

**DEVELOPMENT OF STUDENTS' SOCIAL INTERACTION IN VIRTUAL
ENVIRONMENTS**

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A REPORT
SUBMITTED TO
Universiti Tunku Abdul Rahman
in partial fulfillment of the requirements
for the degree of
BACHELOR OF COMPUTER SCIENCE (HONOURS)
Faculty of Information and Communication Technology
(Kampar Campus)

JANUARY 2023

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ACKNOWLEDGEMENTS

I would like to express my sincere thanks and appreciation to my supervisors, Ts. Saw Seow Hui and my moderator, Dr Mogana a/p Vadiveloo who have given me a golden opportunity to involve in the Virtual Reality field study. It is my first step to establish a career in Virtual Reality field study. A million thanks to you.

ABSTRACT

Virtual reality (VR) technology is the perfect communication tools, which is on the cutting edge of the general evolution of the current communication interface. VR offers user a fully immersive environment and can simulate vivid communication and a social experience that is almost exactly like the real thing. In recent years, VR technologies have mainly been used for leisure activities like gaming and watching videos, or for more traditional uses like meetings or in some professional fields, like medicine, engineering. There are only a small number of VR environments or systems specifically designed for students that allow them to interact socially with others in the virtual environment.

Social distance has been established in the midst of the COVID-19 pandemic, which forbids any face-to-face social interactions between people. The shift to a virtual mode of study limited social contact, and students can only use social media platform to interact with each other, which is a poor substitute for more traditional forms of communication.

This project aims to create a VR environment where students can be socially active among peers and eliminates the condition of going outdoor to perform face to face interaction.

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LIST OF ABBREVIATIONS

<i>VR</i>	Virtual Reality
<i>HMD</i>	Head Mounted Unit
<i>API</i>	Application Programming Interface
<i>UI</i>	User Interface
<i>PUN</i>	Photon Unity Networking

CHAPTER 1

Introduction

1.1 Problem Statement and Motivation

VR technologies, a leading edge of a general evolution of present communication interface, is the perfect communication medium where VR creates a fully immersive environment for user which can also simulate vivid communication and a near true to life social experience. In recent years, VR technologies are being used mostly for entertainment purpose like gaming and video watching, or some conventional uses like meeting and in some professional areas like medical, engineering and so on, there are merely few Virtual environment or system dedicated for students where they are able to establish a social interaction with others within the virtual environment.

Students nowadays are required to have such immersive communication device especially during lockdown where students are forced to study remotely. The shift to a virtual mode of study limited social contact and socialization routines which is a crucial part of students' daily experience especially in the Higher Education Institute. Therefore, students will be out of practice in social interaction and social anxiety often emerge during adolescence as the peer group becomes an increasingly important source of identity and approval. [1] Henceforth, students need to have an immersive virtual environment to allow them to be socially active and connected among peer groups and overcome the social anxiety.

Moreover, there are some situations where students will require to conduct a group study or discussion regarding their academic. It is difficult to do so in normal social application, and hard to express their thoughts through the screen, especially when it comes to writing and solving equations.

1.2 Objective

1. To develop a VR environment for students to interact with each other.

a. To enables students to actively perform social activities during remote education.

The main objective of this project is to enables students actively perform social activities via VR Technology, as it can provides a 3D environment which is identical to real world social experience. Within this 3D social virtual interaction platform, students will be able to conduct a close to face-to-face social interaction with their avatar instead of facing a 2D screen. This project is using VR technology, which means students will also get a close to real life experience and eliminates the need of going outdoors. This is beneficial for students, especially most of the students are required to study remotely at home, they are hardly having chances to attend to school within this period. They are able to be socially active and connected among peer groups which also prevent from having social anxiety.

b. To create immersive social experience

In this project, users are able to speak to each other face to face. This will allow the user to have a better and yet immersive social interaction experience compared to normal chat or social application where user have conversation through texting. In this project, spatial audio has been implemented to further improve the experience of user to simulate real world face to face conversation.

2. To provide education/academic capabilities in virtual environment

Moreover, this project will allow to expand the education and academic capabilities in the virtual environment. In the virtual environment, students will be able to conduct a near face-to-face discussion within their study group. This project will provide a virtual social environment where students will be able to conduct a group study or discussion where students will also be able to draw on the whiteboard provided in the virtual environment, so that the discussion content can have a better and clearer explanation.

3. To create an alternative way for students to convey message to others.

Within the virtual social interaction platform, users are given variety of options to communicate with each other. Therefore, speakers are not limited on just using verbal communication to convey their message to their receiver. In this platform, students to communicate with each other non-verbally, like using drawing, emoji etc. Through this virtual social interaction platform, students can effectively receive and deliver the message effectively through nonverbal communication, eliminates the need of speaking. Moreover, this virtual environment creates a near face- to-face social interaction which is more engaging and allows them to interact with others instead of just texting.

1.3 Project Scopes and Direction

As stated in the problem statement, students during pandemic lockdown are unable to attend school or campus, forcing them to study remotely at home, which makes them unable to experience life of school. Henceforth, the scope of this project is to develop a virtual social interaction environment for students. With this social interaction platform, it can replicate a school life experience which allows students to gather around and interact with each other, simulating a face-to-face communication. Even if students stuck at home, they are still able to be socially active within this virtual social interaction environment.

This project will be covered in VR Technology and communication/voice chat API which allows user to talk and communicate with each other within the virtual environment. This project will provide both verbal and non-verbal communication method to enable users to express themselves using various method. In order to make the social interaction more realistic, this project will include lip sync for avatar as the user is speaking to other user and include a spatial audio API to simulate real life conversation. Gesture, emoji and emotes will also be implemented in this project to allow users to interact with each other in a unique way to make the whole experience more interesting and engaging.

This project will be mostly communication oriented, will be focus on improving the voice chat experience like the include of spatial audio, clarity of the voice. Moreover, this project will also be focusing on the nonverbal communication like using hand gesture and emoji to communicate. Therefore, the project will be lacking graphical design, making the virtual environment slightly not promising in terms of visual design.

Moreover, despite this is a VR project, the system will also be built for PC user as current VR HMD/ Headset is too expensive and most of the students cannot afford it.

1.4 Contributions

This project reimagined the way people communicate with each other, unlike other social media platforms or applications, users (students) are now able to interact with each other in a virtual environment which simulates a face-to-face interaction. Second, it solves the problem where people must go outdoor in order to establish a face-to-face social interaction. Next, this project also helps students to be socially active with peers in virtual environment, allowing them to be more connected and also help prevent social anxiety. Besides, this project also provides educational purpose as users are able to discuss with their course mate or classmates regarding their academic work and able to draw their thoughts on a whiteboard to better explain their ideas.

1.5 Project Background

In the technological advancement era, VR technologies has been vastly improved over the years due to the rapid technological advancement. What is VR, Virtual Reality? VR is a simulation of the environment generated by the computer technology, allowing user to interact in an immersive virtual environment, an alternate existence with realistic images, sounds and other sensations that simulate user's physical presence. The most common component for user to interact with VR is via a head-mounted display (HMD).



Figure 1.1 HMD

VR technologies has created countless possibilities, allowing this technology can be implemented in various areas, such as medical, design, military, architecture, entertainment and more. Even though VR technologies being introduced as early as 1950s with the first VR systems, Sensorama (Figure 1.2), but it never been popularized until 1980s by Jaron Lanier.



Figure 1.2 Sensorama

Early VR technologies were mostly used in professional field such as military training, medical, flight simulation and automobile industry design from 1970 to 1990. VR being brought into the gaming industry around 1990s, until 2010s Oculus designed Oculus Rift headset, unfolding the possibilities of consumer VR.

During 2020, social distance has been established in the midst of the COVID-19 pandemic, which forbids any face-to-face social interactions between people. Students are at a very crucial age where they are developing their social skills through conversation and interaction among peers. However, students are forced to study remotely and can only rely on their phone and social media platform such as WhatsApp, Discord and WeChat to interact with each other, which is a poor substitute for more traditional forms of communication. Therefore, by utilizing the VR technology, it can provide a unique social interaction experience that enables students to be socially active even far away from each other.

CHAPTER 1

1.6 Report Organization

This report is categorized into 6 chapters: Chapter 1 Introduction, Chapter 2 Literature Review, Chapter 3 System Methodology, Chapter 4 System Design, Chapter 5 System Implementation, Chapter 6 System Outcome and Discussion, Chapter 7 Conclusion. The first chapter is the introduction of this project which includes problem statement, project background and motivation, project scope, project objectives, project contribution, and report organisation. Chapter 2 is the literature review carried out studies on several existing virtual social interaction environment to evaluate the strengths and weaknesses of each software. The third chapter is discussing the methodology and tools used in the project. The chapter 4 is regarding the details on how to implement the design of the system. Furthermore, the chapter 5 reports the implementation of the system and the result of the implementation. Then the chapter 6 is about testing of the system and evaluation of the system result. The last chapter will conclude the whole project and discuss the future work that can be done.

CHAPTER 2

Literature Reviews

2 Previous Works on Social Interaction in Virtual Environment

2.1 VRChat



Figure 2.1

2.1.1 Introduction of VRChat

VRChat is a VR social interaction platform designed by VRChat Inc. which offers an impressive and immersive social interaction experience. This is a platform where players/ users can interact with each other through virtual avatars in a virtual world created by them. Players also able to navigate through various Worlds, create and change avatar, do different games and activities within the virtual environment and more. VRChat features full-body avatars with “audio lip sync, eye tracking and blinking and complete range of motion”. Moreover, players get access to their software development kit (SDK), which makes this platform highly customizable. VRChat is available in HTC Vive and Oculus Rift, also capable to run without VR headset, but contains with some limitations, like unable to move limbs of avatar freely or performs multi-hand interactions. [3]

2.1.2 Strengths of VRChat

As mentioned above, full body avatars in VRChat has ability to lip sync, eye tracking/blinking and complete range of motion. These features make the virtual social communication looks more realistic and truer to life. Next, VRChat supports finger tracking and gesture recognition which enables users to express themselves using hand gestures, they are also able to express using emotes and emoji. This feature helps in terms of non-verbal communication where users able to express their feeling non- verbally, which will also benefit disabled individuals. VRChat also has 3-D spatialized audio feature that can assists user to listen the conversation more clearly and filteredout unnecessary conversation. Next, VRChat also allows user to mute and block other user as some of it may be spam and create discomfort to user. [4]

2.1.3 Limitations of VRChat

Although VRChat offers a lot of possibilities in the virtual environment, however, VRChat doesn't offer education or work capabilities. For a students oriented social environment platform, it is important to have these capabilities as they need to present and share their work to others. Moreover, these capabilities is also important to let students to experience a school life experience that similar to real life.

2.2 Virbela



Figure 2.2

2.2.1 Introduction of Virbela

Virbela is a virtual platform built for organization, remote workers and learners to confront with challenges of remote collaboration. Virbela is a platform that assist companies to grow their business more efficiently, creates an immersive virtual space that promotes productivity, collaboration, realistic interactions, creating a different experience that are accessible, affordable and adaptable to users' changing needs and budget. Within Virbela, users able to customize their space and hold event, meet together and able to service all of their remote workforce. Virbela also available in Oculus Rift and HTC Vive. [5]

2.2.2 Strengths of Virbela

Virbela has a series of feature to make users' working experience more interactive and more efficient, such as present slides, PDFs and documents, share screen or webcam, interactive whiteboards and sticky notes, video streaming from local or YouTube and show running software in web browser [6]. This is extremely useful and convenient for a company that working remotely from home, enables them to increase productivity and efficiency. Moreover, Virbela allows users to engage in off work activities such as games, dancing, providing space for fun alongside actual work. Most importantly, Virbela provides enterprise-grade security where there are no conversations are saved and they conduct regular security and compliance testing. This feature is great for personal and companies' privacy, preventing leak of personal or companies' information. Furthermore, Virbela also has a spatialized voice, simulating

real life conversation, as the user move away, the speech gets quieter, allowing dozens of separate conversations in each area. There is also a feature where user can have private conversation in a designation area, free from interruption of other users. [5]

2.2.3 Limitations of Virbela

The limitations of VirBela is the feature of hand gesture. In VirBela, you can perform different hand gesture, however, it is not done by human hand, it provides a gesture menu for user to choose the prefix gesture shortcuts. This is inconvenient for some users as it requires multiple steps to perform the gesture. as Oculus currently supports gestures with hand tracking.

The limitation of VirBela is the feature of hand gesture. In VirBela, you can perform different hand gesture, however, it is not done by human hand, it provides a gesture menu for user to choose the prefix gesture shortcuts. This is inconvenient for some users as it requires multiple steps to perform the gesture as Oculus currently supports gestures with hand tracking. [7]

2.3 AltspaceVR



Figure 2.3

2.3.1 Introduction of AltspaceVR

Altspace VR is a social virtual platform where it allows people to interact, explore and build virtual worlds with other users. It is a social platform where everyone can meet, communicate and able to co-present in small to large groups within a virtual environment. It is also a platform that allows users and artist to hold live, virtual events, such as live concerts, comedy shows, festivals and more. [8] The platform also introduced a feature called FrontRow which allows any number of audience membersto attend wide variety of virtual events that held in this platform. [9] Moreover, AltspaceVR also enables company to hold meetings and work gatherings securely with the integration of Microsoft Mesh. This platform is available is Oculus devices, HTC Vive and Windows Mixed reality devices. It also available as 2D application for Apple and Windows PCs with less feature. (AltspaceVR: Home - AltspaceVR, 2021)

2.3.2 Strength of AltspaceVR

AltspaceVR is among the most reliable VR platforms available. It has a lot of security feature such as secure sign-ins, session management, privacy compliance thanks to the integration of Microsoft Mesh. Besides, the integration of Mesh enables Altspace VR to let user to have 3D photorealistic presence and spatial multiplayer experiences. Altspace also featured spatialized audio which it can mimic real life conversation by making user's voice get quieter as they walk away from another user.

2.3.3 Limitations of AltspaceVR

Although the event feature is superb, AltspaceVR is not appropriate for official meetings or events, which are required for school activities. Altspace VR can benefit only casual events. For the office events, AltspaceVR unable to handle too many participants to equip high end system for not slowing down in between the event. Although AltspaceVR also supports hand gesture, but it only supports button control, not hand tracking feature, it will perform different hand gesture on clicked button. This might be inconvenient for user because user have to memorize different button configuration to perform a simple hand gesture.

2.4 Comparison between the existing system and proposed system

Table 2.4 below shows the comparison between existing system and proposed system. The existing system includes VRChat, VirBela and AltspaceVR.

	VRChat	VirBela	AltspaceVR	Proposed Solution
Emoji Support	Yes	Yes	Yes	Yes
Hand Gesture Support	Yes, use hand tracking feature	Yes, but in a gesture control menu	Yes, but using the controller button to control the gesture	Yes, use hand tracking feature
Spatial Audio	Yes	Yes	Yes	Yes
Work and Education capabilities	No	Yes, able to share slides and ppt	Yes, able to share slides and ppt	Yes, able to share slides and ppt

Table 2.4 comparison between existing system and proposed system

2.5 Remarks of Reviewed System

After reviewing multiple existing system, each of the product can provides immersive and vivid experience in terms of social virtual environment. These systems enable individuals to have a good social interaction even without going outside, especially during pandemic lockdown which people are not able to go outdoors during that period.

All of the systems reviewed supports emoji, which allows user to have a more engaging communication and allows user to better express their current feeling. Next, even though all of the reviewed system supports hand gestures within virtual environment, only VRChat use hand tracking feature to control the hand gesture, as for VirBela, it uses a prefix gesture control menu to enable hand gesture and AltspaceVR uses the button to control the gesture. In all of the reviewed system, they all support spatial audio feature that allows user to identify distance of audio source. Last but not least, it is important to have work and education capabilities for students to present their work to other students, both VirBela and AltspaceVR able to share their documents within the social interaction environment. Although VRchat supports media player, but it cannot share documents within the environment, making it less suitable for schoolwork.

CHAPTER 3

System Methodology

3.1 Methodology Used

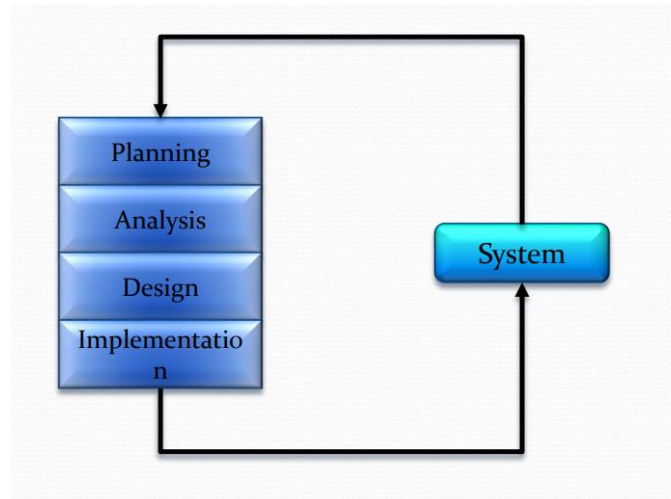


Figure 3.1. Agile Methodology

In this proposed system, agile methodology will be implemented like shown in the Figure 3.1. The Agile methodology is centered around developing a product or service using brief cycles, known as sprints, as a project management strategy. The primary focus of this approach is to enhance the product or service continuously through teamwork and collaboration. Agile methodology offers numerous advantages, including improved product quality, heightened customer satisfaction, greater project control, and decreased risks.

During the planning phase of the agile methodology, the overall flow and feature of the project will be planned and the plugin and SDK that are relevant to the planned feature are selected.

During the analysis phase, a lot of study has been conducted on to decide the main requirements and objective of the project and decide the feature that will be included in the project based on the objective. Then, between plugin and SDK that are selected for a certain feature are being compared to decide on the most suitable for the project. In this phase, the features that are unable to implement for reason such as paid feature and closed API are discarded.

During the design and implementation phase, the design of the user interface is designed and implemented after testing, the scene and avatar also be designed during the phase and the finalized design are implemented. Moreover, trial and error of each

CHAPTER 3

feature are done in these phases. These two phases are repeated until satisfactory result has been reached.

These four phases are repeated when implementing each of the feature into the system.

3.2 Tools Used

3.2.1 Hardware

The hardware involved in this project is computer and a head mounted display (HMD). The computer is being used in doing the coding of the project and testing of the project in non-VR virtual environment and voice-chat feature. As for the testing of VR virtual 3D environment, it will require a head mounted display to execute the testing of the project.

Description	Specifications
Model	Illegear Onyx V
Processor	AMD Ryzen 5 4600H
Operating System	Windows 11
Graphic	NVIDIA GeForce GTX 1650 4GB DDR5
Memory	16GB DDR4 RAM
Storage	1.5TB M.2 NVME SSD

Table 3.2.1. Specifications of laptop



Figure 3.2.1. Oculus Quest 2

As for the head mounted display, Oculus Quest 2 have been used to test the VR part of the project . The Oculus Quest 2 is a standalone consumer used virtual reality headset released in 2020 by Oculus. It features a Qualcomm Snapdragon XR2 processor, a field of view of 97 degrees, a resolution of 1832x1920 per eye, and a refresh rate of 120 Hz. This is the most suitable device to run test on this specific project as this product is the most commonly available HMD in the consumer market. [8]

3.2.2 Software

The software used during the development process

1. Unity

Version : 2021.3.21f1

Release Date : 15 March 2023

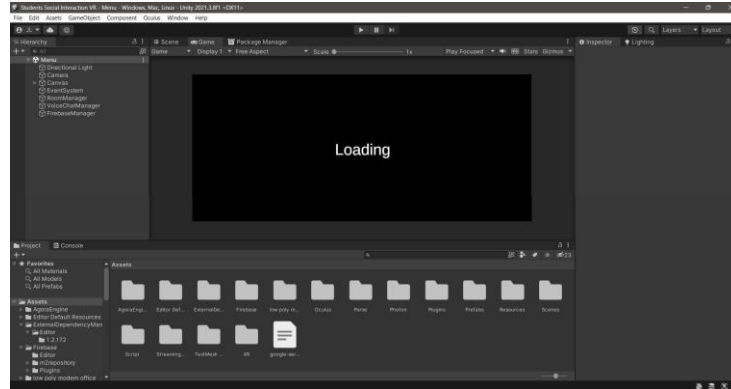


Figure 3.2.2.1: Unity Editor

The project will be mainly developed via a 3D game engine and for this project, Unity Editor has been chosen to develop this project. Unity Editor is a cross- platform game development tools used to develop 3D and 2D games, as well as interactive simulations and other experiences. Unity has become one of the largest XR content creation platforms in the world due to its ease of use and supports on more platforms. Unity Engine is suitable for developers who is mainly using C# language. Furthermore, Unity Engine is also suitable for project that requires a lot of customization, iterative development, prototyping and optimization.

2. Microsoft Visual Studio 2022

Version : 17.3.4

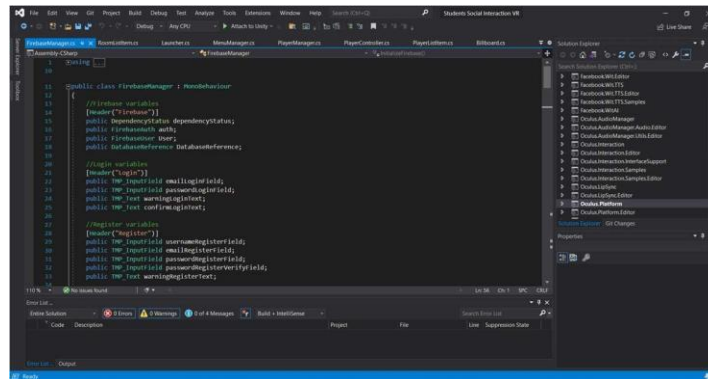


Figure 3.2.2.2: Visual Studio 2022

The custom script that are required to run on this project will be coded and debugged in an external script editor, Microsoft Visual Studio 2022. In this project, all of the custom script will be written in C# and the IDE offers integration with Unity Editor which provides better code experience with IntelliSense, which able to navigate through the scripts easily and utilize powerful refactoring capabilities. The custom script file in Unity Editor can be easily edited via Visual Studio 2022 after importing the Visual Studio Editor SDK in the package manager as shown in the Figure 3.2.2.3.

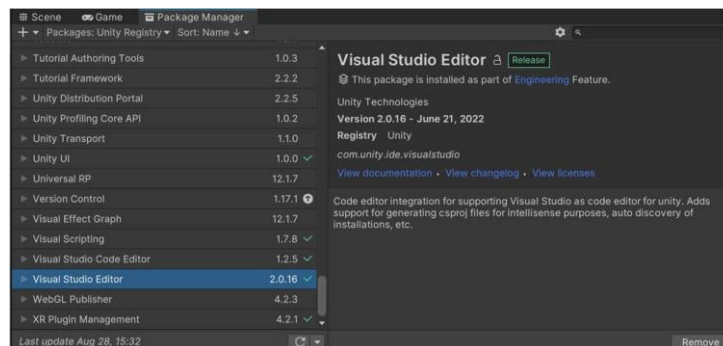


Figure 3.2.2.3 Visual Studio Editor SDK

The Plugin/SDK used during the development process :

1. Firebase Authentication

In this project, Firebase Authentication SDK will be implemented to manage the account of user in this virtual social environment. Henceforth, user can register an account and sign into the platform effortlessly. The usage will be further explained in chapter 4.2.1.

2. Photon Server

Photon Unity Networking (PUN) is a Unity package for multiplayer games. It provides a flexible matchmaking feature where objects can be synced over the network. This allows user to create or join room hosted by the server which enable users to interact with each other over the internet. It provides free usage for up to 20 user connections simultaneously. The usage will be further explained in chapter 4.2.2.

3. Agora Real-Time Voice SDK

For the voice communication within the virtual environment, Agora SDK will be implemented in this project. It allows user to talk to each other and it integrated with spatial audio feature, allowing user to identify direction of sound and the conversation among a small group will not be interrupted by other user within the room. Therefore, it enables effective verbal communication among users within this virtual social environment. The usage will be further explained in chapter 4.2.3.

4. Unity XR Interaction SDK

This toolkit will be used to detect the head movement and the control movement of user via HMD and controller. It allows user to perform various action within this virtual social platform. It also allows the development process of virtual reality easier and convenient as most of the codes are already provided in the SDK and developer only need to drag and drop the game object within the system and adjust the given parameter to achieve the result.

3.3 System Overview

3.3.1 System Architecture Diagram

This students' social interaction virtual environment platform consists of authentication (Firebase), lobby and room server (Photon) and communication server (Agora). When students (client) connected to the Photon server, it will require student to sign in to gain access of the lobby and room that are hosted in the Photon server. After student connected to the lobby and join the room, the system will connect to Agora server to provide voice communication within the room. The student will be able to hear the voice coming from the other user.

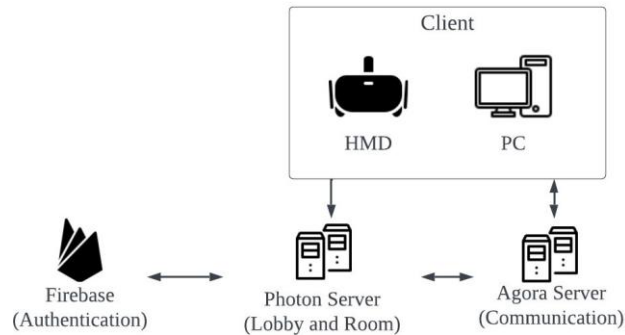


Figure 3.3.1. System Architecture Diagram

3.3.2 Photon Engine Architecture Diagram

As shown in figure 3.3.2, at the very top of the architecture contains Photon Engine's business logic which executes in a .NET CLR hosted by the core and contains the application running on Photons which written in C# or any other .NET language. These applications are built on top of an extensible RPC and event development framework that will address common tasks. like providing simplicity and flexibility for RPC calls by mapping to operation instances, simplify threading problems and traffic saturation to prevent CPU bottleneck. Photon Server also contains a load balancer which will keep track of the load level on the servers which allows for high scalability.

Next, is the Photon Core, it is written in native C++ for performance reasons like handle high-performance socket, implements the heavy load protocols, and it supports reliable UDP, TCP, HTTP and Web Sockets. [10]

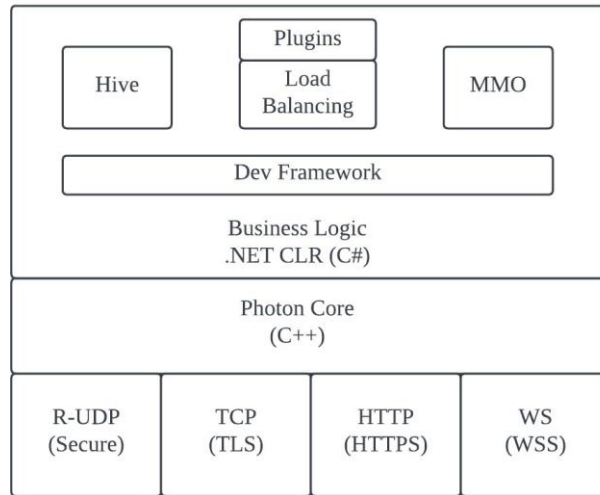


Figure 3.3.2 Photon High-Level Architecture

3.3.3 System Flowchart

1. Login System Flowchart

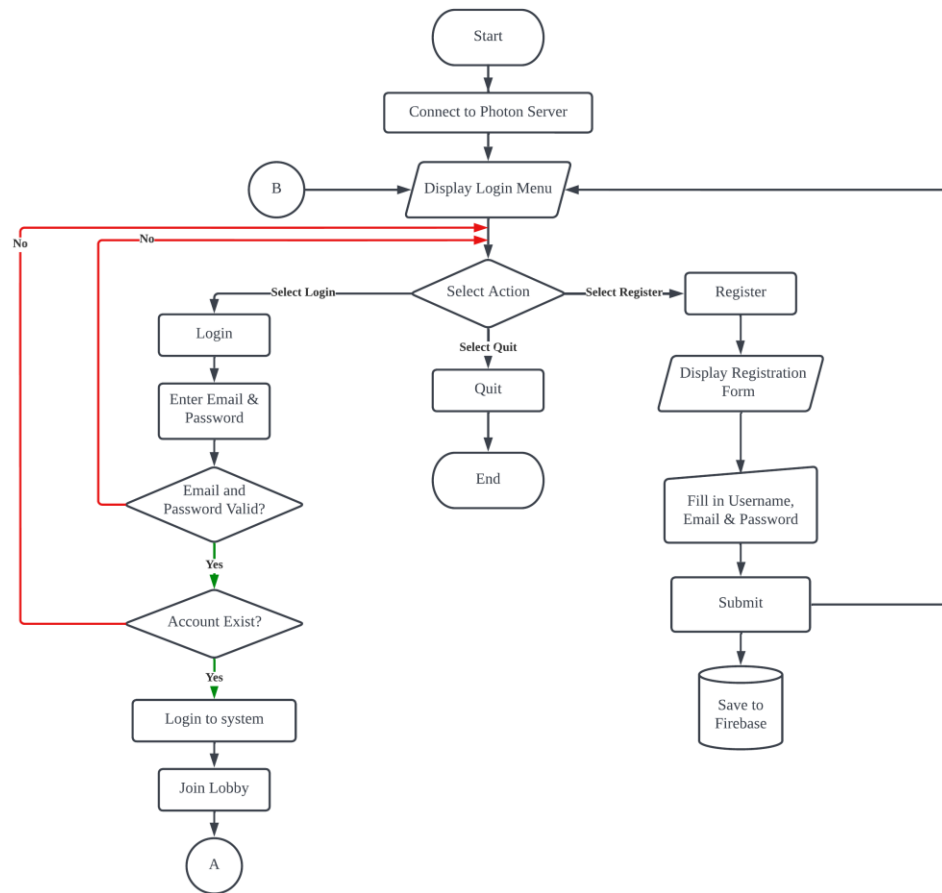


Figure 3.3.3.1: Login System Flowchart

2. Room and Server Flowchart

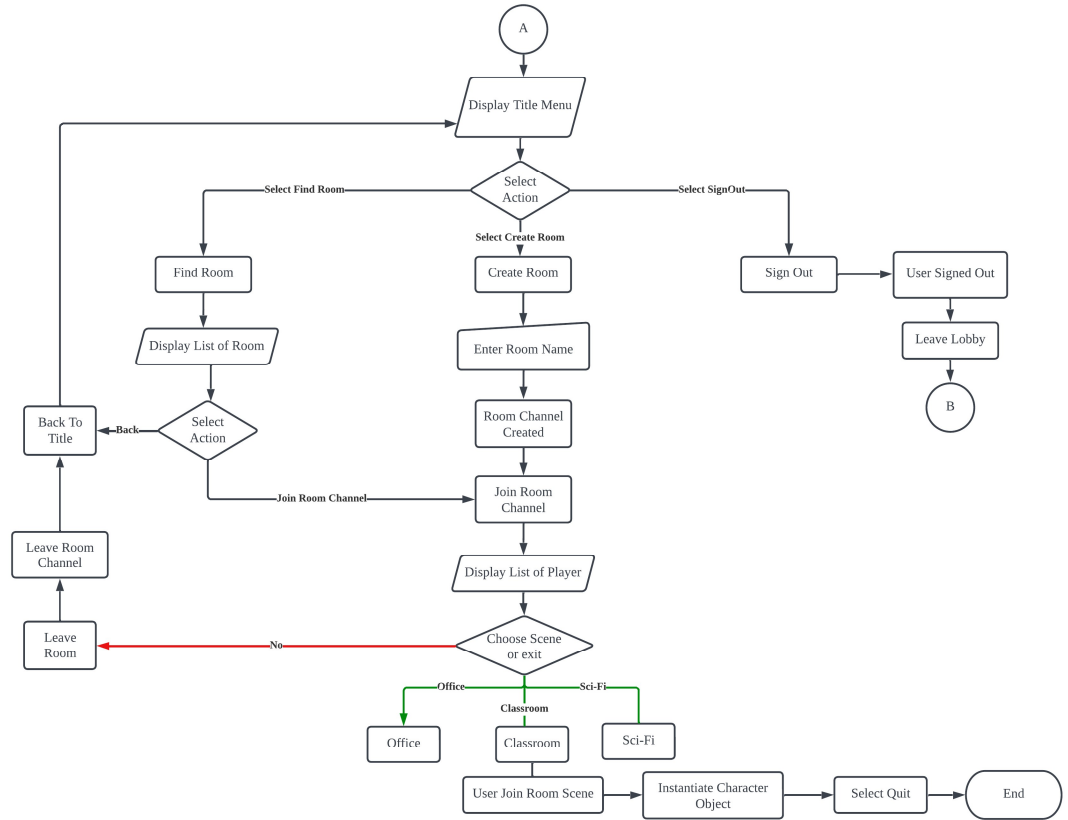


Figure 3.3.3.2: Room and Player System Flowchart

CHAPTER 4

System Design

4.1 Use Case Diagrams and Description

4.1.1 Use Case Diagrams

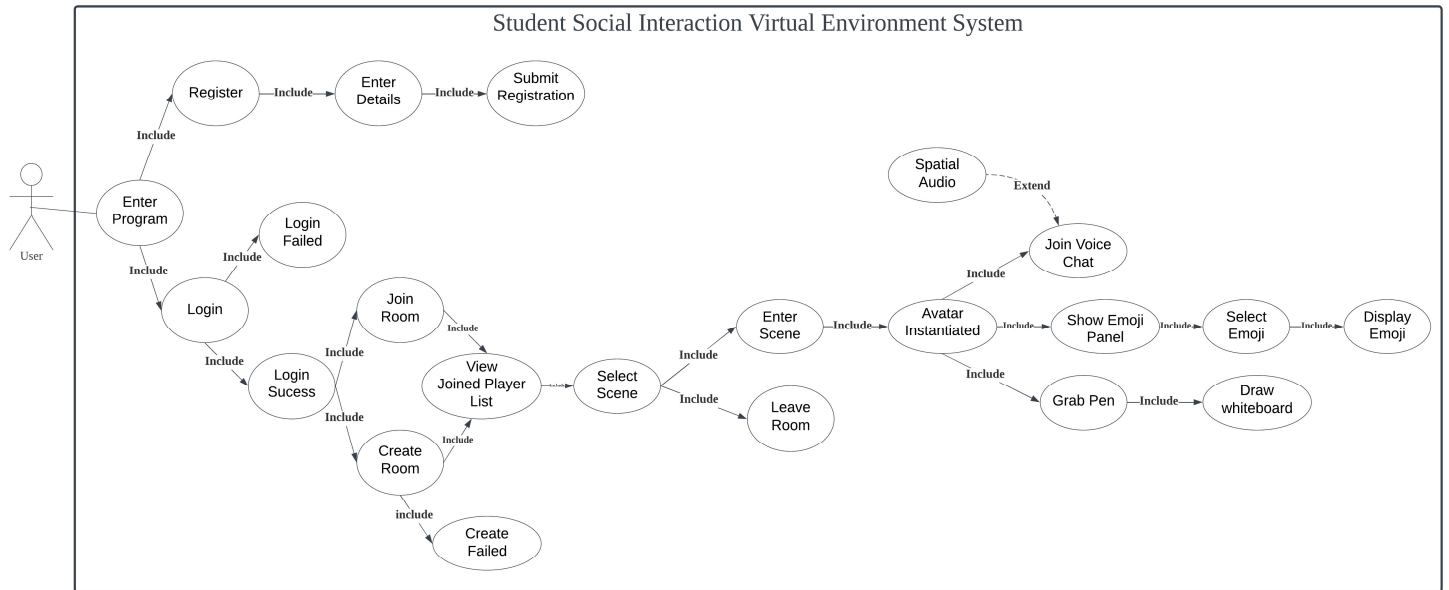


Figure 4.1.1 Use Case Diagram

CHAPTER 4

4.1.2 Use Case Description

Use Case Name: Virtual Social Multiplayer Interaction	ID: 1	Importance Level: 1
Primary Actor: User	Use Case Type: Essential	
Stakeholders and Interests: User – Wants to interact with other user in the virtual environment		
Brief Description: This use case describe how user able to join the virtual environment scene and have social interaction with other user.		
Trigger: User wants to interact with other user Type: External		
Relationships: Association: User Include: Login, Login Failed, Login Successful, Create Room, Create Failed, Select Scene, Join Room, Show Joined Player List, Leave Room, Enter Scene, Avatar Instantiate, Join Voice Chat, Show Emoji Panel, Select Emoji, Display Emoji, Grab Pen, Draw Whiteboard, Register, Enter Details, Information Saved into Database Extend: Spatial Audio Generalization:		
Normal Flow of Events: <ol style="list-style-type: none"> 1. User enters the program. 2. User fills in the login details and login. 3. User successfully login and joins multiplayer lobby. 4. User joins a room. 5. User view list of existing users in the room. 6. User enters the scene. 7. User’s avatar created. 8. User joins the voice chat and have conversation with other users. 		
SubFlows: Not applicable		
Alternate/Exceptional Flows: <ol style="list-style-type: none"> 2a. User register a new account in the system. 3a. User fills in registration information. 4a. User submits the information. 3b. User failed to login due to wrong email or wrong password or account not exist. 6b. User leave the room 7a. User flips left hand to show the emoji panel. 8a. User click on an emoji. 9a. System shows the selected emoji to other users. 7b. User grabs a pen. 8c. User draws on whiteboard. 		

Table 4.1.2 Use Case Description

CHAPTER 4
4.2 System Activity Diagram

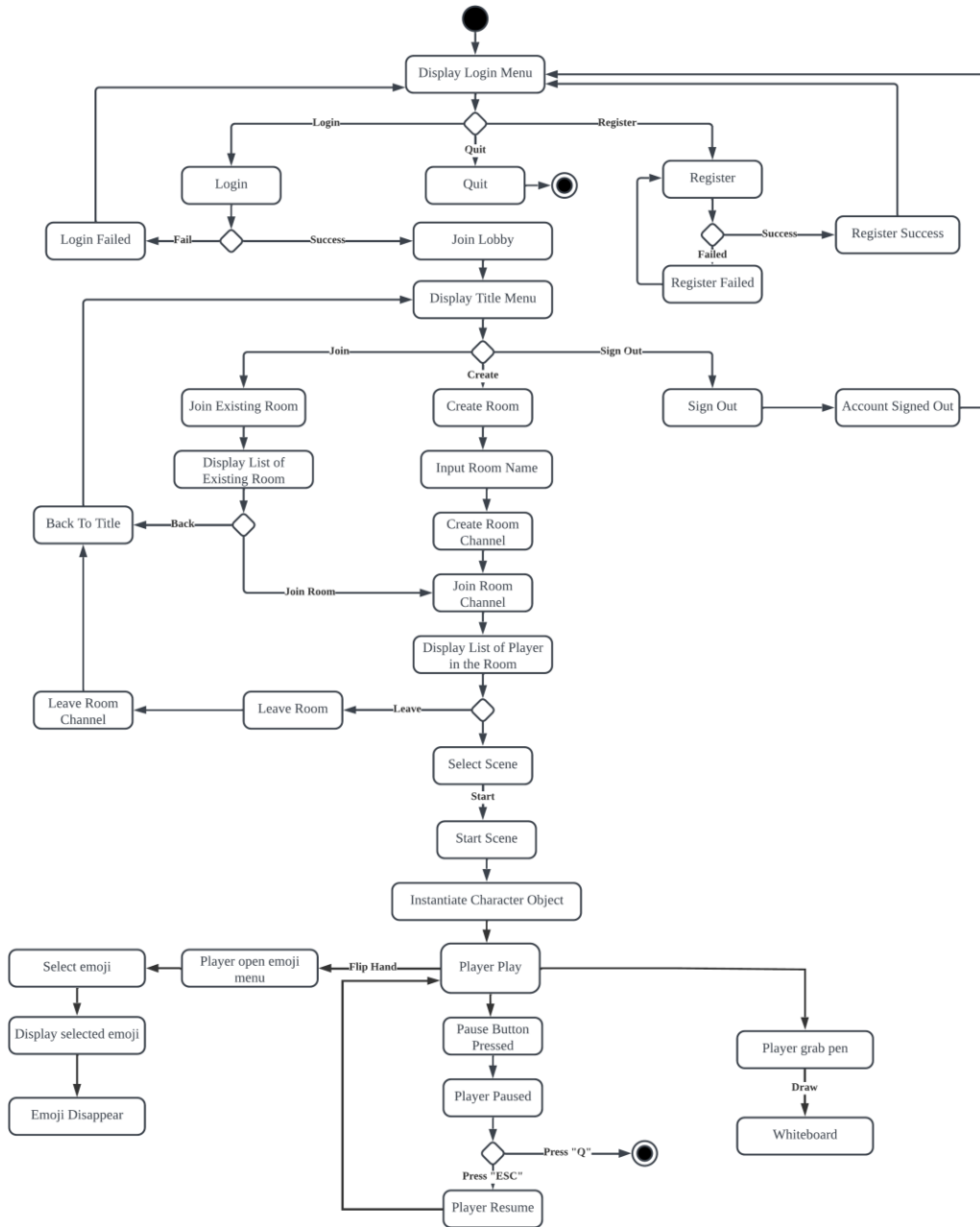


Figure 4.2. System Activity Diagram

CHAPTER 4
4.3 System Block Diagram

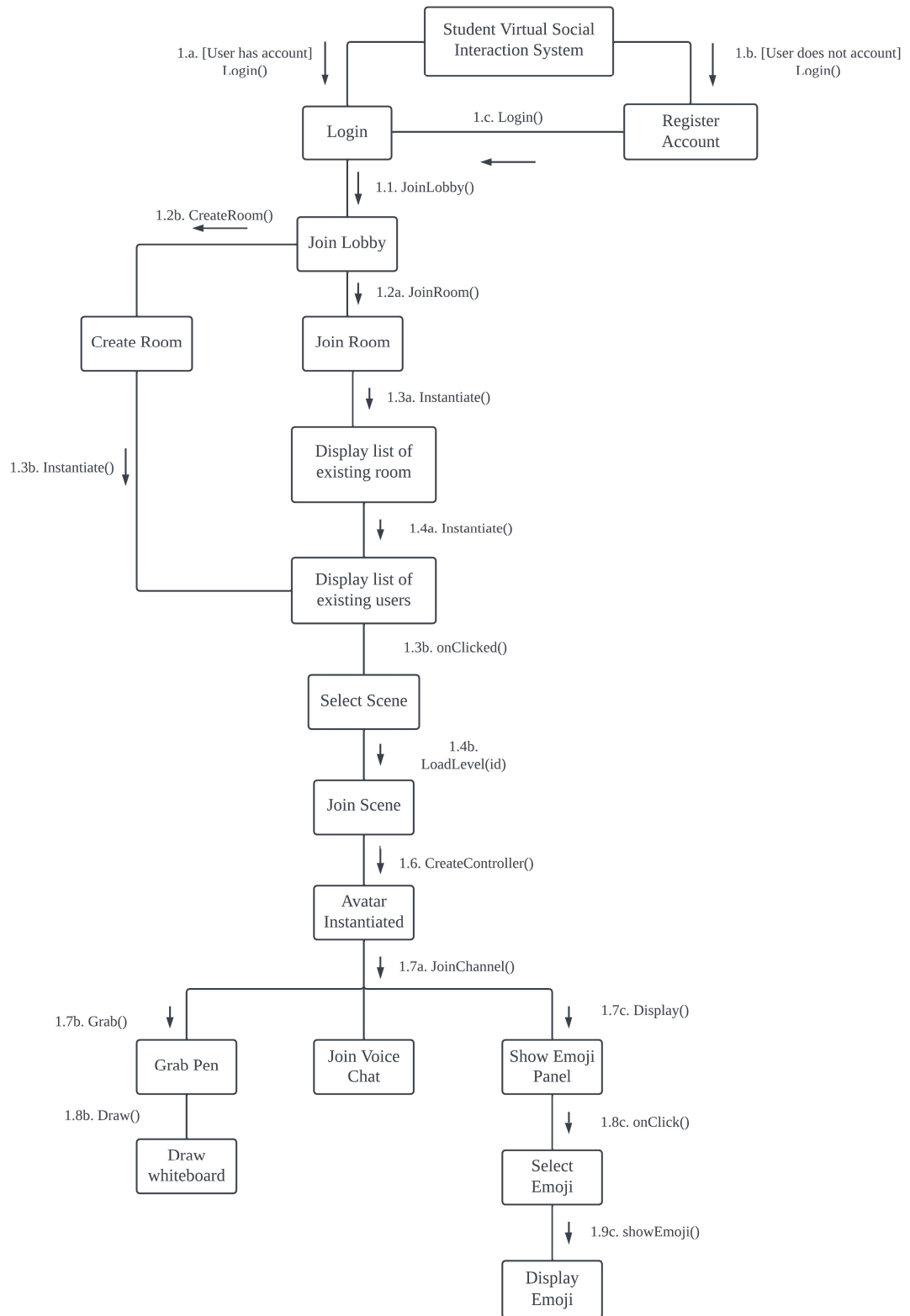


Figure 4.3. System Block Diagram

CHAPTER 5

System Implementation

5.1 Hardware Setup

As mentioned in 3.2.1, this project is being tested using Oculus Quest 2, therefore in order to test the project, the device will be connected to the Laptop via USB connection, then after granting access to PC to access the device, from the Quest 2 it will launch Oculus Link which will allow casting PC to the Quest 2 as shown in figure 5.1. After done setting up, when the program is being executed in the Unity Editor, the program will switch to VR mode and will be shown in the Quest 2.



Figure 5.1. Quest Link

5.2 Software Setup

5.2.1 Unity Package

During the development of the project, it to import SDK in order to implement certain features. So, for some of the SDK will require to get it from asset store and most of the SDK needed can be found in Unity's own package manager (shown in Figure 5.2.1) like XR interaction toolkit, XR plugin and so on. After downloaded, just simply import into the project.

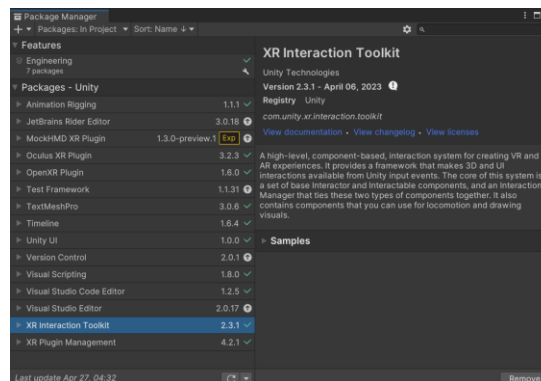


Figure 5.2.1. Package Manager

CHAPTER 5

5.2.2 Firebase (Authentication System)

To allow user to get authenticate in this system, Firebase Auth SDK is being implemented within the system. Once Firebase project is created and the authentication method has been setup, it can be imported into the project as an SDK package in Unity. After user registered an account, the relevant information will be saved as shown in Figure 4.1.2. After user sign in into the system, user will be connected to the Photon server and the username will be pass to Photon Server to create user instance.

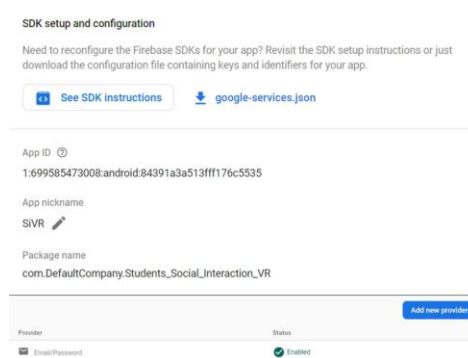


Figure 5.2.2 Firebase Setup

5.2.3 Photon Network (Multiplayer System)

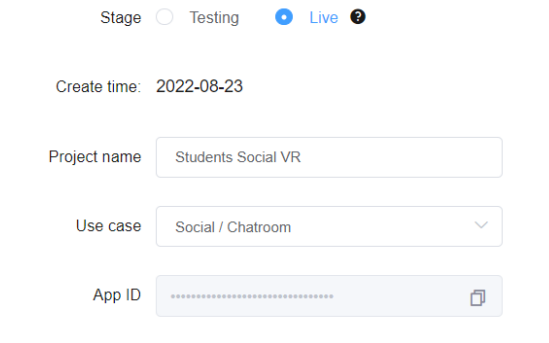
The multiplayer system is powered by the Photon Network. Before importing, a project will need to be created in the console and it will generate an API code which will be input later in the Unity. The Photon Network SDK can be downloaded in Unity assets store and then can be imported as a Unity SDK into the project. After user joined the lobby hosted by the server, the room creation and connection will be handled by the room manager utilizing the Photon Network APIs.



Figure 5.2.3. PUN Setup

5.2.4 Agora SDK (Voice Chat System)

Agora voice SDK has been implemented to drive the voice communication among users within the environment. Before importing, a project will need to be created in the console and it will generate an API code which will be insert later in the Unity. The Agora voice SDK can be downloaded in Unity assets store and then can be imported as a Unity SDK into the project. After user joining the scene, user will be joining the voice chat server hosted by Agora to enable voice communication with others. Furthermore, the SDK enables spatial audio within the project, the perspective of the audio will be changed as the head move around. Moreover, if the distance of one user is too far from another user, the user will not be able to hear another's user voice.



The screenshot displays the Agora console interface for project configuration. At the top, there are radio buttons for 'Stage' (unselected) and 'Live' (selected). Below this, the 'Create time' is listed as '2022-08-23'. The 'Project name' field contains 'Students Social VR'. The 'Use case' dropdown menu is set to 'Social / Chatroom'. The 'App ID' field is partially obscured by dots, with a copy icon to its right.

Figure 5.2.4 Agora Voice Setup

CHAPTER 5

5.3 System Operation

5.3.1 Multiplayer

This project is a multiplayer based program powered by Photon Network; this enables multiple users to interact with each other in the same lobby. So, after user enters a room, a player manager will create a player object and display the username of current user in the room at the list. Moreover, the username will also be displayed at the top of users to let users identify each other like as shown in Figure 5.3.1.1. After user join the scene, user will be able to interact with other user in the same scene like shown in Figure 5.3.1.2

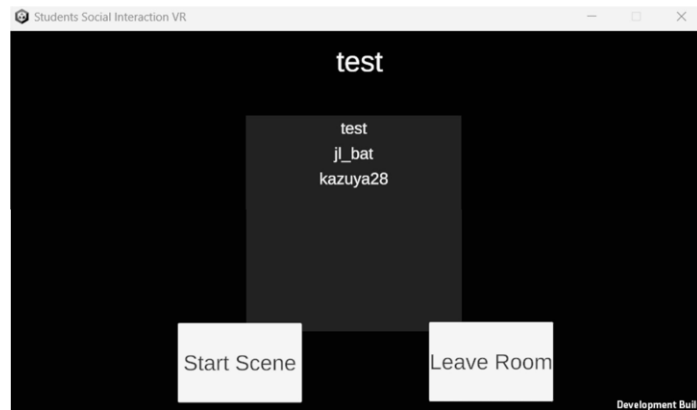


Figure 5.3.1.1 Multiplayer 1

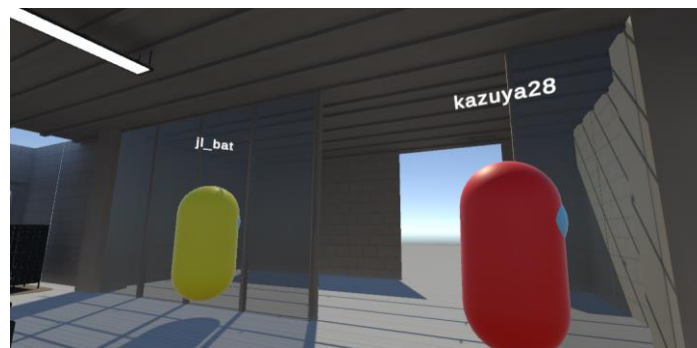


Figure 5.3.1.2 Multiplayer 2

CHAPTER 5

5.3.2 Scene Creation

Figures below show the scenes where users can interact with each other in the virtual environment. After user joining the room and choose the scene, the user will jump into the selected scene. These scenes are built using the asset downloaded from the assets store. It can be import into Unity through the package manager. In the package, it has included a lot of game object which looks realistic.

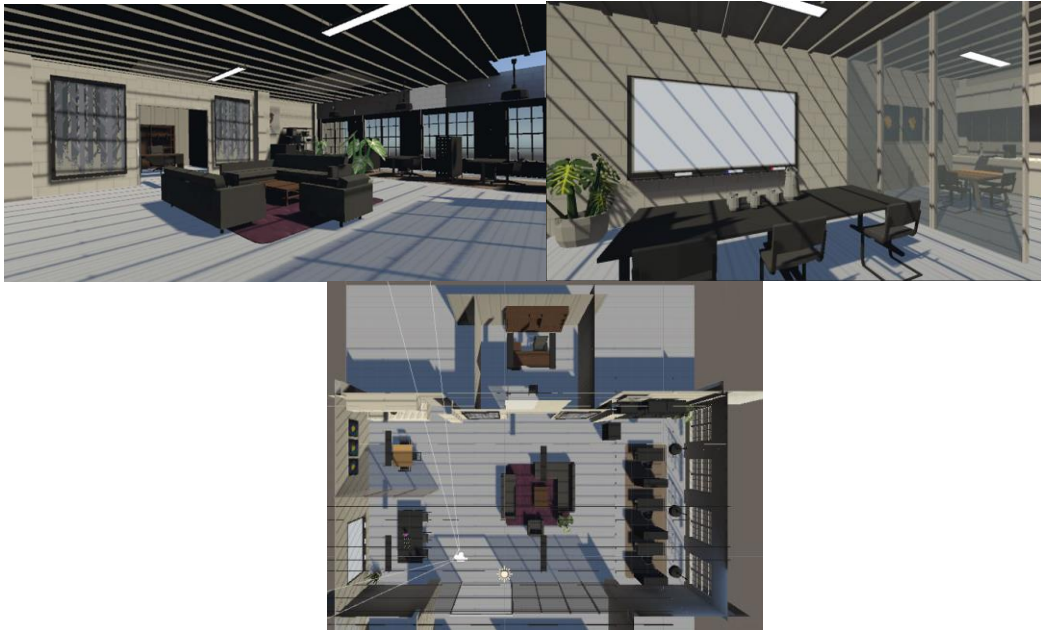


Figure 5.3.2.1 Office Scene

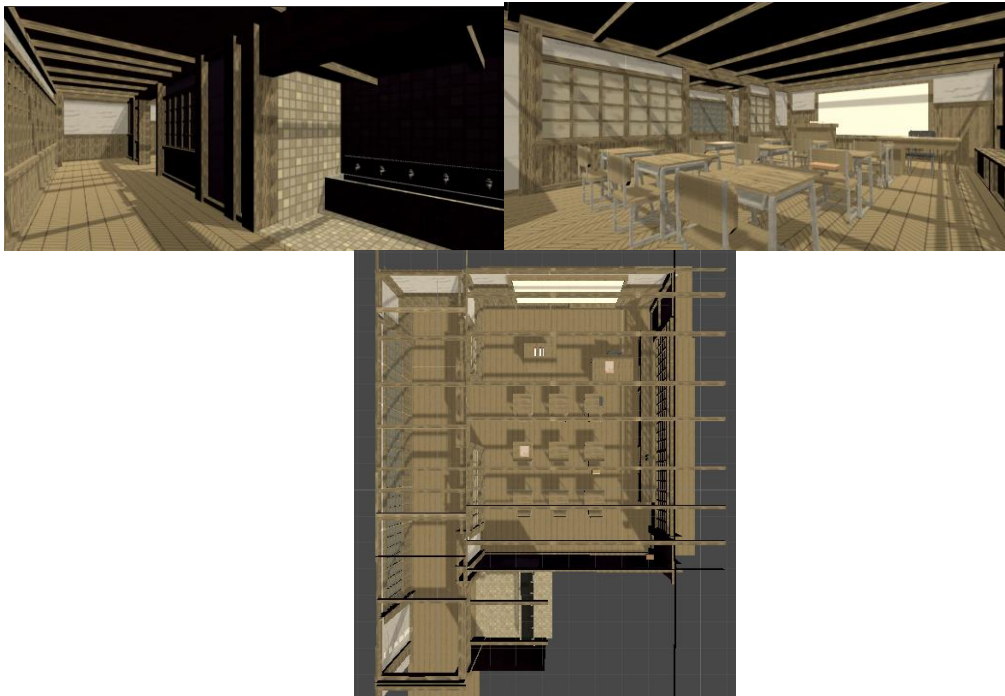


Figure 5.3.2.2 Classroom Scene

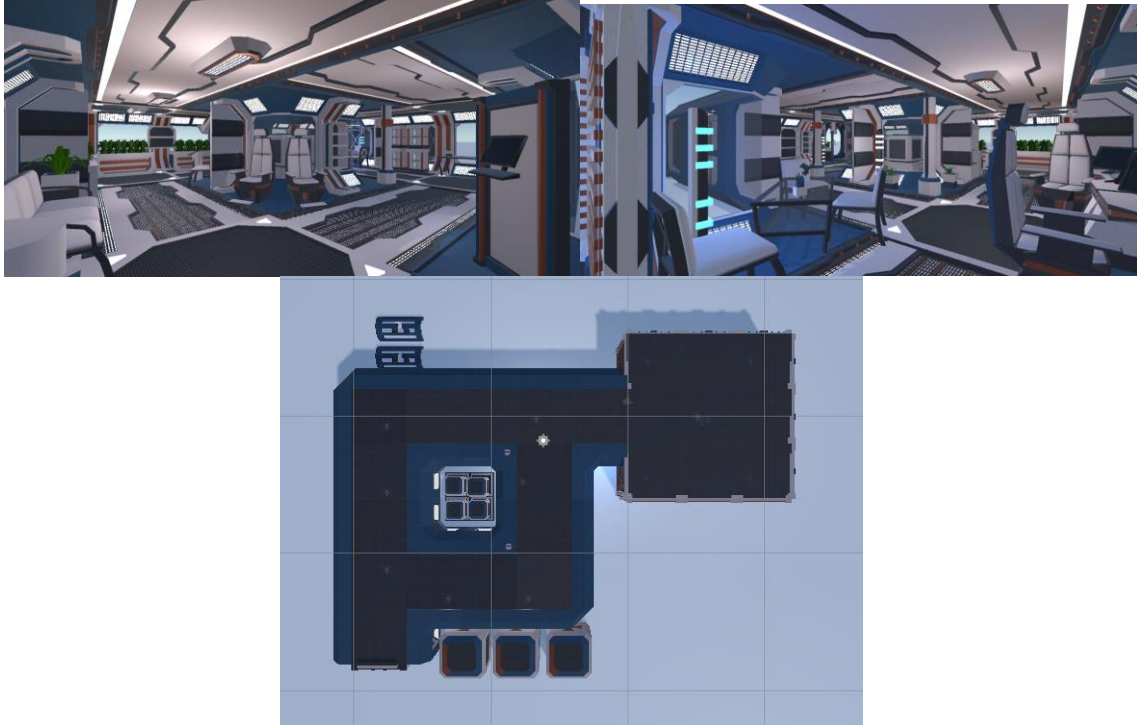


Figure 5.3.2.3 Sci-Fi Scene

CHAPTER 5
5.3.3 Emoji

User can display emoji to express their emotion by clicking the button on the emoji panel that are displayed on the left hand of the user when user twist their hand facing their eye. The results are as shown in Figure 5.3.3.1 and 5.3.3.2.

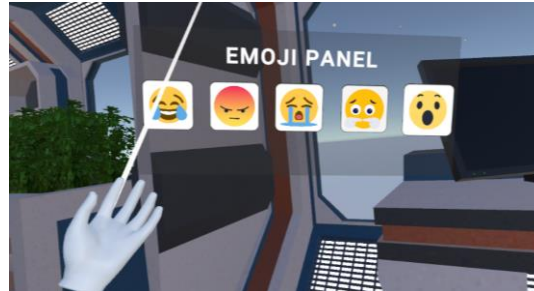


Figure 5.3.3.1 Emoji Panel

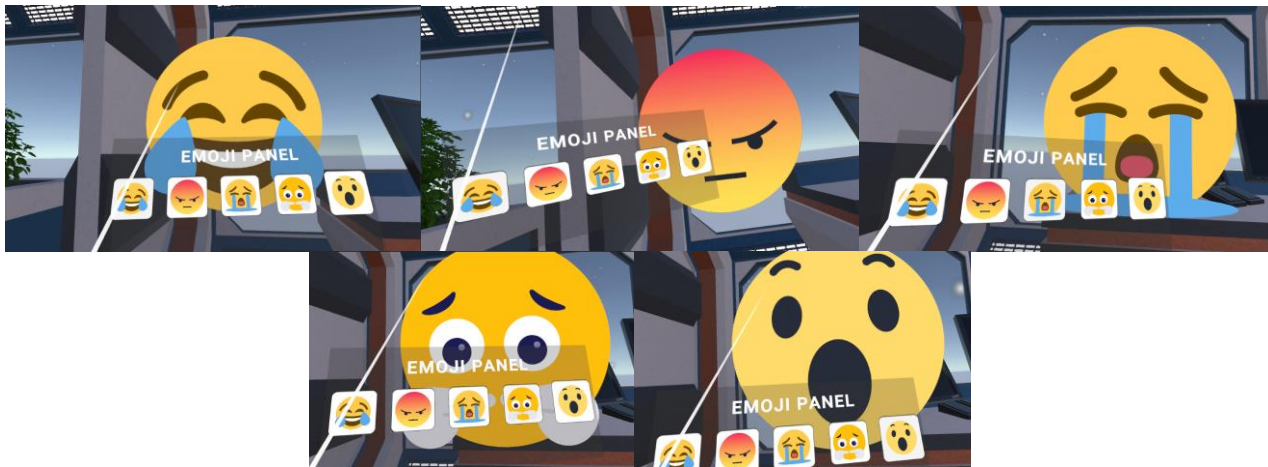


Figure 5.3.3.2 Show Emoji

5.3.4 Drawing

As for the drawing feature, user will have to grab the pen or drawer in the scene and interact with the whiteboard in order to write or draw something. If user draws out of the whiteboard boundary, the drawing will not be recorded. The drawing feature has been accomplished by applying the color texture of the pen to the whiteboard.

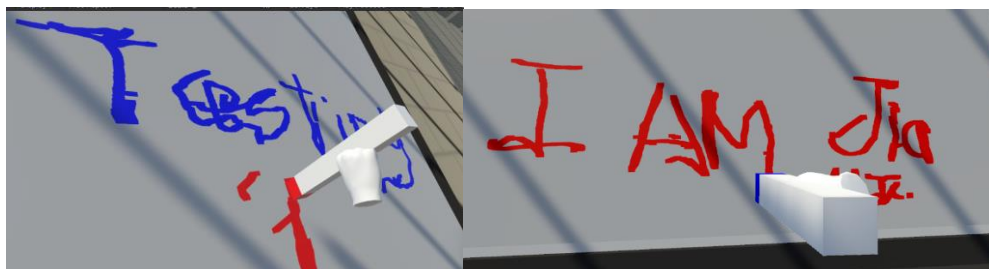


Figure 5.3 Drawing

CHAPTER 5

5.4 Implementation Issues and Challenges

During the implementation of the emoji, there are some issues regarding the latest Poke Interaction Plugin introduced in the latest XR Interaction Toolkit 2.3.0. After implementing it into the hand model, the controller unable to poke on the button appeared in the panel, therefore it has been changed back to ray interaction.

The biggest challenge of developing this VR project is set the correct parameter of each game object and avatar as they will collide with each other and cause issues.

Moreover, there are some technical issues with the development software and plugins during the development process of this project. Mostly are technical bugs like the development software constantly crashing or long running loading process.

CHAPTER 6

System Evaluation and Discussion

6.1 System Test Case

After developing the project, it is crucial to confirm that the system is functioning according to its intended design as there might be some occurrence where students might not be able to do so. Henceforth, some verifications are required to fulfil such as:

1. PUN Server

No	Test Case	Expected Outcome	Result
1.	Verify connection to server after starting the program.	Students will be able to get connected to the server	Pass

Table 6.1.1: Testing Connection to PUN Server

2. Authentication System

No	Test Case	Expected Outcome	Result
1.	Verify user fill in the form with NULL data (either email or password)	Students will not be able to login and error message will be shown. (Missing email or password)	Pass
2.	Verify user fill in the account info that exist but with wrong password	Students will not be able to login and system will show error message of “Wrong Password”	Pass
3.	Verify user fill in the account info that does not exist	Students will not be able to login and system will show error message of “Account does not exist”	Pass
4.	Verify user fill in the correct account info that exist	Students will be able to login to the system and display title menu	Pass

Table 6.1.2: Testing Authentication System

3. Room System

No	Test Case	Expected Outcome	Result
1.	Verify user able to create new room	System will generate a room and able to display in room list when other clients want to join.	Pass
2.	Verify user able to join existing room	Students will be able to see the existing room created by others and join.	Pass
3.	Verify user able to see list of users (students) that joined the room	Students will be able to see the list of users that are currently inside the room.	Pass
4.	Verify user able to start the selected scene	Students will be able to switch to the selected scene after clicking start.	Pass

Table 6.1.3: Testing Room System

4. Scene

No	Test Case	Expected Outcome	Result
1.	Verify “Office” Scene	User will be teleported to Office scene.	Pass
2.	Verify “Classroom” Scene	User will be teleported to Classroom scene.	Pass
3.	Verify “Sci-Fi” Scene	User will be teleported to Sci-Fi room scene.	Pass

Table 6.1.4: Testing Scene

CHAPTER 6

5. Avatar

No	Test Case	Expected Outcome	Result
1.	Verify user whether able to see program in VR headset	User will be able to interact with the virtual environment using VR headset and controller	Pass
2.	Verify user able to look around	User will be able to look around.	Pass
3.	Verify movement of the user.	User will be able to move around the scene.	Pass
4.	Verify user able to see username of another user	User will be able to see username of another user.	Pass

Table 6.1.5: Testing Avatar

6. Voice Chat System

No	Test Case	Expected Outcome	Result
1.	Verify sounds coming from the microphone of another user	User should be able to hear when someone is talking through the microphone	Pass
2.	Verify spatial audio feature	User will be able to identify the direction of the audio source and unable to hear the voice after the other user leaving to certain distance.	Pass
3.	Verify that the sound indicator is working.	Username turned red when voice is detected from the user	Pass

Table 6.1.6: Testing Voice Chat System

CHAPTER 6

7. Emoji System

No	Test Case	Expected Outcome	Result
1.	Verify the emoji panel will appear.	An emoji panel will appeared when user flip their left hand.	Pass
2.	Verify emoji	An emoji will be displayed in front of the user after emoji is selected via the button.	Pass

Table 6.1.7: Emoji System

8. Drawing System

No	Test Case	Expected Outcome	Result
1.	Verify user able to grab the drawer in the scene.	User should be able to grab the drawer within the scene.	Pass
2.	Verify drawing on the whiteboard with correct color	User will be able to draw on the whiteboard with the selected color drawer.	Pass
3.	Verify that the drawer will not draw outside the whiteboard	User will not be able to draw outside the border of the whiteboard.	Pass

Table 6.1.8: Drawing System

6.2 Project Challenge

Challenging part during the development of this project is to create an immersive and true to life virtual social experience. This project tries to simulate the experience of real life like including the spatial audio, interaction between avatars and objects and so on.

Moreover, there are some features being discarded as some was too complicated to implement and some are paid or closed source API which unable to implement.

6.3 Objectives Evaluation

The objectives of this project are to develop a VR environment for students to interact with each other, to provide education or academic capabilities in virtual environment and to create an alternative way for students to convey message to others.

CHAPTER 6

For the first objective, this objective has been accomplished by implementing the voice chat communication in the project which allows students to interact with each other through verbal communication. The project also provided realistic looking 3D scene such as office and classroom and also implemented spatial audio technology which boost the interaction experience.

As for the second objective, this project has also been accomplished by allowing students to have group discussion or group study within the virtual environment. Students can also write down important stuff by drawing their ideas on the whiteboard given in the scene.

As for the last objective, the objective has been successfully accomplished through the drawing system and the emoji system. The drawing system allows user to express their thoughts that can't be express using verbal communication. As for the emoji system, it allows user to express their current emotion.

6.4 Concluding Remark

According to the result from the project, the result is promising as all of the objective has been reached. Users are now able to join into the virtual scene or room over the internet, to interact with each other. The basic communication functionality which is voice chat has been successfully implemented and allowing users to convey their message through verbal communication. Moreover, the spatial audio feature has also been successfully implemented which allows user to identify the direction of the voice and sound.

Different scene has been included to make the social interaction more versatile and enjoyable. The VR implementation also makes the social interaction experience more realistic looking.

Non-verbal social interaction features are also being implemented such as drawing and emoji which enable users to better express themselves in a more amusing way instead of just speaking out their thoughts.

CHAPTER 7

Conclusion And Recommendation

7.1 Conclusion

Due to the pandemic lockdown, students are forced to study remotely, confined to their homes and rooms, looking at their computer screens every day. Students are at a very crucial age where they are developing their social skills through interaction among peers. However, they have limited social contact with peers due to the lockdown. By utilizing VR technology, it will deceive user's brain into thinking the virtual world is real by offering immersive experience that no other medium could. As mentioned, VR can also be used to tackle the social anxiety of students and help improve their social skills.

Therefore, this project is aimed to build a virtual social environment that mimics the actual world so that students can be socially active even away from each other. For the goal to be accomplished, tons of effort need to be put in building this virtual environment.

This platform will allow user to access via a VR HMD or using only PC. The project has successfully implemented multiplayer system which allows students to join a room together virtually and eliminates the condition of going outdoor to perform face to face interaction. Students have also successfully implemented a voice chat system which allows user to communicate with each other via voice chat. Moreover, student will also be able to identify the direction of the audio source.

In conclusion, the project has been delivered successfully and it could be useful and bring contribution to the students and believed that this project will be part of the new social interaction platform for students.

CHAPTER 7

7.2 Recommendation

This project can be improved more in different aspects, such as improvements on the avatar. For now, the avatar are just randomly generated from 3 pill shaped avatar, in the future, this can be changed by including more realistic looking avatar like human-shaped avatar and better to include customization on different parts of the avatar. Lip-sync feature can also be implemented to detect user speaking instead of just showing an indicator and also mimic human speaking.

Moreover, the emoji selections are only limited to only 5, the emoji selection can be increased in the future to help better express users feeling in the virtual environment.

Presently, the maximum number of users that can access the system simultaneously is restricted to only 20 users. However, obtaining a superior Photon Network plan could facilitate an increase in the maximum number of users allowed.

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REFERENCES

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FINAL YEAR PROJECT WEEKLY REPORT

(Project 11)

Trimester, Year: Trimester 3, Year 3	Study week no.: 5
Student Name & ID: Lee Jia Wing 2002591	
Supervisor: Ms Saw Seow Hui	
Project Title: Development of students' social interaction in virtual environments	

1. WORK DONE

Planning and analysis of the work will be done in the project

2. WORK TO BE DONE

Study of the methods to be used to develop the project

3. PROBLEMS ENCOUNTERED

There are some features unable to implement

4. SELF EVALUATION OF THE PROGRESS

-



Supervisor's signature



Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

(Project 11)

Trimester, Year: Trimester 3 Year 3	Study week no.: 7
Student Name & ID: Lee Jia Wing 2002591	
Supervisor: Ms Saw Seow Hui	
Project Title: Development of students' social interaction in virtual environments	

1. WORK DONE

Implement VR capabilities into the project, user able to interact using the HMD headset

2. WORK TO BE DONE

Create more scene and implement other f

3. PROBLEMS ENCOUNTERED

-

4. SELF EVALUATION OF THE PROGRESS

-



Supervisor's signature



Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

(Project 11)

Trimester, Year: Trimester 3 Year 3	Study week no.: 9
Student Name & ID: Lee Jia Wing 2002591	
Supervisor: Ms Saw Seow Hui	
Project Title: Development of students' social interaction in virtual environments	

1. WORK DONE

Able to include two new scenes in the system, added drawing feature into office scene and classroom scene

2. WORK TO BE DONE

Implement emoji feature

3. PROBLEMS ENCOUNTERED

-

4. SELF EVALUATION OF THE PROGRESS

-



Supervisor's signature



Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

(Project 11)

Trimester, Year: Trimester 3 Year 3	Study week no.: 11
Student Name & ID: Lee Jia Wing 2002591	
Supervisor: Ms Saw Seow Hui	
Project Title: Development of students' social interaction in virtual environments	

1. WORK DONE

Able to include emoji feature into the scene

2. WORK TO BE DONE

Try to add human avatar into the scene

3. PROBLEMS ENCOUNTERED

-

4. SELF EVALUATION OF THE PROGRESS

Progress a bit slow



Supervisor's signature



Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

(Project 11)

Trimester, Year: Trimester 3 Year 3	Study week no.: 13
Student Name & ID: Lee Jia Wing 2002591	
Supervisor: Ms Saw Seow Hui	
Project Title: Development of students' social interaction in virtual environments	

1. WORK DONE

Fixed bugs, drop the human avatar, create more avatar based on the original

2. WORK TO BE DONE

Do report

3. PROBLEMS ENCOUNTERED

Avatar animation is a bit too complicated

4. SELF EVALUATION OF THE PROGRESS



Supervisor's signature



Student's signature

APPENDIX
POSTER

LEE JIA WING

DEVELOPMENT OF STUDENTS' SOCIAL INTERACTION IN VIRTUAL ENVIRONMENTS



Introduction

Aim of this project is to enable students to experience school life via VR Technology, as it can provide a 3D environment which is identical to real world social experience. Within this 3D social virtual interaction platform, students will be able to conduct a close to face-to-face social interaction

Results



OBJECTIVE

- 01 To enable students to experience school/ campus life in remote education
- 02 To provide education/academic capabilities in virtual world
- 03 To create an alternative way for students to effectively convey message to others.

METHODOLOGY

- 01 Apply Firebase Auth for authentication feature
- 02 Apply Photon Engine for Multiplayer Feature
- 03 Apply Agora Voice for Voice Communication
- 04 Apply UnityXRInteraction Toolkit to implement VR feature

CONCLUSION

VR Technology is a next generation of social interaction tools for students which encourage face-to-face interaction even far away from each other

DEVELOPMENT OF STUDENTS' SOCIAL INTERACTION IN VIRTUAL ENVIRONMENTS

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FACULTY OF INFORMATION AND COMMUNICATION TECHNOLOGY

Full Name(s) of Candidate(s)	LEE JIA WING
ID Number(s)	2002591
Programme / Course	CS
Title of Final Year Project	Development of students' social interaction in virtual environments

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Signature of Supervisor

Name: Ts. Saw Seow Hui

Date: 27/4/2023

Signature of Co-Supervisor

Name: _____

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