

CO3302 Computer Engineering
Project

Space Sync

Group Number 09

20/ENG/014

20/ENG/043

20/ENG/157

Abstract

Space Sync is an innovative augmented reality (AR) application developed on the Unity platform, aimed at revolutionizing the way users interact with their physical spaces. Leveraging the power of AR technology, Space Sync enables users to seamlessly integrate virtual furniture into their real environments, offering a unique and immersive experience in interior design.

This project focuses on bridging the gap between the digital and physical worlds, allowing users to visualize and interact with furniture in real-time. By employing Unity's robust capabilities, the application provides a user-friendly interface for placing, rotating, and exploring virtual furniture within the confines of their physical surroundings.

Key features include precise spatial mapping, ensuring accurate placement of virtual objects in relation to real-world structures. The application incorporates an extensive library of furniture models, offering users a diverse range of customization options to suit their preferences and design aesthetics. The intuitive controls and real-time rendering contribute to a seamless user experience, fostering creativity and exploration.

This report outlines the development process, challenges faced, and the technological considerations that have contributed to the success of Space Sync. By combining cutting-edge AR technology with Unity's versatile platform, the project aims to redefine the boundaries of spatial design and user engagement in augmented reality applications. Space Sync stands as a testament to the capabilities of Unity in creating immersive and interactive AR experiences, with potential applications extending beyond virtual furniture placement into various domains of augmented reality.

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1. INTRODUCTION

In the ever-evolving landscape of interior design, the integration of cutting-edge technologies has become a catalyst for transformative experiences. The advent of Augmented Reality (AR) presents a paradigm shift, enabling users to transcend the confines of imagination and visualize prospective designs in the context of their own living spaces. This project introduces a groundbreaking mobile application that leverages AR to revolutionize the way individuals conceptualize, plan, and execute their interior design aspirations.

The primary objective of this application is to bridge the gap between imagination and reality, offering users an immersive platform to experiment with furniture placement virtually. By seamlessly integrating digital elements into the physical environment through the lens of a mobile device, users can explore a dynamic and interactive design process that was once confined to the realm of blueprints and sketches.

The significance of this project lies in its potential to democratize interior design, making it accessible and engaging for users across diverse demographics. From homeowners seeking to revitalize their living spaces to professional designers looking for a tool to streamline their creative process, this AR application promises to be a game-changer.

This report will delve into the development process, key features, and the technological backbone of the application. Furthermore, it will explore the potential impact on user experience, market dynamics, and the broader landscape of interior design.

2. OBJECTIVES

1. Develop a Single Mobile App for Ease of Interior Designers:

The primary objective of this project is to create a unified mobile application tailored to streamline and enhance the workflow of interior designers. By consolidating essential design tools and features into a singular platform, the aim is to empower designers with a cohesive and efficient solution that simplifies the intricacies of their profession. This includes incorporating design elements, furniture catalogs, and visualization tools to amplify the creative capabilities of interior design professionals.

2. Enable Users to Have an Augmented Experience via a Mobile App:

Harnessing the potential of Augmented Reality (AR), the application seeks to provide users with an immersive and augmented experience. Through the lens of their mobile devices, users can engage with virtual elements seamlessly integrated into their real-world living spaces. This objective aims to redefine the user's interaction with interior design, offering a novel and visually rich experience that transcends traditional design methodologies.

3. Allow Users to Place Furniture in Their Own Living Spaces:

One of the core functionalities of the application is to empower users to virtually place furniture within the confines of their own living spaces. This objective caters to the inherent need for personalization, enabling users to experiment with different furniture layouts and configurations without the physical constraints of moving furniture in reality. By providing a platform for this virtual experimentation, the application aims to revolutionize the decision-making process for users seeking to enhance their living environments.

4. Provide User-Friendly Interface:

Creating a user-friendly interface is crucial for the application's success. This involves developing an intuitive and accessible platform for a diverse user base, including both professionals and homeowners. The interface must guide users through the design process seamlessly, ensuring accessibility to the application's powerful features. This approach enhances the overall experience and promotes wider adoption.

3. ARCHITECTURE OF THE SYSTEM

In the development of this Augmented Reality (AR) interior design application, a robust and scalable architecture has been implemented to ensure seamless integration of new furniture models and efficient data retrieval. The architectural framework is designed to leverage cloud services, specifically Google Cloud, for enhanced accessibility and scalability. The following key points outline the architecture's core components:

01. Data File Management and Cloud Integration:

Developers generate standardized data files (.json, .hash, .bin) for each new furniture model, encapsulating essential information.

These data files are then uploaded to Google Cloud, providing a centralized and scalable repository for storage and management.

02. Dynamic Model Loading and Offline Accessibility:

The application dynamically loads furniture models from the Google Cloud repository when connected to the internet.

A caching mechanism ensures offline accessibility by storing essential data files locally on the user's device, guaranteeing a seamless user experience even without an internet connection.

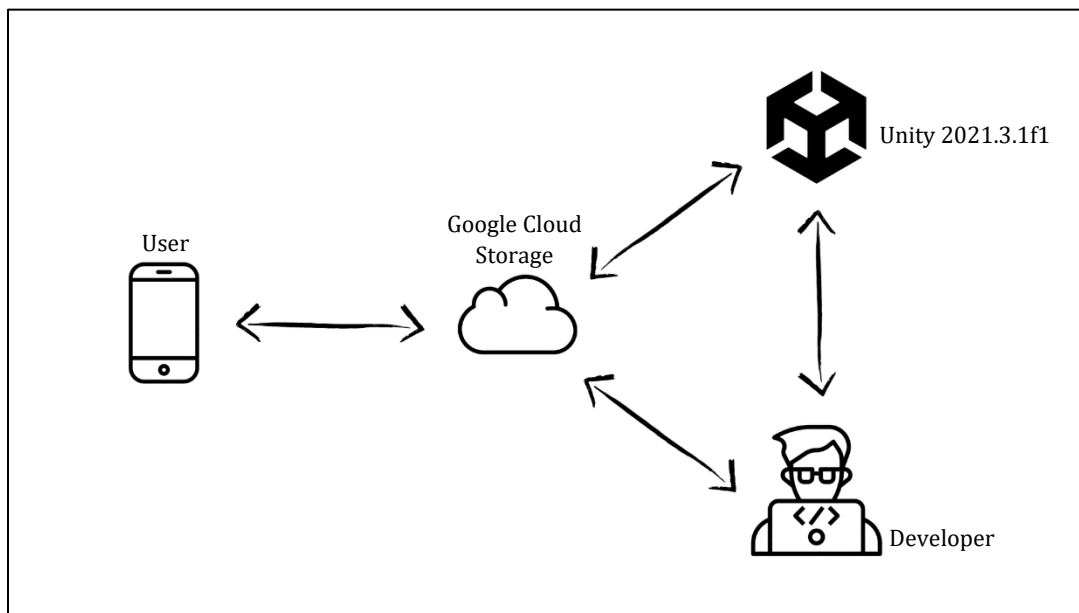


FIGURE 1: ARCHITECTURE OF THE APPLICATION.

4. TECHNOLOGIES USED IN DEVELOPING

Unity Platform (2021.3.1f1)

This is the main platform that we used for the development process. Unity is a powerful and versatile game development engine that has gained widespread acclaim for its applicability beyond traditional gaming contexts, making it an ideal choice for augmented reality (AR) applications. Unity facilitates the creation of immersive and interactive experiences by providing a robust set of tools and features. Its user-friendly interface allows developers to seamlessly design, prototype, and deploy AR projects across various platforms. Unity's cross-platform compatibility ensures that AR applications can reach a diverse audience, enhancing accessibility and user engagement. Furthermore, Unity's extensive asset store and a vast community of developers contribute to a rich ecosystem of pre-built assets, plugins, and knowledge-sharing, expediting the development process. In essence, Unity stands as a pivotal technology for AR projects, offering a comprehensive toolkit that empowers developers to bring their creative visions to life.

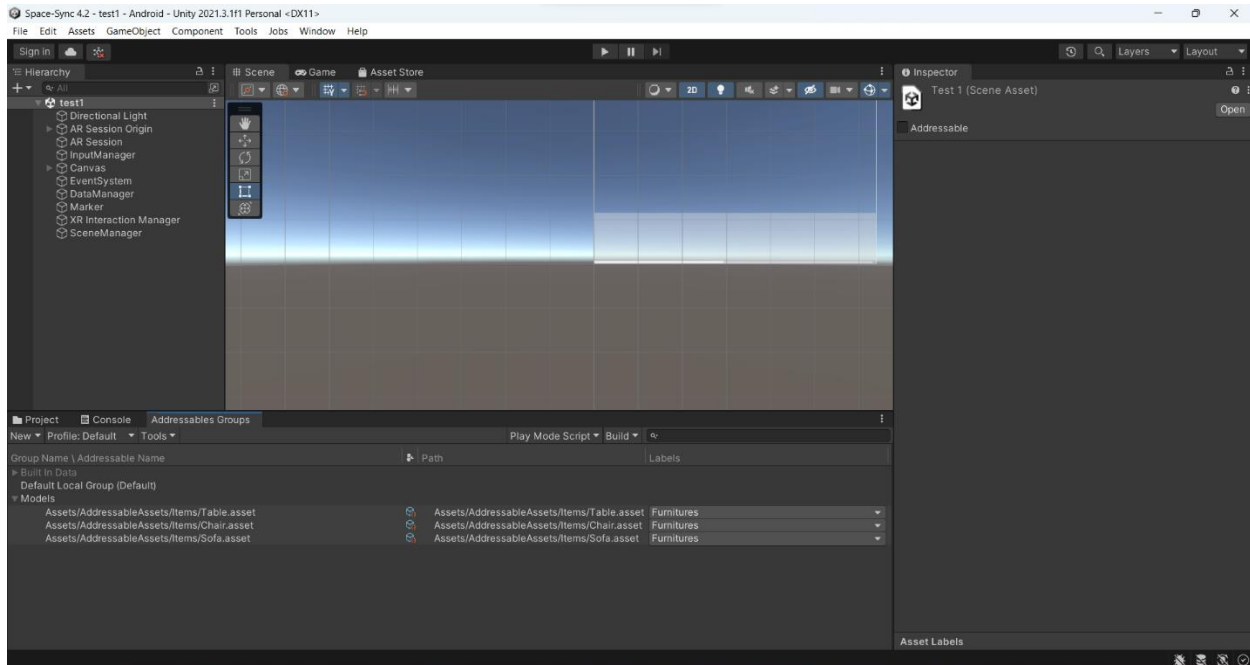


FIGURE 2: UNITY PROJECT DEVELOPMENT INTERFACE.

Depth Sensing

Depth-sensing cameras or sensors, like LiDAR or structured light cameras, provide information about the distance of objects in the environment, enhancing the accuracy of AR interactions. Moreover, gyroscope and accelerometer are also employed much in the detecting process.

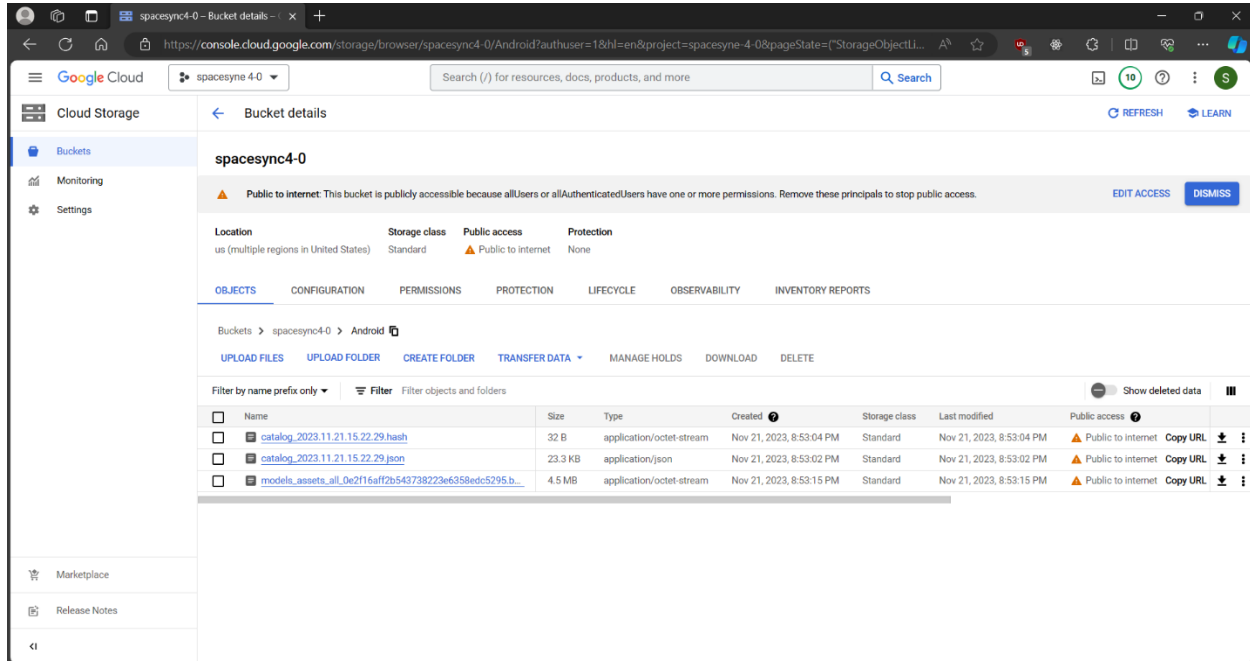


FIGURE 3: GOOGLE CLOUD BUCKET.

Mobile Devices (Handheld AR)

There are several types of augmented reality such as Head mounted AR, Handheld AR, Marker based AR and Location based AR. Here in our project, we used Handheld AR and therefore we used a mobile device capable of working augmented reality. Specially the AR capable mobile devices have special set of tools or the sensors that must have to use augmented reality.

5. GUIs WITH GUIDANCE

There below is the welcome screen of mobile app. There are two buttons and following the explore button you can get a clear idea about how to use the app by placing different objects in the space. The get started button will bring you to the main working screen of the app.



FIGURE 4: WELCOME SCREEN OF THE APP.

Once you clicked the 'Get Started' button, your camera will open, and the app will automatically detected the horizontal plain. Once the plain is detected, a crosshair will appear on the floor as in below image, enabling you to place an object on it. And then once you selected the furniture model it will appear as below.



FIGURE 5: CROSSHAIR PLACEMENT ON THE FLOOR.



FIGURE 6: FURNITURE IS PLACED ON THE FLOOR

When you selected the 'Explore' button you will take into the help window which describe how to use the app.

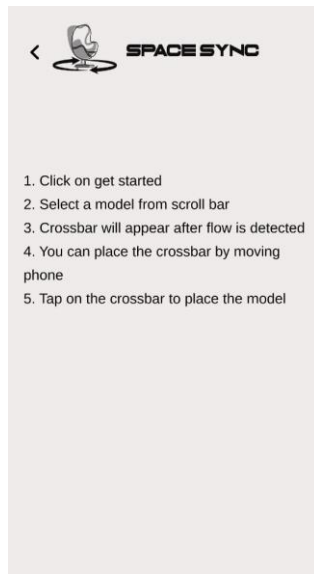


FIGURE 7: EXPLORE WINDOW

The gear button at the top left corner allows you to view the details of each model. Select the model you want to view the details.

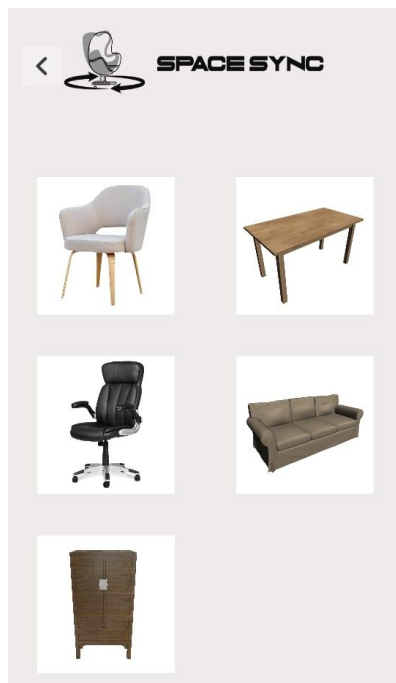


FIGURE 8: AVAILABLE FURNITURE MODELS.

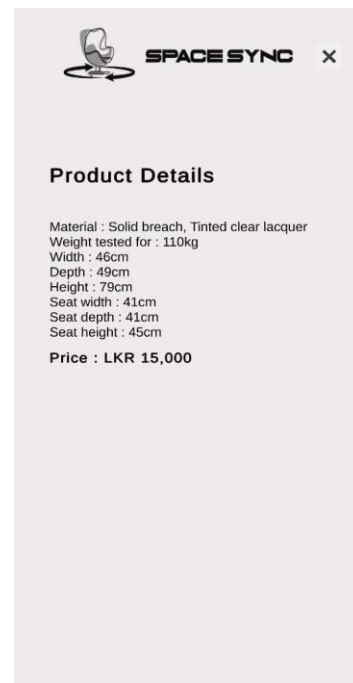


FIGURE 9: DETAILS OF A PRODUCT

This is how you can look when you place the model on the selected plane. The blue color box indicate that it is the current selected object.



FIGURE 10: MULTIPLE FURNITURE MODELS ARE PLACED

6. CHALLENGES

There were few challenges we faced during the development process of this application.

☐ **Accurate Plane Detection:**

- Challenge: Accurately detecting and placing virtual furniture on horizontal surfaces.
- Consideration: Utilizing robust plane detection algorithms, handling changes in the environment, and minimizing false positives/negatives.

☐ **User Interface Design:**

- Challenge: Designing an intuitive and user-friendly interface for selecting, placing, and interacting with furniture.
- Consideration: Implementing a simple and intuitive UI, providing clear instructions, and offering user feedback during interactions.

☐ **Device Compatibility:**

- Challenge: Ensuring compatibility with a variety of AR-supported devices and platforms.
- Consideration: Testing on different devices and platforms, staying updated with AR Foundation updates, and addressing platform-specific requirements.

☐ **Version Compatibility:**

- Challenge: when working with unity there are many versions. In some versions some libraries were depreciated. So debugging the errors were difficult.
- Consideration: Application was developed using the stable versions of unity and followed some courses from learn unity.

☐ **Updating models:**

- Challenge: Updating the existing application with new furniture models with time to time.
- Consideration: Integrate the application with google cloud services. Using this the owners of the application can directly upload their new models to the user application.

□ **User Guidance:**

- Challenge: Guiding users on how to interact with the AR app effectively.
- Consideration: Incorporating tutorials, tooltips, or on-screen instructions to guide users through the app's features.

7. FUTURE IMPROVEMENTS

- Introducing a furniture Catalog Management:

Managing a diverse catalog of 3D furniture models efficiently. Implementing a scalable content management system, optimizing model loading, and organizing the catalog for easy user navigation.

- Launching this application as a commercial application.

As we got an opportunity develop this application further commercially, we will continue the development of this application further for interior design purposes.

- Expect to develop a machine learning model to identify the surrounding and suggest only suitable models.

With the surroundings the objects which are relevant to the area will be suggested to the user. This can be implemented by relevant algorithms.

- Develop detection algorithms further and smoothen the augmented experience.

In some occasions such as when the floor is shiny, reflective or if the floor space is lesser the floor detection takes some time to recognize the floor. Because of that, the floor detection algorithm will be further optimized.

- Add payment gateways considering customer expectations.

If the customer wants to buy some furniture from the stores, then using the payment gateways they can purchase them. This can be implemented when the application is provided to the furniture stores.

8. PROJECT SET UP

Setting up space sync involves several steps. Below is a simplified outline of the project setup using Unity and AR Foundation. Note that this is a general guide, and you may need to adapt it based on your specific requirements and the version of Unity/AR Foundation you are using.

Prerequisites:

1. Install Unity:

- Download and install Unity Hub: [Unity Hub Download](#).
- Create a new Unity ID if you don't have one.
- For the development of the project we used the unity version 2021.3.1f1. because it was one of the stable version of unity.

2. Install AR Foundation:

- Open Unity Hub, create a new project.
- In the project setup window, choose "Universal Render Pipeline" or "Built-in Render Pipeline" based on your preference.
- Add AR Foundation and AR Subsystems packages:
 - Go to Window > Package Manager.
 - In the Package Manager window, click on + (Add package) and add AR Foundation.
 - Add AR Subsystems for the specific platform (ARKit for iOS, ARCore for Android).

Project Structure:

1. Assets:

- **3D Models:**
 - Create a folder for your 3D furniture models.
 - Import furniture models in formats compatible with Unity (e.g., FBX).
- **Scripts:**
 - Create a folder for scripts.
 - Write scripts for AR interaction, plane detection, and furniture placement.

- **Materials:**
 - Store materials for your models.
- 2. **Scenes:**
 - Create a scene for your AR furniture app.
 - Set up the AR Camera and necessary lighting.
- 3. **UI:**
 - Design and implement a simple user interface for selecting and interacting with furniture.

AR Interaction Scripts:

1. **AR Plane Detection:**
 - Write a script to handle plane detection and display.
 - Subscribe to AR Foundation events for plane detection changes.
2. **Furniture Placement and rotation:**
 - Write a script to handle furniture placement on detected planes and furniture rotation.
3. **Crosshair movement:**
 - Crosshair movement is important if the user uses a tablet. Then the user has to use both hands. so crosshair movement is done by moving the mobile device without touching the screen.
 - Relevant scripts are written for the crosshair movement.
4. **Cloud integration and storage:**
 - Write a script to load all the furniture models into a mobile device through cloud storage.

Testing:

- Test your app on AR-supported devices (iOS/Android) to ensure functionality and performance.
- Consider using AR Remote for testing in the Unity Editor.

Additional Considerations:

- **Optimization:**
 - Optimize 3D models and textures for mobile devices.
 - Implement level of detail (LOD) systems for complex models.
- **UI/UX:**
 - Design an intuitive user interface for selecting and interacting with furniture.
- **Testing and Iteration:**
 - Regularly test your app on various devices to identify and fix issues.
 - Gather user feedback and iterate on your app based on user experience.

This is a basic setup guide, and you may need to expand and customize it based on the specific features and requirements