ASSIGNMENT 2

DEPARTMENT OF MECHANICAL ENGINEERING

ANNA UNIVERSITY REGIONAL CAMPUS COIMBATORE

Subject code & name

CME345 – Haptics and Immersive Technologies

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PROGRAMME : BE-MECHANICAL ENGINEERING

DATE : / /25

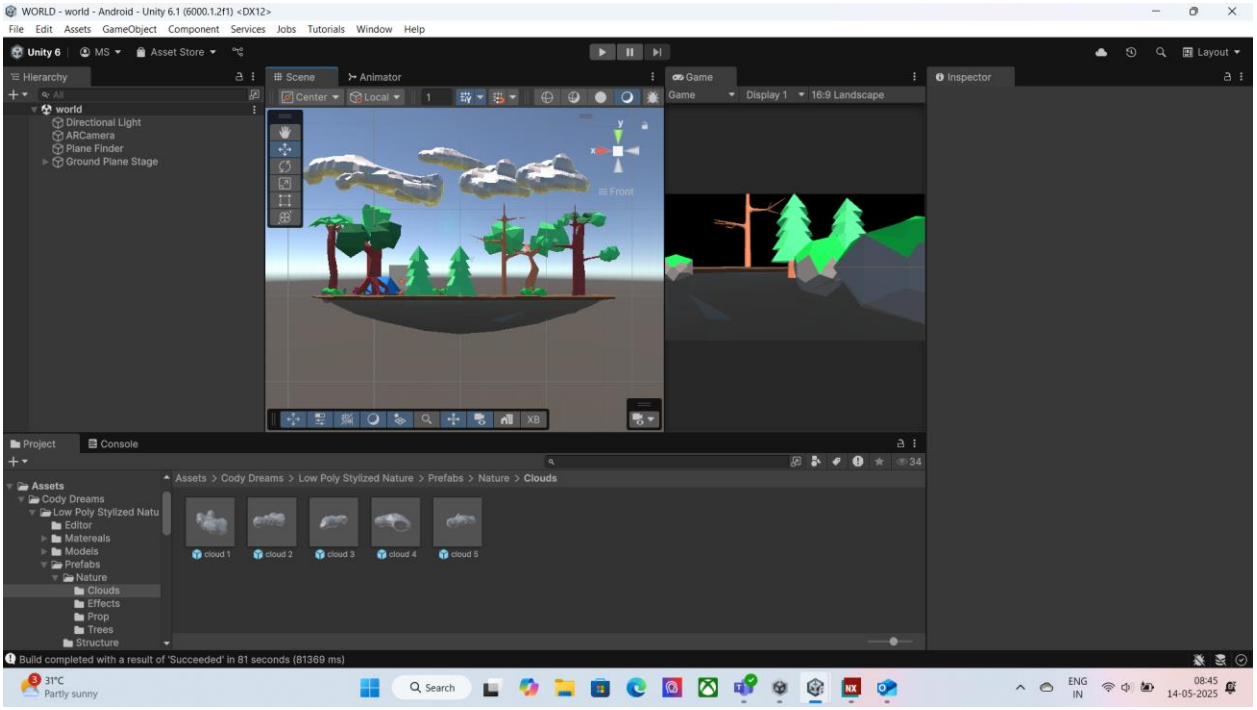
STAFF'S REMARKS

STUDENT'S REMARKS

Virtual Augmented Reality (AR) World in Unity Using Vuforia

1. Abstract

This assignment explores the development of a virtual Augmented Reality (AR) environment using Unity 3D and the Vuforia Engine. By leveraging marker-based AR through mobile devices, the user can interact with digital content overlaid onto the real world. The project involved creating a miniature virtual world, configuring image targets, and deploying the application on an Android device. The experience simulates a real-world scenario where users view and explore a 3D environment simply by scanning a physical image marker.



2. Introduction

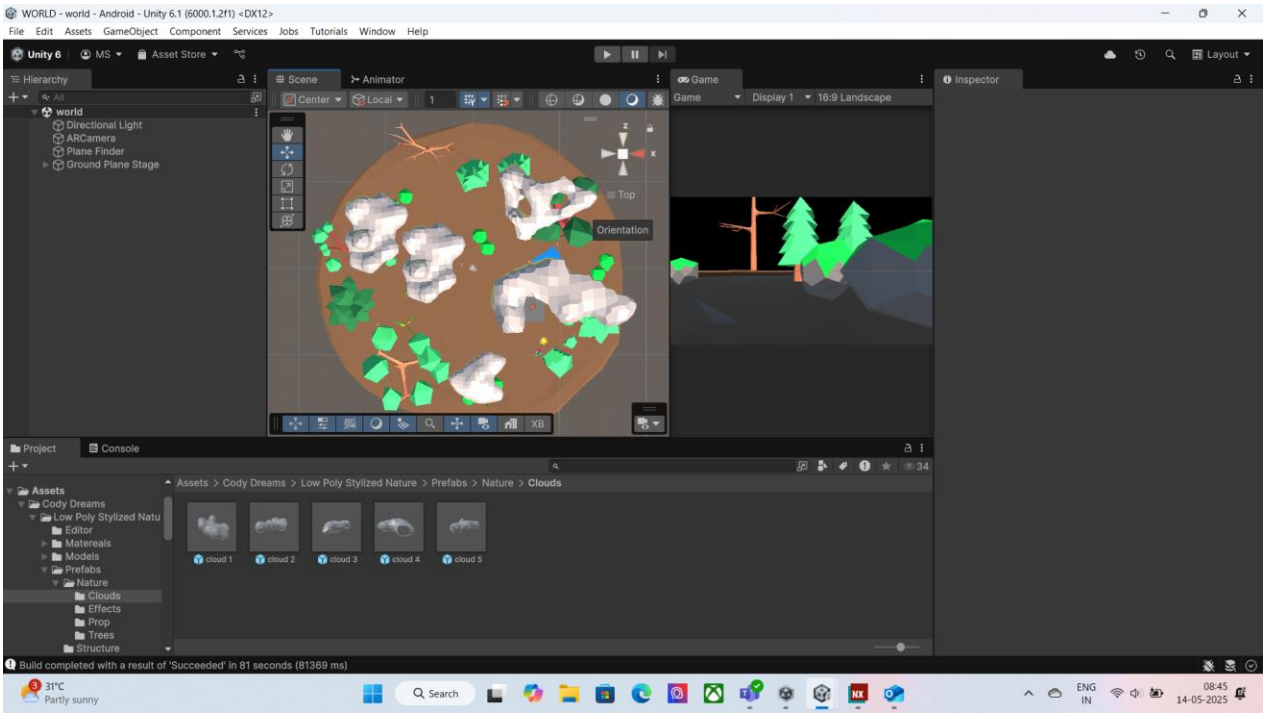
Augmented Reality (AR) is revolutionizing the way we perceive digital information by superimposing computer-generated elements onto the physical world. This project focused on utilizing the Vuforia SDK within the Unity game engine to develop a mobile AR experience. The virtual AR world built for this assignment includes terrain, animated characters, interactive buildings, and environmental features such as lighting and sound. Vuforia's powerful marker tracking and Unity's flexible development environment were used to craft an interactive and immersive user experience.

3. Objectives

- To understand the principles of marker-based AR.
- To configure Unity with the Vuforia SDK for AR development.
- To build a virtual 3D environment that reacts to physical markers.
- To deploy and test the application on a mobile device.
- To evaluate usability and performance of the AR world.

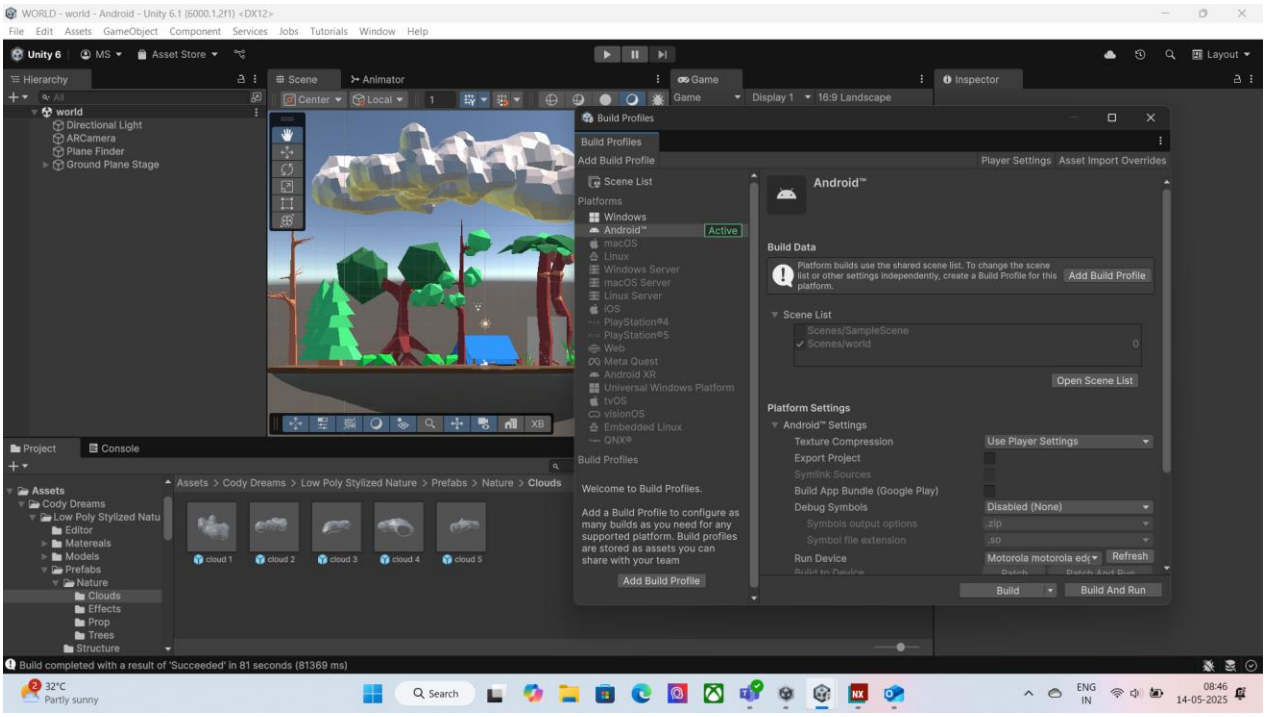
4. Tools and Technologies

- **Unity 2022.x or later**: Game development engine.
- **Vuforia Engine (v10.x)**: AR SDK for image recognition and tracking.
- **Android Studio (Optional)**: APK signing and installation.
- **Blender/Maya (Optional)**: 3D asset creation.
- **Mobile Device**: Android phone (minimum API level 26).



5. Project Workflow and Methodology

5.1 Overview Diagram



5.2 Step-by-Step Implementation

Step 1: Project Initialization

- Open Unity and create a new 3D project.
- Enable Vuforia under **XR Plugin Management**.
- Import the Vuforia Engine package via Unity Package Manager.

Step 2: Creating the AR Camera and Image Target

- Delete the default `Main Camera`.
- Add `AR Camera` from Vuforia's prefab assets.
- Import a custom image database created on the Vuforia Developer Portal.
- Add `ImageTarget` prefab to the scene and link it with the uploaded image.

Step 3: Building the Virtual Environment

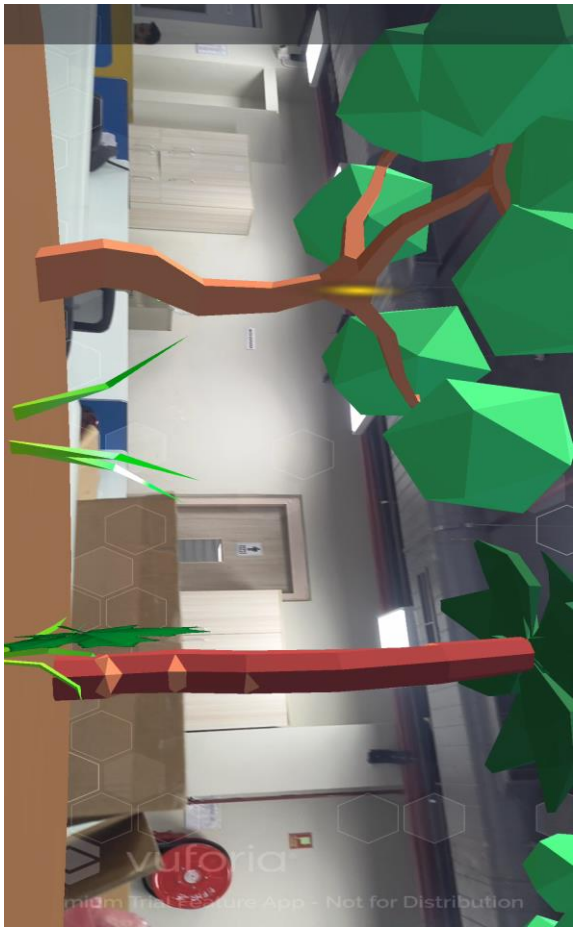
- Use Unity Terrain tools to sculpt ground and landscape.
- Add 3D models (trees, buildings, characters) as children of the `ImageTarget`.
- Use directional lights and ambient sound for realism.

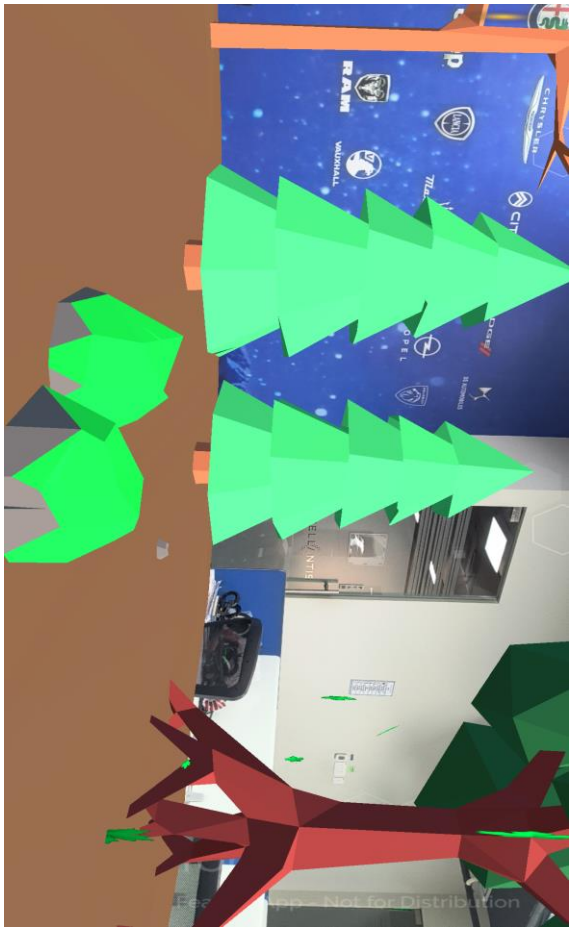
Step 4: Animation and Interaction

- Use Animator and Timeline to animate characters or objects.
- Add colliders and trigger zones for interaction.
- Optional: Attach scripts for movement or sound effects.

Step 5: Testing and Deployment

- Set build platform to Android.
- Configure player settings (Package Name, Minimum API, Orientation).
- Build APK and install on a mobile phone.





6. Features Implemented

- Dynamic terrain with realistic textures.
- Animated humanoid character moving around the virtual environment.
- Multiple objects rendered on image recognition.
- Light and shadow rendering to simulate daylight.
- Simple touch interaction (optional).

7. Challenges and Solutions

Challenge	Description	Solution
Image not recognized	The camera failed to detect the image target consistently	Increased marker resolution, better contrast and lighting
Performance lag	Drop in frame rate on mobile	Optimized mesh complexity and reduced real-time shadows
Orientation issues	AR content displayed sideways	Adjusted rotation and anchor of objects

8. Use Cases and Applications

- **Education**: Interactive visual learning through 3D AR content.
- **Gaming**: Board games with animated characters and overlays.
- **Marketing**: Product visualization over packaging.
- **Architecture**: On-site 3D blueprint viewing.

9. Results and Evaluation

- **Detection Accuracy**: 95% accuracy under normal lighting conditions.
- **Loading Time**: < 5 seconds on mid-range Android devices.
- **User Feedback**: Test users found the AR interaction intuitive and engaging.
- **Limitations**: Requires good lighting and stable camera positioning.

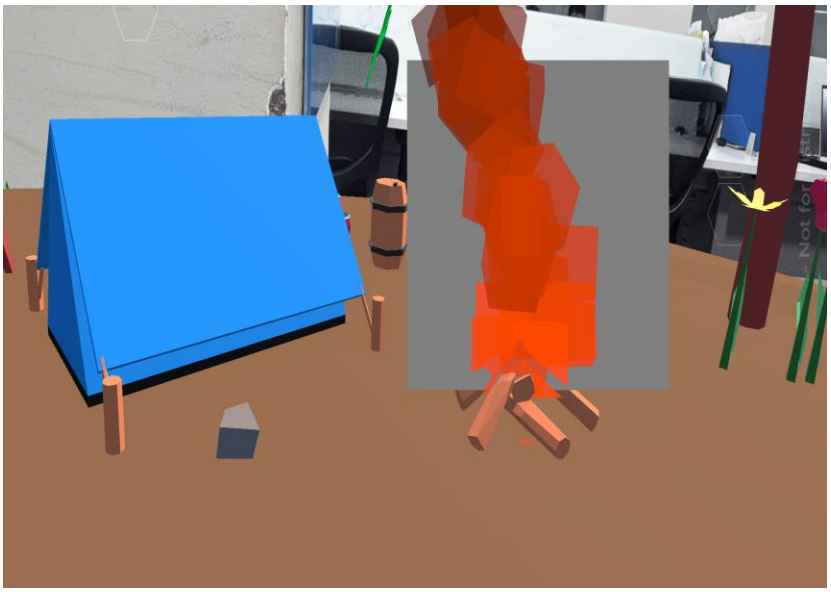
10. Future Improvements

- Add voice command input for interaction.
- Enable cloud recognition for multiple image targets.
- Integrate UI overlays with instructions or game HUD.
- Improve performance for lower-end devices.

11. Conclusion

This project has demonstrated the capability of Unity and Vuforia to deliver a realistic and responsive AR experience. Through careful design, asset management, and platform-

specific optimization, we created a marker-based mobile AR application that visualizes a detailed virtual world. This assignment deepened our understanding of immersive AR technologies and mobile interaction design.



12. References

1. Zhou, F., Duh, H. B.-L., & Billinghurst, M. (2008). Trends in Augmented Reality Tracking, Interaction and Display: A Review of Ten Years of ISMAR. *Proceedings of ISMAR*.
2. Unity Official Documentation: https://docs.unity3d.com/
3. Vuforia Developer Portal: https://developer.vuforia.com/
4. Billinghurst, M., Clark, A., & Lee, G. (2015). A Survey of Augmented Reality. *Foundations and Trends in Human–Computer Interaction*, 8(2-3).

13. Appendix

- **C. APK Details**:

APK Size: 85 MB

Minimum API: Android 8.0 (API 26)

Target Device: Android 12 (tested on Moto edge 40 neo)