technology developers seeking to leverage AR to reimagine the future of online and in-store shopping.

Keywords: *Augmented Reality, Furniture Placement, E-commerce, Visualization, Purchase Behavior, Decision-Making, User Experience, Retail Innovation, Product Returns, Customization.*

1. Introduction

Upgrading your home with new furniture is one of the challenging tasks. There are many difficulties in choosing the right furniture in the store and arranging it in the space being considered in the home. The user should have knowledge of the dimensions of the space to select approximately sized furniture. Additionally, after purchasing, trying different positions and combinations for visually rich appeal and convenience can be physically challenging and time-consuming. The integration of augmented reality (AR) into interior design has emerged as an innovative solution for visualizing furniture placement. With AR technology, users can visualise the desired furniture with accurate dimensions in their homes, helping them to visualise and measure the size in real space. By allowing users to make more informed decisions about furniture selection and placement. AR covers the gap between design and actual execution. [1,12]. The proposed work aims to develop a user-friendly website integrated with AR to visualize the furniture placement in interior design. AR allows virtual objects to be visualized in real-world spaces, providing designers and end-users with new opportunities to visualize furniture in their homes [2,14]. By integrating 3D models and deep information, AR solutions can accurately place furniture in defined spaces, helping users make informed purchase decisions and reduction in common mistakes [3]. Using React.js further improves

these AR applications by enabling dynamic and responsive user interfaces. Additionally, Web XR combined with blockchain technology offers immersive, cross-platform AR experiences directly in browsers, making interior design visualization more accessible and secure.

Everyday Convenience

From smartphones and online shopping to navigation and digital banking, technology simplifies daily life, making tasks faster, safer, and more convenient. measurement tools, and basic recommendation logic, thereby offering a more complete, user-centered solution for virtual furniture visualization and interior design decision-making.

2. Literature Survey

Augmented Reality (AR) has become a transformative tool in interior design by allowing users to project virtual 3D objects on real-world environments, thereby enhancing visualization and facilitating correct purchasing decisions. Early studies highlight AR's ability to reduce uncertainty in furniture selection and improve spatial understanding, covering the gap between static 2D images and physical spaces. Modern markerless AR systems, leveraging simultaneous localization and mapping, enable precise object placement without the need for physical markers, as demonstrated by Syahputra et al. (2020) [8], and are central to mobile toolkits such as ARCore and ARKit. Usability and interaction design are equally critical for AR adoption. Intuitive gesture controls, clear onboarding, and minimal cognitive load have been shown to enhance user performance and reduce errors, particularly in tasks such as rotating, scaling, and positioning furniture. Existing applications, both academic prototypes and commercial offerings like IKEA Place and Wayfair, confirm the market interest but often lack deep customization features such as dimension changes or material swaps. While cross-platform frameworks present trade-offs between convenience and tracking accuracy. Performance optimization through lightweight 3D modeling and rendering techniques, alongside measurement accuracy ensured via measuring and sensor fusion, which are key technical considerations for meaningful user experiences. Emerging research suggests the potential of AI-driven, geometry-aware recommendations to suggest furniture based on room dimensions and style, though robust implementations remain limited. This project seeks to address these gaps by integrating robust, high-performance markerless AR tracking, optimised 3D assets, and real-time customisation of size, colour, material, and textures in practice.

3. Methodology

In the development of the AR furniture application, it followed a structured and repetitive methodology designed to ensure technical accuracy, user-centered design, and practical usability. The methodology was organized into five key phases: requirement analysis, system design, prototype development, testing and feedback, and iterative refinement as per Figure 1.

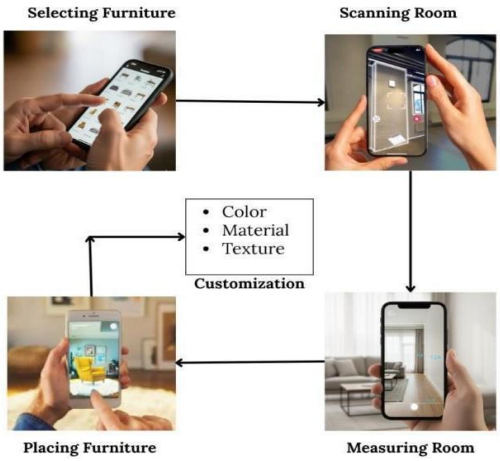

Figure 1: Workflow

A. Requirement Analysis

The process began with a review of existing AR-based furniture applications such as IKEA Place, Amazon AR View, and Wayfair. These studies highlighted common limitations, including the absence of real-time customization features and understanding user interactions. In parallel, informal surveys and discussions with potential users, including homeowners, interior design enthusiasts were conducted. Their feedback revealed a demand for precise visualization, interactive customization, and intelligent recommendations. This requirement analysis informed the functional and non-functional specifications of the proposed solution, as given in Table 1.

Table 1: Comparison Table

Features	IKEA	Amazon View	Wayfair
Platform Support	iOS, Limited Android	iOS & Android	iOs & Android
Full Room Scanning	No	NO	Yes
Texture & Realism	High	Moderate	Moderate to High
Accuracy of scaling	Accurate	Moderate	Good
Multi Furniture Placement	No	NO	Yes

B. System Design

The system was designed using an Agile framework, enabling modular development and incremental feature integration. Architectural diagrams, data flow models, and user interface prototypes were developed to visualize system components and interactions. The technical

stack included **Unity with AR Foundation** for cross-platform AR capabilities, **ARCore** for Android-based tracking & **ARkit** for iOS, and a lightweight cloud backend for potential storage of furniture models and user preferences. The design states usability, real-time responsiveness, and extensibility for future enhancements.

C. Prototype Development

Development was carried out in iterative sprints:

- **Sprint 1:** Implementation of plane detection and basic AR furniture placement.
- **Sprint 2:** Addition of object manipulation (move, rotate, scale) and catalog browsing.
- **Sprint 3:** Integration of customization features such as color, material, and texture.
- **Sprint 4:** Enhancement with other tools, including an AR measuring tape, a budget calculator, and screenshot/share functionality.

D. Testing and Feedback Collection

The prototype will be tested in real-world environments with volunteer participants. Usability tasks included furniture placement, rotation, and customization. Both qualitative feedback and quantitative metrics were collected. The feedback revealed key usability issues, such as difficulty in rotating furniture and challenges in low-light conditions.

E. Iterative Refinement

Based on test results, incremental improvements were introduced. Rotation controls were simplified, lighting guidance tips were improved, and instructions were made clearer. This iterative process ensured that the app meet user expectations.

F. Ethical Considerations

All user participation was voluntary, with informed consent obtained prior to testing. No sensitive personal data was collected, and all responses were anonymized and used solely for academic purposes. These surveys were taken from the actual customers who were looking for furnitures in store.

7. Aims And Objectives for an Ar-Based Furniture Customization and Measurement APP

I. Overall Aim

To upgrade the furniture shopping and buying experience by providing a user-friendly, accurate, and immersive Augmented Reality (AR) application that allows users to virtually customize, measure, and preview furniture items in their actual physical space before purchase.

II. Specific Objectives

These objectives are concrete, measurable, achievable, relevant, that support the overall aim:

- **Usability and Experience Objectives:** Placement and Visualization: Enable users to accurately place a 3D model of a customized furniture item into their real-world environment just by tapping on the desired place on screen. Customization Interface: Develop a seamless user interface that allows users to modify key furniture attributes (e.g., color, material, size, texture)

- **User Satisfaction**: Achieve a minimum user satisfaction score of 4.5 out of 5 in post-interaction surveys regarding the ease of use and realism of the AR visualization.
- **Measurement and Accuracy Objectives**: Measurement Accuracy: Implement an AR measurement tool that will allow users to measure the space or the virtual furniture with an accuracy of approx same compared to a physical measurement.
- **Platform Compatibility:** Ensure the app is compatible and performs optimally on the latest three generations of major mobile operating systems (iOS and Android).
- **Performance:** Optimize the app to maintain a consistent frame rate above 30 frames per second during active AR visualization to ensure a smooth, non-jittery experience.

8. Major Challenges

The development of an AR-based furniture customization and measurement app gives several significant challenges that must be addressed to ensure usability, performance, and long-term adoption.

1. **Performance and Optimization**: Rendering the detailed 3D furniture models in real time requires considerable computational power. But on mid-range smartphones, this can result in frame drops or lag, which will disrupt the immersive experience. Maintaining smooth performance at 30 frames per second while ensuring measurement accuracy within a few units remains a critical challenge.
2. **Accuracy of Measurement Tools:** Inaccurate values in AR-based measuring tools caused by sensor errors or poor calibration may mislead the users, leading to poor purchasing decisions. Ensuring reliable distance and dimension calculations across different devices is essential but difficult to standardize. Measurement should be approximate or a little close at least.
3. **Technical Limitations of AR**: Although ARCore and ARKit provide strong foundations for augmented reality experiences, environmental tracking, limitations in plane detection, and low-light performance can impact the accuracy of measurement. Unstable tracking often leads to misaligned furniture placement, which reduces user confidence in the app.
4. **Limited Smart Recommendations:** While the project aims to provide intelligent suggestions based on room dimensions, developing robust AI-driven recommendation systems remains difficult due to limited datasets and the complexity of personal preferences in the interior design.
5. **Data Management and Model Integration**: Integrating huge furniture catalogs with customizable attributes (color, size, material) requires efficient backend management. Storing, updating, and rendering large 3D model libraries without compromising performance poses a significant technical challenge. Not every device can be supported.

9. Advantages of Proposed Model

The proposed application offers several advantages over traditional online shopping methods and existing AR furniture visualization apps. These benefits highlight its potential to transform the furniture retail experience for customers.

1. **Interactive Customization:** Unlike many of the existing solutions, the app allows users to modify furniture attributes such as color, material, texture and dimensions in real time.

This feature empowers users to experiment with different styles and configurations, enhancing decision-making confidence.

2. **Accessibility of cross-platforms:** The use of Unity with AR Foundation enables the application to run on both Android and iOS devices, making it accessible to a wide range of users without the need for specialized hardware.
3. **Realistic Visualization of model**: By using ARCore and ARKit, the model enables users to place 3D furniture models directly into their real-world environments. This provides a lifelike preview of size, scale, and fit.
4. **Recommendations:** By analyzing room dimensions and design patterns, the system can suggest suitable furniture options. This personalized recommendation feature saves time, improves user satisfaction, and adds value beyond simple visualization. Users can select recommendations according to their taste.
5. **Enhanced User Experience:** The proposed model focuses on intuitive gesture-based controls and clear onboarding, making the system accessible even to non-technical users. This lowers the learning curve and promotes widespread adoption of the app.

10. Conclusion

The proposed ARniture application demonstrates the effective use of Augmented Reality to overcome key limitations of traditional online furniture shopping by enabling users to visualize, customize, and measure furniture within their own physical environments. By enabling real-time placement of virtual furniture models with accurate scaling and interactive controls, the system reduces uncertainty size, fit, and aesthetic compatibility, which are common sources of dissatisfaction in e-commerce purchases. The integration of realistic 3D visualization, material and color customization, and intelligent recommendation features enhances user confidence and supports informed decision-making, resulting in a more engaging and reliable shopping experience. In addition to benefiting customers, the application provides designers and retailers with a powerful platform to showcase products and layouts interactively, thereby improving customer trust, reducing product return rates, and strengthening brand credibility. While the system successfully addresses major usability and visualization challenges, certain limitations remain, including performance optimization on mid-range devices, maintaining measurement accuracy across varied environments, and ensuring consistent tracking under low-light conditions. Despite these challenges, the project establishes a strong technical and conceptual foundation for future enhancements. Further development could include advanced AI-driven furniture recommendations, collaborative design features that allow multiple users to participate in layout planning, and potential integration with virtual reality for fully immersive experiences. Overall, ARniture represents a practical and innovative solution to a real-world problem, highlighting the transformative potential of Augmented Reality to reshape online furniture retail and interior design, creating more confident, efficient, and satisfying purchasing experiences.

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