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Augmented Reality in Interior Design

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Abstract

The recent advances in digital technologies have paved way for substantial improvements in the field of interior design. Augmented reality (AR), one of the biggest trends in the digital market, is used to visualize the placement of furniture in interior spaces. As the demand for online stores and shopping increases, AR presents a promising solution to bridge the gap between virtual and the real environment. By utilizing AR functions, users can virtually place furniture in their living spaces, conceptualize their design, and make proper decisions by accurately visualizing their desired interior design. The proposed system aims to develop a website that enhances the user experience in choosing the furniture that suit their living space. Furthermore, the precise visualization and interactive platform makes the website user-friendly.

Keywords: Augmented Reality, Interior Design, 3D Furniture Models, Digital Market

1. Introduction

Furnishing your home with new furniture is one of the challenging tasks, as there are many difficulties between choosing furniture in the store and assembling it in the desired space in the home. The user should have the knowledge about the dimension of living space, to select appropriately sized furniture. Additionally, after purchasing, trying different positions and combinations for aesthetic 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, users can visualize the desired furniture with accurate dimensions in their homes, helping them to conceptualize and helps to measure size in real space. By enabling users to make more informed decisions about

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furniture selection and placement, AR bridges 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 projected into real-world spaces, providing designers and end-users with new opportunities to visualize furniture in their homes [2,14]. By integrating 3D models and depth information, AR solutions can accurately place furniture in defined spaces, helping customers make informed purchase decisions and reducing 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 [10,15].

2. Related Work

Based on ergonomics, aesthetics, and interior design principles, the furniture is automatically arranged in the virtual setting of the room. This approach uses a genetic algorithm to generate multiple combinations of interior designs while taking cost into consideration [4].

The research presents an innovative approach to quickly generate furniture arrangements in interior scenes that improves the outcome of optimization-based interior design and produces outcomes that are equivalent to a previous method for automatic interior design in terms of user preferences was suggested in [5].

The author in this work generates furniture configurations procedurally for large virtual indoor settings, with the goal of only furnishing the rooms closest to the viewer as the user explores a building in real time [6].

The study [7] presents a novel rule-based layout solving strategy that is particularly well-suited to be used in combination with procedural generation techniques. It also demonstrates how procedural generation may be accomplished with this solving approach by giving the solver a user-defined plan.

AR is predicted to have a big impact on interior design in the future as technology develops, providing clients and designers with cutting-edge ways to create and experience individualized and practical living and work spaces [13].

The research presented in [8] suggests a novel approach to integrating augmented reality technology into interior design projects. It allows users to interact with 3D virtual furniture data through a dynamic and adaptable user interface, and it allows them to observe virtual furniture.

To improve customers' comprehension and involvement in the personalized interior design project, specialized stereoscopic equipment can simulate the augmented content and sensory information of decorative material, furniture, and appliances for soft decoration, creating an AR3D interior prototype in the ARID system [9].

This study aims to shed light on the following factors: the tendency of students using augmented reality technologies to perceive new representation; gender; course duration; degree of computer game experience; impact of computer programs that they can use in their past augmented reality experiences and designs, if any; and the relationship between them [11].

Based on the literature study, the proposed work aims to develop a user-friendly website to enhance the user experience by enabling customers to make informed decisions about furniture purchases.

3. Proposed Work

The proposed work aims to use augmented reality (AR) technology to improve interior design, focusing mainly on furniture placement. The website is developed by integrating AR module, 3D models repository and the furniture database to enable users to visualize the 3D models of the furniture in their living space. The overall aim of the user interface is to offer an affordable, efficient, and user-friendly solution for finding and placing furniture in real-time.

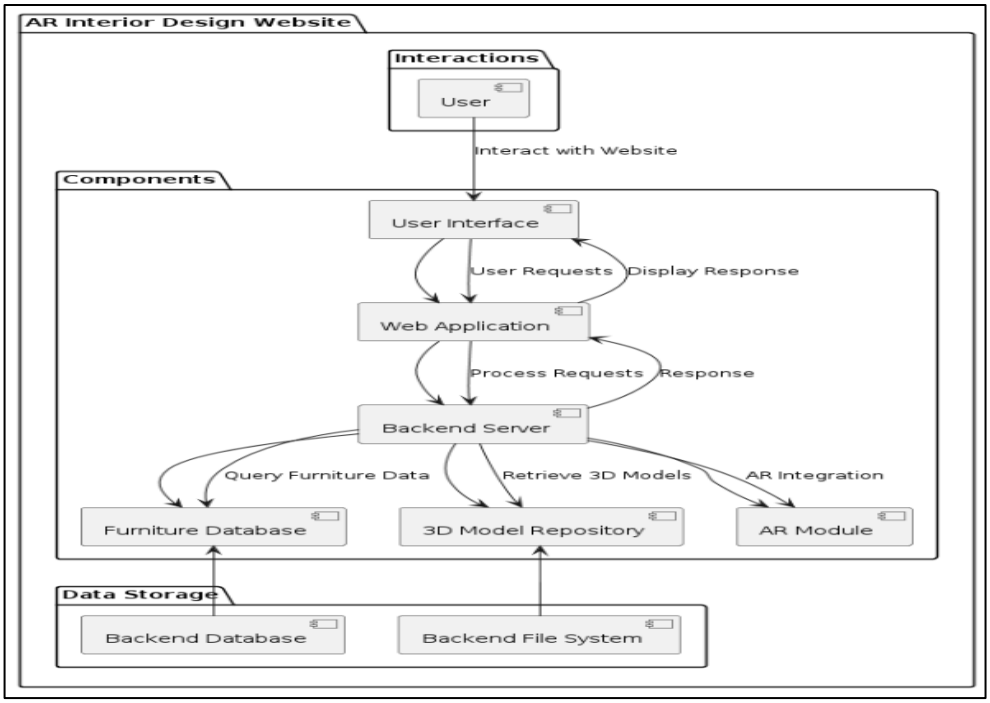

Figure 1. Proposed Design

The architecture of an AR interior design website is shown in Figure 1, which is divided into three primary sections: Data Storage, Components, and Interactions. The user's involvement in interacting with the website making requests and getting answers is shown in the Interactions section. The internal workings of the system are described in detail under the Components section. The User Interface is the frontend where users interact, handling their requests and displaying the results. The Web Application processes these requests and coordinates with the Backend Server, which is responsible for heavy computational tasks. The Backend Server retrieves necessary data from the Furniture Database, which stores information about various furniture items, and the 3D Model Repository, which contains the 3D models of the furniture. It also integrates augmented reality features through the AR Module, allowing users to visualize and place 3D models in a virtual environment. Finally, the Data Storage section consists of the Backend Database, which holds all persistent data required by the system, and the Backend File System, which manages and stores necessary files like images and 3D models. The user interaction typically involves making a request through the user interface, which the web application processes. The backend server then retrieves and integrates the necessary data and AR features, sending the response back through the web

application to the user interface, providing the user with the requested information or AR visualization.

4. Methodology

The AR interior design website integrates the following technologies to provide a seamless user experience.

4.1 Techniques

- **React.js**

React.js is utilized to display list of furniture that users can place in their AR space. It Provides controls for interacting with AR objects, such as rotating or climbing furniture. It manages the selected furniture space and its properties (position, rotation, scale).

- **Three.js**

Three.js allows to create and manipulate 3D models of furniture items, enabling realistic visualization of interior design concepts. It facilitates user interaction by providing tools for controlling camera movements, object transformations (like rotation and scaling), and implementing animations. Additionally, Three.js supports various materials and shading techniques to achieve realistic rendering effects such as reflections, refraction, and shadows.

Algorithm for generating 3D furniture models using Three.js

Step 1: Initialize Three.Js scene to set up the scene, camera and add lighting to the scene.

Step 2: Define the geometries for different parts of the furniture (e.g.,table leg, tabletop).

Step 3: Define the materials for the geometries (e.g.,wood texture, colors).

Step 4: Combine geometries and materials to form the complete model. Apply transformations (translation, rotation, scaling) to position the parts correctly.

Step 5: Add the assembled model to the scene.

Step 6: Render the scene and update it in an animation loop.

- **Web XR**

It ensures compatibility with Web XR on a vast array of devices, including mobile phones and AR-enabled browsers. It enables interactive features such as gesture recognition and spatial tracking using Web XR API. Web XR is used to create an augmented reality experience that allows users to visualize furniture in their physical environment.

5. Results and Discussion

HTML, CSS, and JavaScript form the core of the User Interface, enabling interaction with the website. The User Interface processes requests, which the Web Application handles by coordinating with the Backend Server to retrieve data and integrate AR functionalities. The Backend Server queries the Furniture Database and 3D Model Repository, using the AR Module to project models into real-world spaces. React.js manages the dynamic display of furniture lists and AR objects, while Three.js creates and manipulates 3D models for realistic AR visualization. Web XR ensures AR functionalities are accessible across devices, allowing users to visualize furniture in their environment through their browsers. This architecture delivers an immersive AR experience for interior design, aiding users in making informed purchasing decisions.

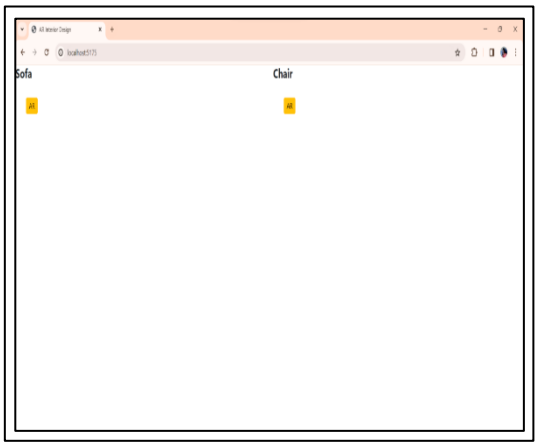

Figure 2. Web Page

Figure 2 illustrates that the user enters the webpage and selects a piece of furniture. Different furniture options can be selected one at a time. After choosing a model, click 'AR' option is used to experience the future of furniture shopping with our interactive 3D models.

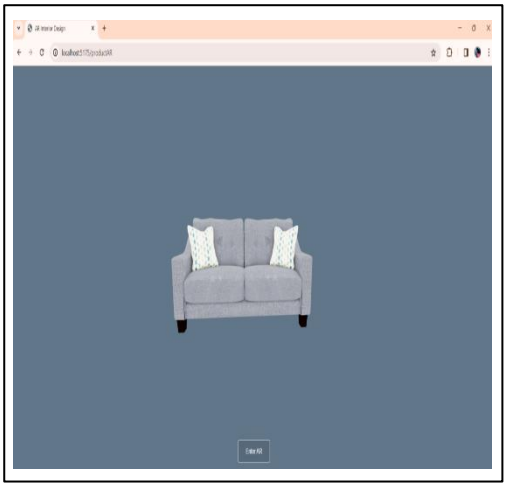

Figure 3. 3D Model

Figure 3 illustrates that, using the menu slider, the user can select different pieces of furniture. Once a piece is chosen, the user can tap on the coloured plane to view a 3D model showing the actual placement location of the furniture. To place the model in augmented reality, simply click 'AR

Figure 4. Object Placing

Figure 4 illustrates that once the furniture has been rendered, the user can view it from different perspectives. Additionally, the user can manipulate the furniture using gestures: dragging to move it around the environment and using pinch gestures to rotate it.

6. Conclusion

Integrating augmented reality (AR) into furniture design websites enhances customer experience by enabling real-time visualization of furniture in users' spaces, addressing concerns about fit, style, and functionality. AR bridges the gap between imagination and reality, offering an immersive platform that enhances user experience. Customers can use smartphones or tablets to digitally place virtual furniture, assess factors like scale and colour coordination, and

experiment with design configurations for informed decision-making. Despite its benefits, implementing AR involves challenges such as technical complexity, the need for high-quality 3D models, and seamless integration with e-commerce platforms, requiring significant investment and expertise.

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