

Mobile Multiuser AR/VR for Training

Syltinsy P. Jenkins

COSC 829 Advanced Virtual Reality Systems

*Department of Computer Science
Bowie State University
Bowie, USA*

Instructor: Dr. Sharad Sharma

Introduction

- COVID-19 required quarantines and shutdowns that require the use of remote online education and training.
 - Parents and teachers note:
 - Students are less attentive and engaged in online class
 - Students choose to spend more time engaged in social media and online gaming
- What is the difference? Interactive and immersive content.
 - Prior studies demonstrate an improvement in attention for users engaged in immersive experiences.
 - Augmented and virtual reality may be able to provide more immersive and engaging experience platforms for learning.
 - Which is better for learning, AR or VR?
 - This study aims perform a direct comparison between AR and VR for learning.

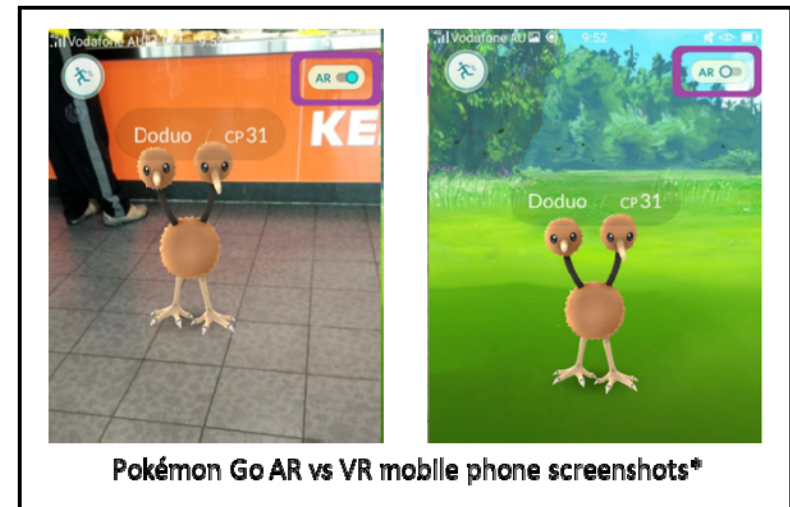
“It is time to change the way we work and study from home”

Goals and Objectives

- Create and compare mobile 3D multiuser interactive augmented reality and virtual reality experiences for training
 - Using a common baseline, compare a mobile AR application to a corresponding mobile VR implementation for training

Background

- The Unity development platform is used to create interactive 3D for AR and/or VR applications.
- Analogous AR and VR experiences for the same educational content can be created using common:
 - Codebase
 - Application flow
 - Set of models
- Existing AR/VR application examples:
- Mobile game apps such as Pokémon Go and Harry Potter Wizards Unite



Images from: user106385 <https://gaming.stackexchange.com/questions/272648/theres-a-pok%C3%A9mon-in-the-lebab-store-can-i-turn-off-augmented-reality>

Background

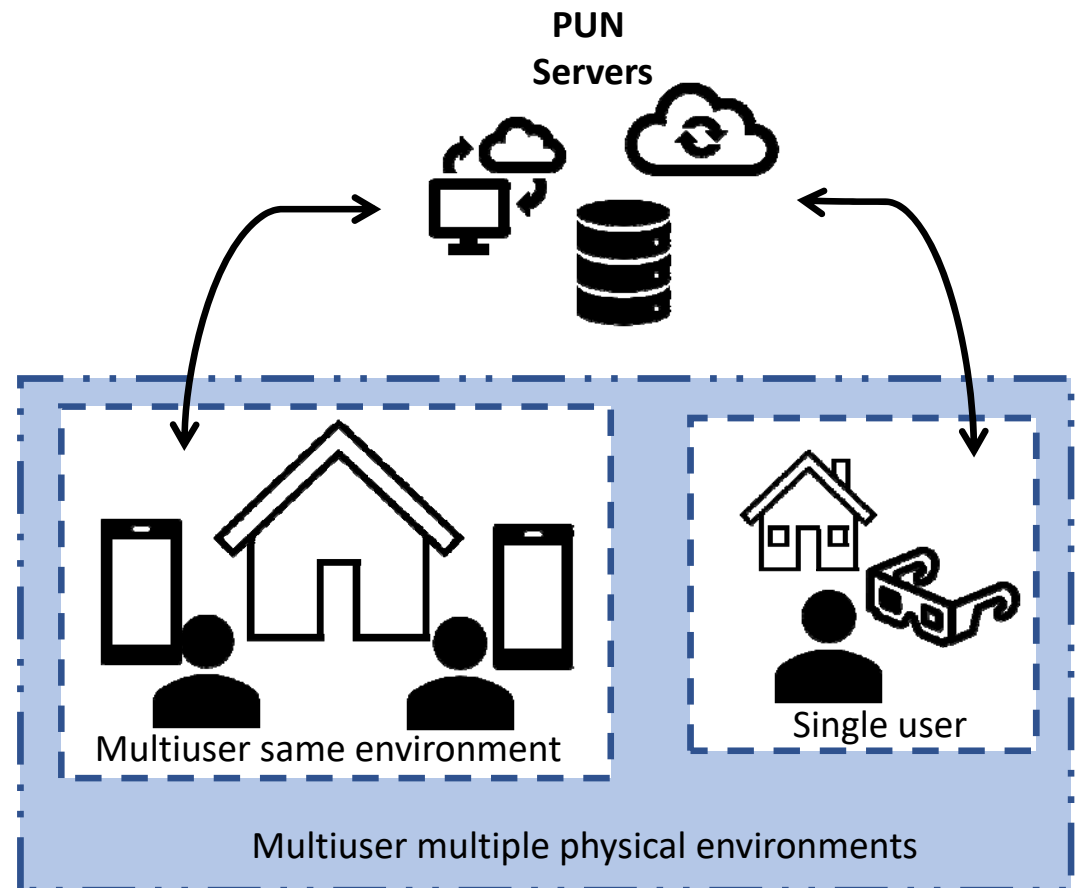
- Users notionally see and feel an immersive difference between AR and VR experiences
- Few studies attempt to quantify and capture AR/VR differences with respect to learning.
- Perspective: 1st Person
 - Often considered more immersive
- Platform: Android Mobile AR/VR
 - Widely available platform
 - Multiple handheld form factors supported
 - Compatible HMD formfactor for 360° immersion via Samsung Gear Oculus and Google VR headsets

Research Questions

- Objectives:
 - To create common 3D multiuser interactive content for training
 - To compare the mobile augmented reality implementation to a corresponding mobile virtual reality implementation
- Which is more immersive, AR or VR?
- Which is more engaging, AR or VR?
- Does AR or VR provide better learning results?

System Design

- Computer
- Software
 - Unity
 - Unity 3D with AR Foundation – AR
 - Android SDK
- Android mobile devices
- AR/VR Environmental Setup
 - AR/VR Single User
 - AR/VR Multiuser mode
 - Same environment
 - Different environments
 - AR/VR Single User



Project Requirements

- Vision: Use of textures and 3D models to provide detailed information in the project.
- Sound: Use speech, music or ambient sounds to help provide information about this place.
 - Speech and background music
- Animation: Use at least three animated object in the project.
 - Wall clock
 - Spinning Tops
 - User selection scene
- Interactivity: Use at least five user-triggered events in the environment.
 - User selection menus
 - Video Controller
 - Spinning Tops
 - User Movements
- Characters: Have animated agents (path following behavior) in the environment.
 - User avatars
 - Virtual instructor
- Sensors: Use at least three different types of sensors (Proximity, Time, Touch, and Visibility) in the project.
 - Timer – lobby open
 - Adjust buttons and levers to place main object into environment
 - Visibility adjusted to transition between AR and VR
- Player: Add a Player Controller to the Scene: 3rd Person Controller
 - AR 3rd person control

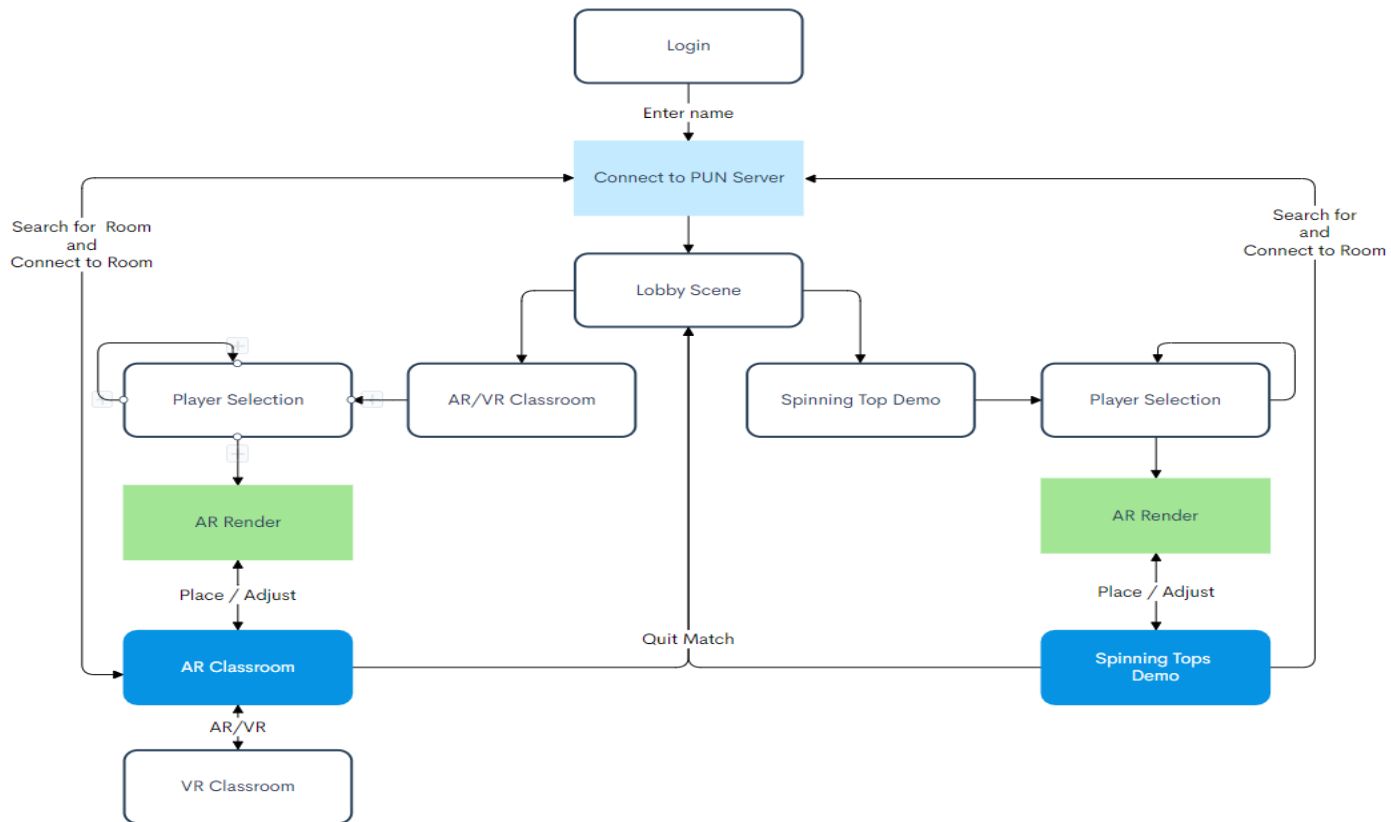
Project Requirements Continued

- Multi-User Environment: More than two people to be present in the same environment.
 - More than 2 person engage at a time
- CUSTOM avatar: (car/fish, etc.) and at least 1 INBUILT avatar in vizard/Unity3D to create the multi-agent system.
 - User avatars
 - Virtual instructor
 - Spinning Tops
- Interface: Design the interface that include menu items such as buttons, etc.
 - Lobby / Player selection
- AI: Implement AI functionality depending upon the project (navigation, behaviors, shortest path, etc.), implement different behaviors (selfish, altruistic, learning, adaptive, etc.) in the environment through a user menu (number of agents assignment).
 - Spinning Top Lag compensation
- Extra Credit: Hardware Integration: Oculus integration or 5DT data glove integration.
 - Stretch - Integrate with oculus

Application Development

- AR and VR are first different scenes developed in tandem
- AR principle development due to external dependency on users to setup the external environment
 - Challenge because there could be a difference between users in a common simultaneous physical environment for AR and different remote environments with simultaneous users of AR
 - Discovered that Plane Detection provided better stability than image target

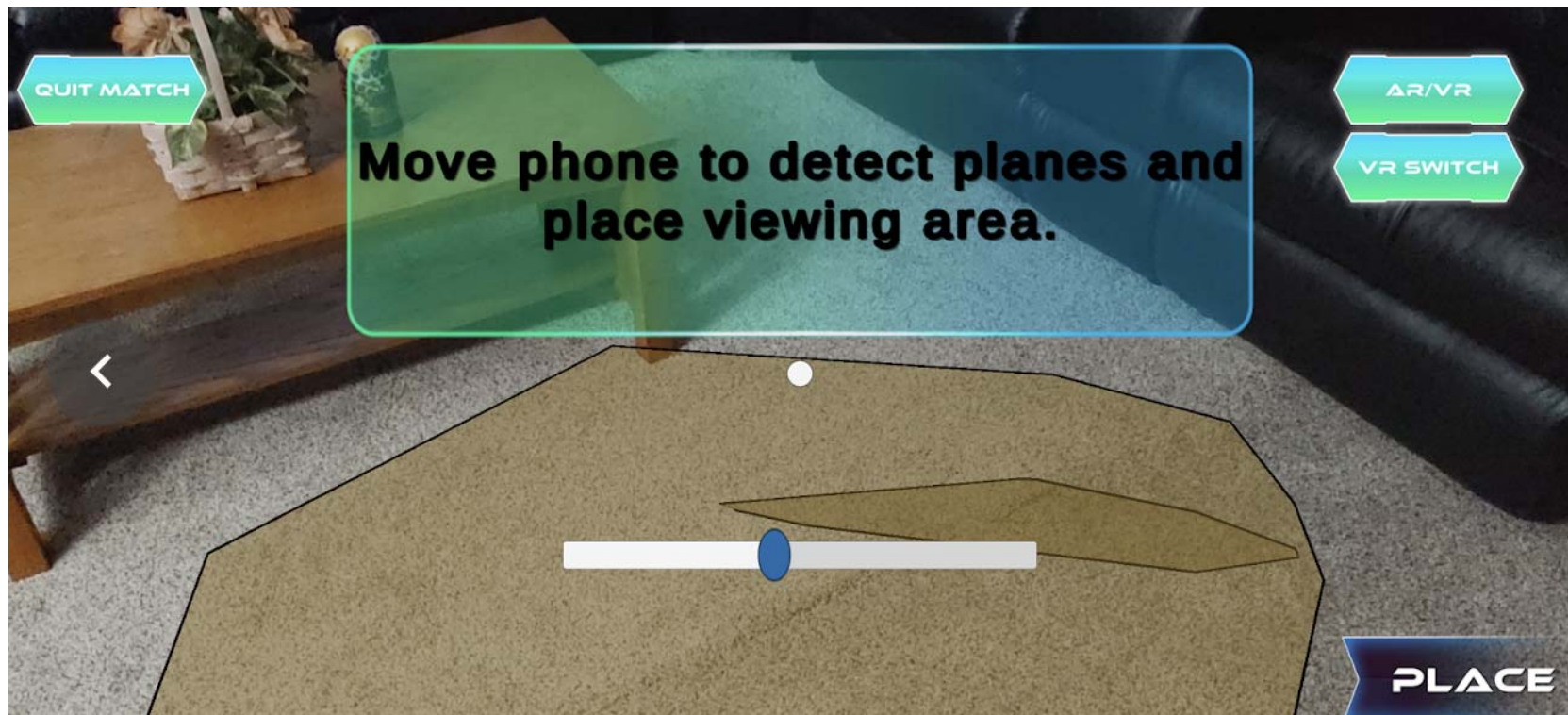
Application Flow



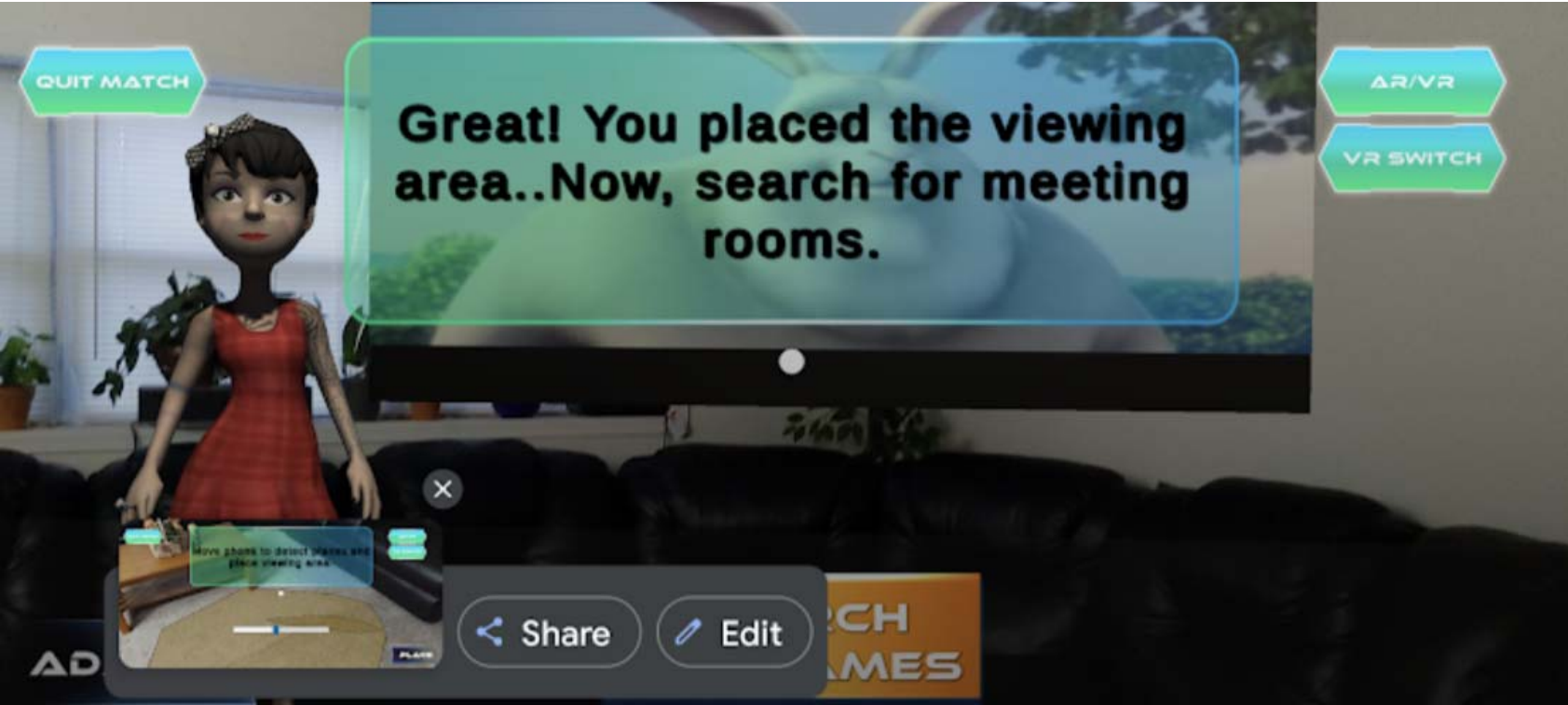
Player Selection



Plane Detection and User Placement



Joining Room



Multiplayer AR Classroom



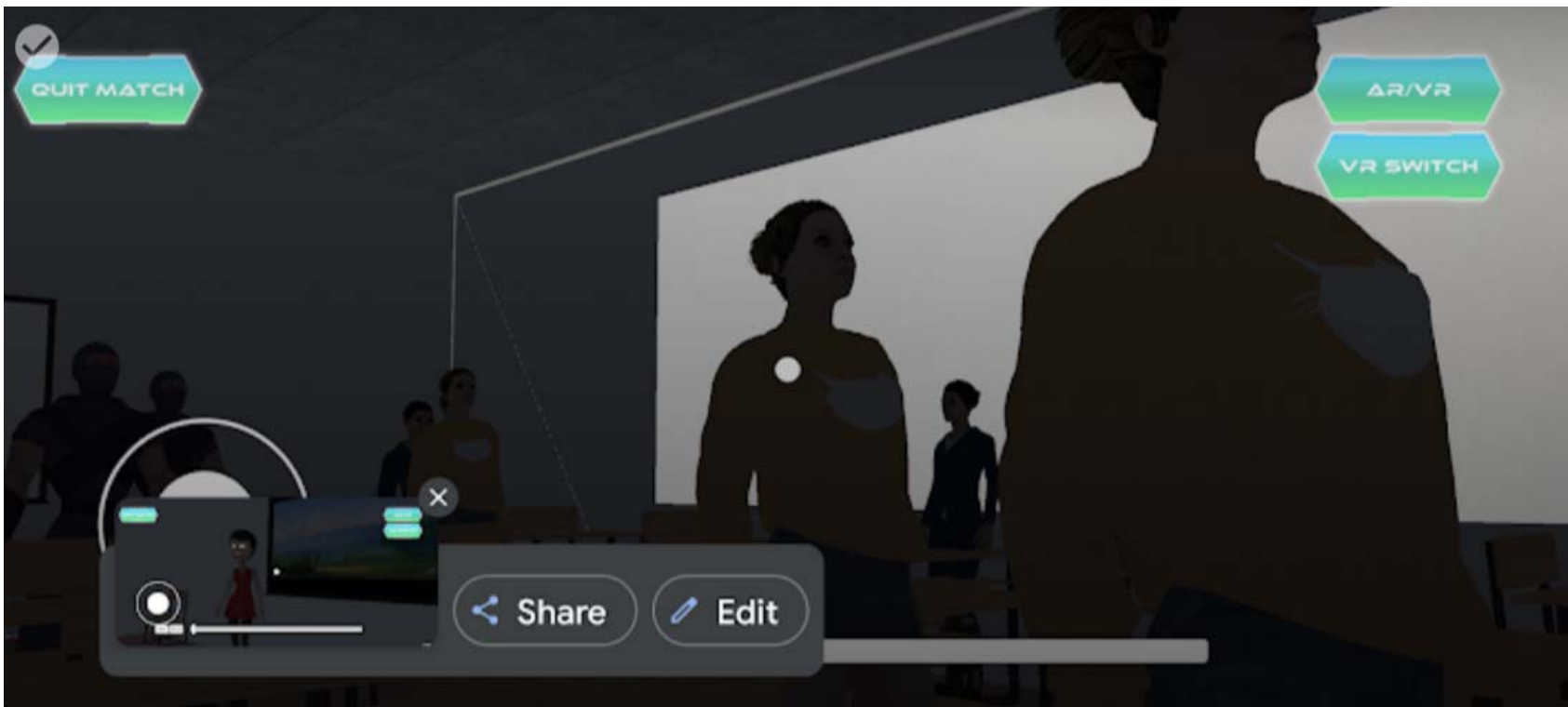
AR Classroom



VR Classroom Overlay



VR Classroom Overlay



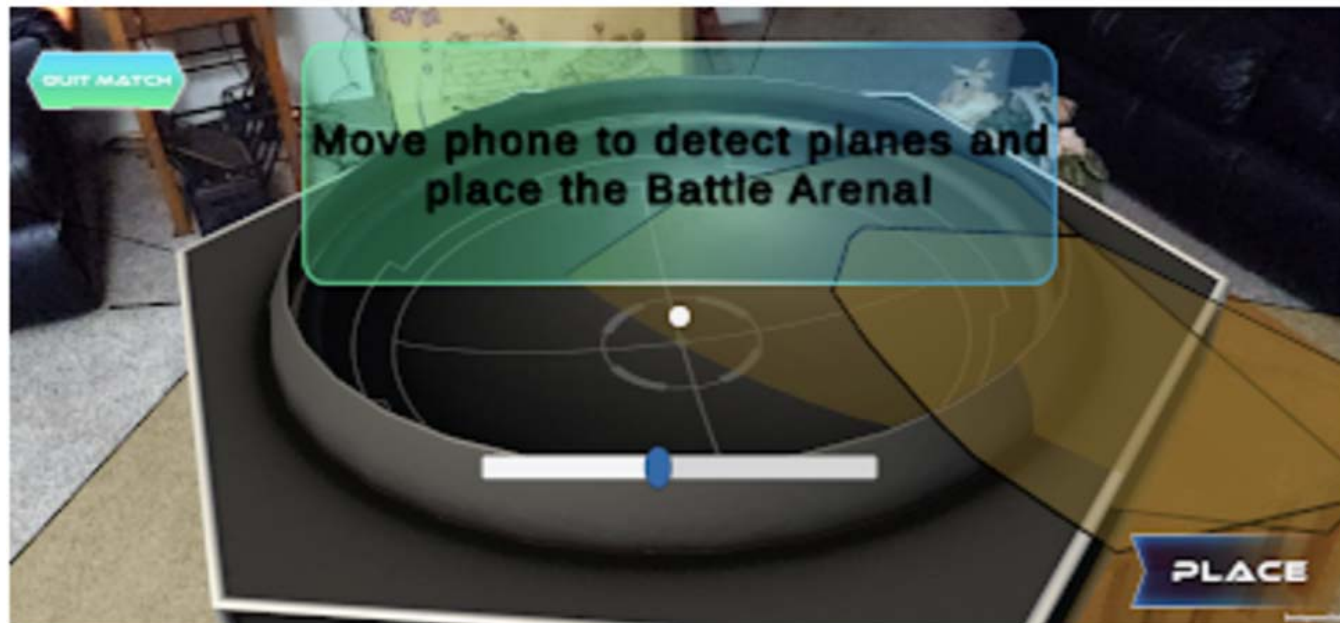
VR Classroom



Player Selection



User Object Placement



Joining Session



Multiuser Gaming



- Leverage built in materials and physics
- Lag compensation
- Multiplayer scoring

Discussion

- Several techniques were investigated for implementing multiuser AR including
 - Vuforia and AR Foundation for augmented reality
 - Photon Unity Network and Player IO were explored during development.
- AR Foundation and PUN were selected for final implementation
 - primarily due to the availability of resources. Plane detection was found to be more stable and useful than image targeting in AR Foundation.
 - AR Image targets were found to be more stable in Vuforia, but combining with Vuforia with multiuser support was more difficult.
 - Vuforia has a separate implementation for supporting multiuser AR. Vuforia also has a development environment that is different than Unity. AR Foundation is developed and maintained by Unity. Similarly, PUN was selected over Player IO due to the availability of resources.

Results

- Potential contribution
 - With further refinements for controlling content, this can contribute to developing an AR/VR platform to learn more about user interaction and learning in a mixed-reality environment.
- Partial success
 - Achieves the objective of having AR and VR transition for a virtual classroom within the same scene
 - Lighting and placement challenges
 - Need more content – animations, interactions, and behaviors
- Next Steps
 - Adding animations and behaviors to the agents and avatars
 - Improve video player synchronization, and correcting AR lighting
- Future Research - Compare AR vs. VR for training
 - Attention, focus, immersion, and interest (AR/VR qualities and characteristics)
 - Test results (requires more research to test educational performance outcomes)
 - Provide insights whether to focus on AR vs VR for education

Conclusion

- This prototype demonstrates that multiuser AR and VR can be implemented with object stability between environments.
 - Successful implementation of a unified multiuser AR/VR design for an AR/VR Classroom
 - Successful implementation of multiuser AR game leveraging synchronization and compensating for lag
 - Extensibility
 - Project assets and design paradigm can be used in AR or VR environments

Video Demonstration Links

Multiuser AR/VR Classroom PC setup

- <https://web.microsoftstream.com/video/8ba532a1-718b-4ce4-910b-3814f1d7d654>

Multiuser AR/VR Classroom PC Running

- <https://web.microsoftstream.com/video/95bf010a-8850-4d15-a732-ee40cb7998>

Mobile Phone Multiuser AR/VR Classroom

- <https://photos.google.com/search/tv/Videos/photo/AF1QipNSkFq4dlbE9k1gGBxyRRFj2Qsx6wFGjW6aMusb>
- <https://photos.google.com/search/tv/Videos/photo/AF1QipNv4ZMfpu0KSzItlvYN9BEAjvQf2vhtUSUBdpdl>

Mobile Phone Multiuser Spinner Top Demo

- <https://photos.google.com/search/tv/Videos/photo/AF1QipMsjSm9coU4PGrwqAVfACEdXkceletLMLFWgEj3>

Questions?

Author: Sultinsy P. Jenkins
jenkinss0218@students.bowiestate.edu

Instructor: Dr. Sharad Sharma
ssharma@bowiestate.edu

Department of Computer Science
Bowie State University
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