AUGMENTED REALITY INTERIOR DESIGN APPLICATION

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Abstract: *Augmented reality (AR) has emerged as a transformative tool in modern interior design, enabling enhanced spatial awareness, real-time visualization, and interactive decision-making. This project introduces an Augmented Reality Interior Design Application which help to improve spatial visualization of spaces and provide multiple components of interior planning through dynamic interactions. Designed in Unity engine using AR Foundation, Android, the application has two main functions: examine furniture and measure a room. Upon entering the Examine Furniture mode, users can scan their surroundings to find flat surfaces and drop virtual 3Dfurniture models. Options include changing furniture colors, positioning several models, with realistic shadows and lighting, and stripping away objects or surface texture. This will allow the user to visualize furniture set-ups in their own real-world space before physically making changes to their home or buying new furniture. The Measure Room mode provides a function for the user to measure how far different points are from each other on the detected surfaces using a tap-and drag motion while the measured value is displayed in inches. This help facilitate measuring space and get measurements when planning layouts and measuring for furniture. The app has user-friendly and simple layouts, smooth flow even on older Android devices and provides a functional solution. By incorporating AR technology, the app improves the aspect of concept and reality; whether for imagination or action it allows the user the ability to access their situation with knowledge and provides immersive experiences.*

Keywords: Augmented Reality(AR), AR Interior Design, Real-Time Visualization, Room Measurement, 3D Furniture Placement, Unity 3D, Mobile AR Application

1. Introduction

Interior design has historically relied on 2D blueprints, physical measurements, and 2D renderings which can often lead to misjudging the space and scale of the design. Thanks to advances in spatial computing and mobile augmented reality (AR), designers and buyers now have interactive resources to facilitate their spatial awareness and make informed decisions about their interiors. A member of XR (Extended Reality), Augmented Reality allows digital content to be overlaid on the physical world providing feedback in real time and immersing the user experience using devices with depth sensors, cameras, and AR-specific SDKs. To respond to the distance between conceptual design to physical design, a Unity Engine based AR application for interior design was developed with AR Foundation and ARCore on Android devices. The system consists of two modules: Examine Furniture and Measure Room. The Examine Furniture module uses surface detection and plane tracking to permit users to place, manipulate, and customize photorealistic 3D furniture models within their environment. It even allows for material switching based on mesh renderer controls, and lighting will be estimated for appropriate rendering.

The Measure Room mode employs raycasting and vector calculations to accurately measure distances between anchor points, and provide accurate spatial measurements in inches. These technical developments allow users to easily visualize, analyze, and change interiors in real time - all while providing an understanding of the real-world scene, and providing a clear and easy-to-use UI turned

mobile AR into a user-friendly and seamless tool for interior design.

2. System Architecture

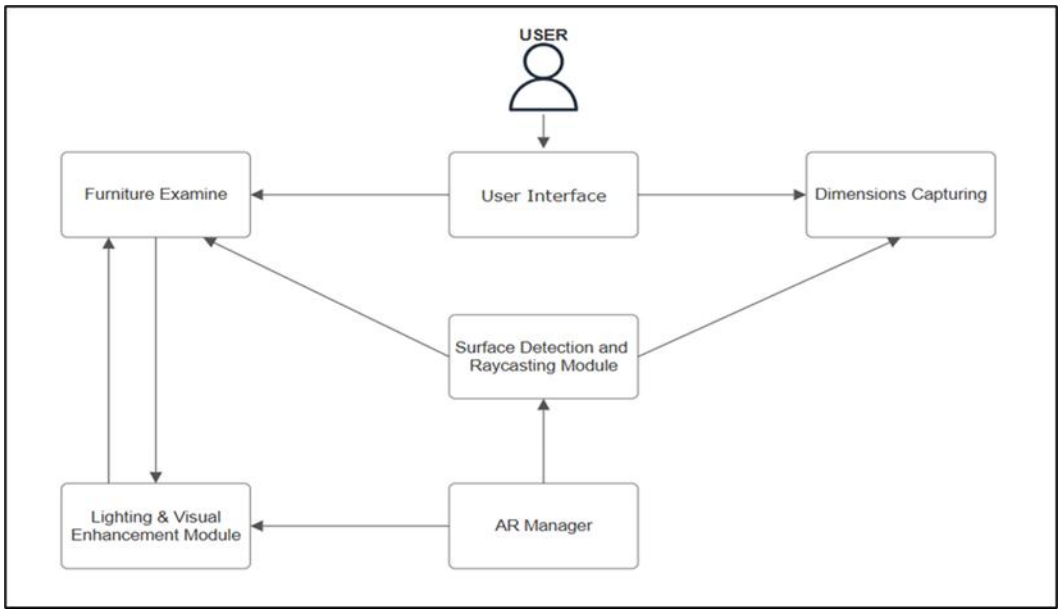

Figure 2.1: System Architecture

Figure 2.1: The Augmented Reality Interior Design Application is based on a modular architecture that guarantees real-time interaction, spatial tracking, and ease of use. The User Interface is the main part of the system, and it is the place for the user to access the two main functionalities of the app; Furniture Examine, and Dimensions Capturing. Upon launching the application, the user interacts with the main interface to either place and customize virtual furniture, or measure distances between points in the physical environment. The application also has tutorials and related messages based on the mode to help guide the users make their interaction with the app straightforward.

The system is reliant on the Surface Detection and Raycasting Module for both functionalities. This module detects surfaces in the physical world utilizing AR Raycasting technology. The Surface Detection and Raycasting Module makes its information available to the AR Manager that is in charge of the AR session on the device, which includes tracking the environment and input from the camera. Once it detects surfaces in the environment, users can touch the surfaces to place virtual furniture or to establish points of measurement.

In the Furniture Examine mode, the surface information is used to anchor a virtual 3D furniture model into the real world, which the user can move, resize, rotate, or alternate with an alternate material. To enhance the realism of the scene, the Lighting and Visual Enhancement Module introduces light, shadows, and material rendering to the experience based on the detected lighting captured by the device, allowing the virtual objects to appear realistically within the physical space.

In Dimensions Capturing mode, users can tap and drag between two points that are detected on a given surface. The system then calculates the difference points to find out how many inches exist between these points. Dimensions captured using this method can now be used for planning layout purposes while ensuring the measurement is accurate for furniture fitting. In both modes, the Surface Detection and

Raycasting Module handles all the spatial interactions to ensure the mapping remains responsive and accurate.

Overall, the system provides an immersive and real-time Augmented Reality experience that combines user input, spatial detection, visual enhancements, and measurement capabilities to assist users in visualizing and planning their interior arrangements prior to making physical adjustments.

3. Development and Deployment

The application was developed using the Unity Engine and AR Foundation, with support for Google ARCore, targeting Android platforms. Various methodologies were employed to implement the application's features, as outlined below:

1.Surface Detection and Visualization:

Accurate surface detection is crucial for anchoring virtual objects. The application used AR Foundation and Google ARCore, which enables the application to continually survey the environment using the device's rear camera.

- The **ARPlaneManager** component detects planes horizontally-aligned surfaces, this is done by detecting depth and visual features in real-time.
- When a plane is detected, it is rendered as a temporary mesh overlay with Mesh Rendering that tells the user where they can place valid anchors.

2.Object Placement:

The **ARRaycastManager** recognizes when users tap on their screens to project raycasts into the AR world and find intersections between the raycast and detected planes.

- When the user selects the right 3D furniture model, we create (or instantiate) it at the valid pose using Unity's **Instantiate()** method.
- To maintain stable spatial conditions, we utilize **ARAnchorManager** to attach anchors to the placed objects to maintain the correct position in the physical world and afford the user to place multiple models.

3.Object Manipulation:

- Users can manipulate furniture that has been placed through gestures, such as dragging (translating), pinching (scaling), and twisting (rotating).
- Gesture recognition functionality is accomplished using Unity’s **ARGestureInteractor** and custom gesture scripts. The gesture scripts interpret the user's touch inputs and real-time transformations are made to an object’s Transform component.
- The VariantSwitcher script also allows for visual customization of furniture materials and textures by dynamically applying user selected finishes at runtime.

4.Measurement Logic:

- Distances between two selected points are computed through Unity's **Vector3.Distance()** method to acquire correct linear measurements and measurements are shown in inches.
- A **LineRenderer** component draws a line that visually connects the measured locations within the AR environment for immediate user feedback.

5. Lighting and Surface Realism:

- Ambient lighting conditions are captured in real-time with **ARCameraManager** and **ARLightEstimationData**, which provides brightness and color temperature data.
- **AREnvironmentProbeManager** works with environmental reflections and light probes to simulate light interactions in the real world, increasing the realism of virtual objects.

Deployment:

- The application does not require any external or internal database, as all the furniture models are pre-embedded within the application. Since there is no user-generated or dynamic data to store, no database integration is necessary.
- The deployment process is straightforward. Unity enables direct export of the project as an APK, which can be installed on any compatible Android device.

4. Results

The application is tested in different environments and it provides the results efficiently according to the requirement of the users.

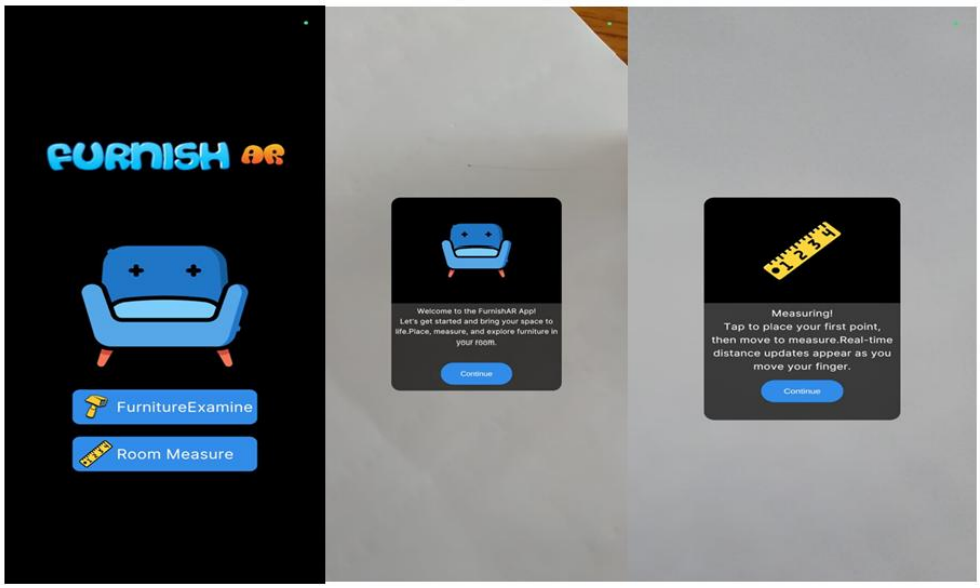

FIGURE 5.1 UI of the Application

Figure 5.1: The image shows some of the UI scenes application Furnish AR which include home page of the providing two buttons to explore furniture and take measurements of rooms, A greeting message greets the user and describes how the app allows them to place, measure, and visualize furniture in their room and provides instructions for the measurement feature.

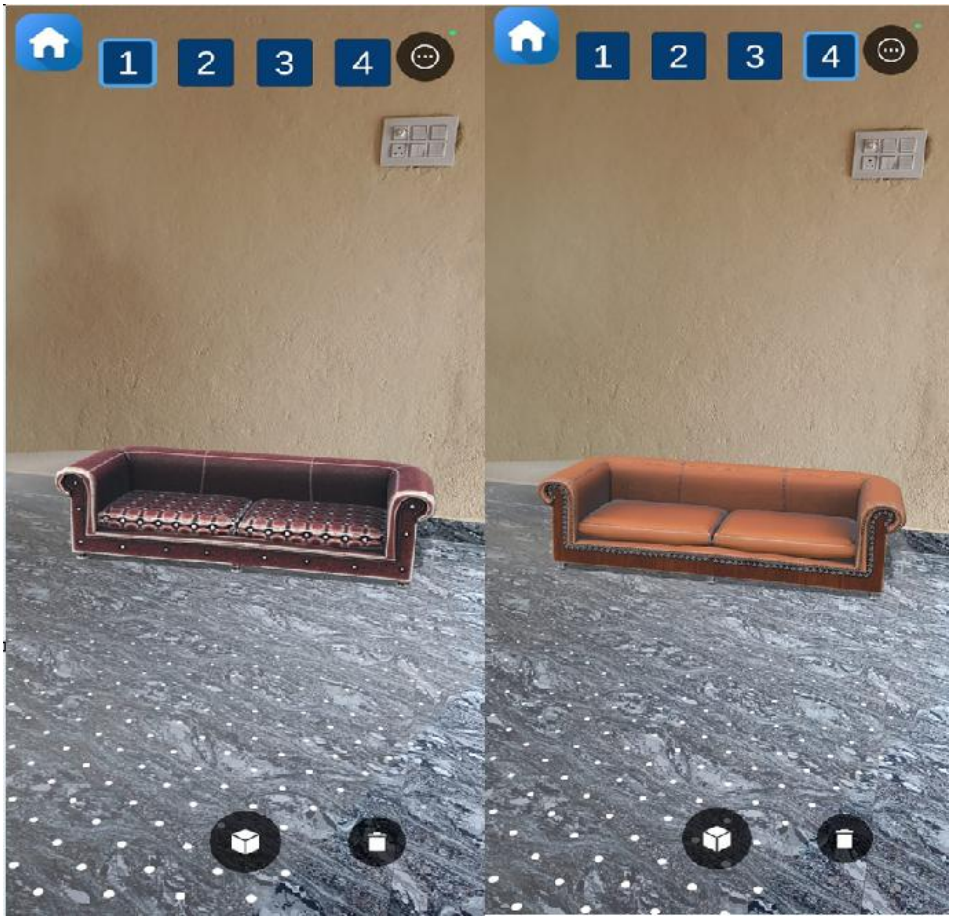

FIGURE 5.2 Single Object Placement and Customization

Figure 5.2: The above image Displays the virtual surface (dotted) over the original surface, so that users can see flat areas where they placed furniture models. This sight helps enhance precision in the placement of objects and a natural reference for scale and alignment. Then users can choose furniture from the catalog, place it on the detected surface, and adjust the color, material, or size according to design preference, allowing for a fully immersive interior planning experience.

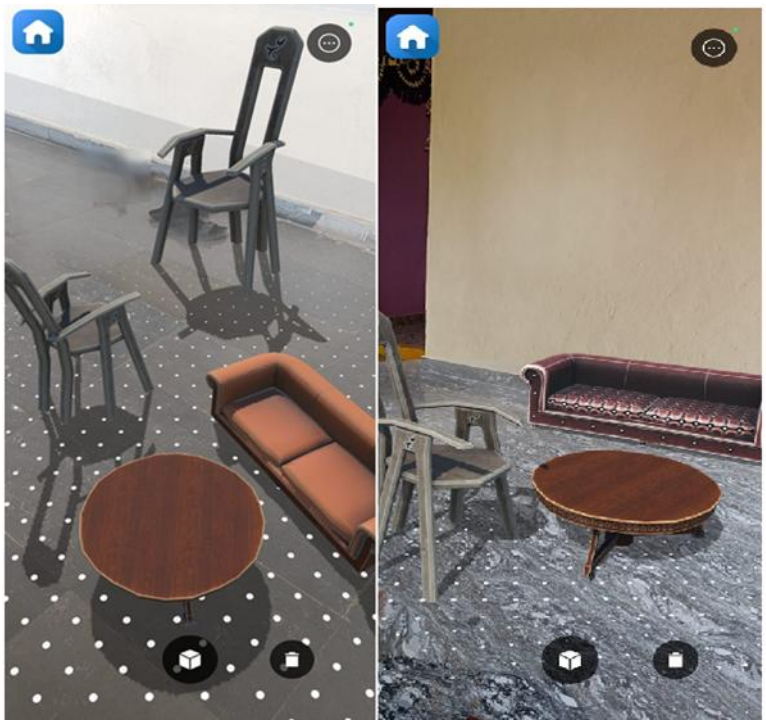

FIGURE 5.3 Multi-Object AR Placement with Lighting and Shadows

Figure 5.3: Demonstrates the app's ability to position and render multiple 3D models of furniture within a physical environment using AR. The virtual objects are anchored correctly on a detected surface, allowing users to place and rearrange items as they please. Real-time lighting estimation is applied, creating realistic shadows and lighting based on the ambient light captured. This improves depth perception and spatial realism, which helps users imagine what a number of different furniture combinations might look like in their real living room.

FIGURE 5.4 Dimension Capturing

Figures 5.4 demonstrates the measurement function where users are able to measure physical distances in their own context by finding and selecting points on the scanned surface. By pressing the screen and dragging across the points, the system can calculate the linear distance, thus providing accurate measurements to help with planning space layouts and fitting furniture. The real-time measurement reflects the spatial dimensions when finished, allowing the user to better conceptualize spatial relationships.

5. Conclusion

The AR Interior Design Application created from this project successfully illustrates the potential of augmented reality to complement the conventional interior design process. Making use of Unity and AR Foundation, the application allowed users to scan a space for a real-time view of the environment, measure spaces with accuracy, and view 3D models of furniture. The interactive object placement, material selections, and matching of shadows through lighting all allow for vivid, realistic design opportunities.

The user interface of the application was designed to encourage usability and simplicity for the user, allowing for effortless execution of functions such as examinations of furniture and space measurements. Extensive testing solidified the accuracy of the measuring tool, the reliable interactive functions of objects, and the stabilized functionality of the system in varying kinds of lighting, and on varying types of surfaces.

Each feature was tested thoroughly, and collectively demonstrate the system's functionality and usability in practical use. Overall, this project underscores the potential for augmented reality to bridge the gap between what is imagined and what is executed in interior design projects, providing a functional, simple application option for designers and consumers alike.

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