



**MULTI-USER VIRTUAL
REALITY ENVIRONMENT
FOR RESPIRATORY
THERAPY FOR COVID-19
PATIENTS IN UNITY 3D**

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OVERVIEW

This project is to create a multi-user virtual reality environment for respiratory therapy for COVID-19 patients which can be enhanced and used as a simulation for respiratory therapists and for COVID-19 recovered patients. Patients with corona virus disease 2019 (COVID-19), especially in elderly patients, suffers from various degrees of disorders in respiratory function, physical function and psychological function. Timely respiratory rehabilitation intervention can improve prognosis, maximize functional preservation and improve quality of life of COVID-19 patients. Hence a project on respiratory function is essential and has been implemented for simulation under this project.

Unity3d and forge networking development was used to develop this multi-user player application.

The project will show the respiratory rehabilitation training exercises for COVID-19 recovered patient by a therapist in a clinical environment respiratory rehabilitation

GOALS AND OBJECTIVES

- The aim of this project is to develop a simulation environment which can be used as a respiratory rehabilitation training on respiratory function for therapists and COVID-19 patients with for faster recovery and integration into the society.
- To utilize the capabilities of unity3d multi-user virtual reality and forge networking development environment to develop an application that could be used by coronavirus patient's timely recovery.
- To use technology to contribute to a societal need of speedy recovery of covid-19 patients.

In this project, a multi-user environment for a therapist and a patient interaction was developed. The patient's body temperature checks, patient interaction with a nurse for nurse to access the prevailing condition and ushers into the training session where a respiratory therapy video is watched. The patient is then made to rehearse the required body exercises with a doctor observing the patient and patient performs the body exercises. The therapists then checks the patients breathing pattern and observes patient for a period of time before patient leaves.

The application can be used by the hospitals with covid-19 rehabilitation centers in training their recruit therapist and covid-19 patients. Covid-19 patients could do self-learning on respiratory functions and required exercises at home.

This application is being done to show that Virtual reality with multi-user functionality can be used to train therapist and patients undergoing rehabilitation.

Figure 1. Covid-19 Rehabilitation center

MODELLING

A hospital building complex environment which includes the covid-19 rehabilitation center building with roads, car parks, street lights. The rehabilitation center is equipped with temperature guns, medical furniture medical staff and patient. One patient and one Therapist interacts in the scene. A controlled video of the respiratory function is played for training the patient on required exercises and functions of the respiratory organ. Since the virtual environment of the simulation will be done on at a clinical environment, there will be other nurses, medical stretch, patient bed, thermometer and other medical staff on the environment.

Main Building: - Covid-19 Rehabilitation Center one-level building structure with sliding doors where patient training activities will occur. Other buildings in the environment will mimic the hospital complex buildings.

Roads-

The environment has roads and traffic joints for access into the buildings in the environment.

Carparks:

There are three car parks for parking before entry into the buildings on the hospital complex.

Medical Equipment:

There are temperature guns used by nurses, medical desks, medical beds, medical chairs, computers devices used by medical staff.

Television Monitor:

For display of respiratory therapy video

Three Therapist Men: - Observes patients whilst performing exercises, access the respiratory function of patients in the care room and train patients on body exercises.

Three Nurses: Interacts with patients and check body temperatures.

Five Patients: - One being accessed by a nurse before the therapy session, one whose temperature is checked, one undergoing the exercise, one watching video and practicing exercise movements.

The patient practicing exercise body movement is a multi-player controlled patient.

Description of features simulated:

- **Performed Exercises**

Patient performing full body exercises before respiratory function checks are performed. Patient jumps, moves in various positions whilst being observed by therapist.

- **Respiratory Video Content**

Content consist of human respiratory function and exercises that produces benefits in the immune and defense system of the human body. This includes body movements and breathing techniques with alternate depth of breathing to move mucus from small airways at the bottom of the lungs to bigger airways.

- Practicing Body Movements**

After watching video on respiratory function and body exercise, patient undergo exercise movement practices.

The movements includes left, right, forward and backward moves whilst being observed by the therapist.

Patient moves to the right with the R key on keyboard, Patient moves to the left with the L key on keyboard,

Patient moves forward with the F key and moves backward with the B key on keyboard.

- **Interaction with Nurse before therapy session**

Nurse interacts with patient after which patient stands to perform initial breathing techniques before the therapy session.

- **Breathing techniques observation in care room**

Doctor interacts with patient after performing exercise and observes breathing function of patient.

PROGRAMMING

The simulator was built using Unity3D 2019.4.10f development engine with the C# programming language and Forge Networking engine to handle host or server and client connection for the multi-player environment development.

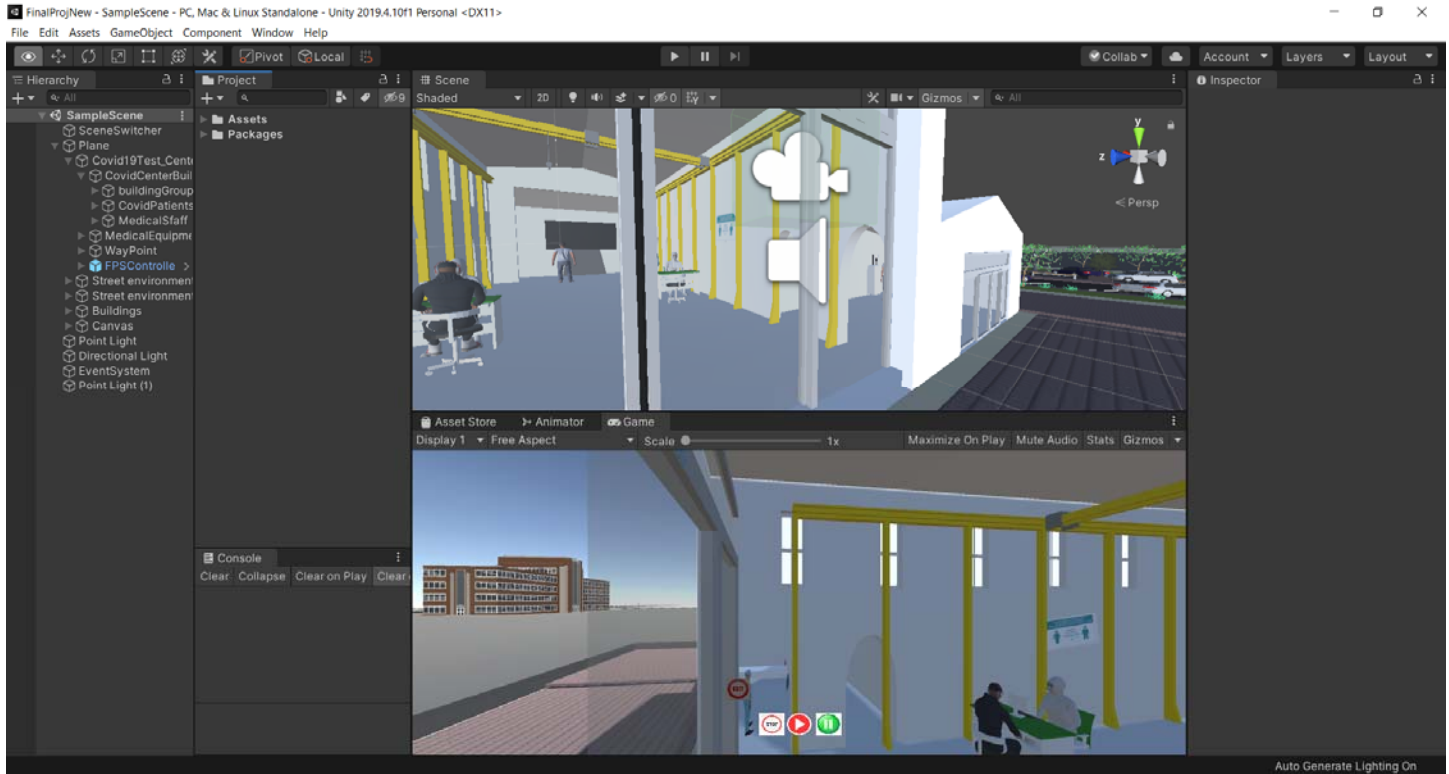
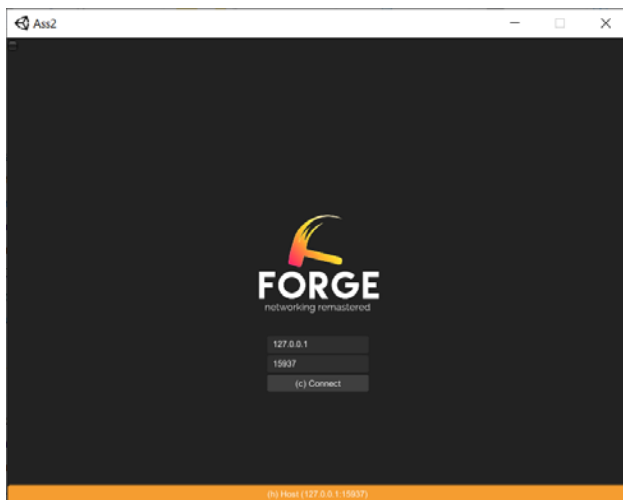
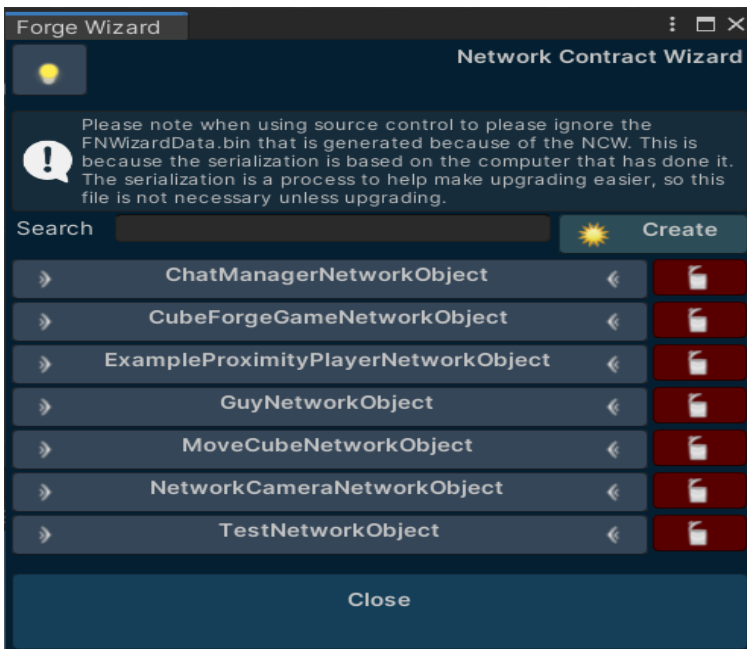
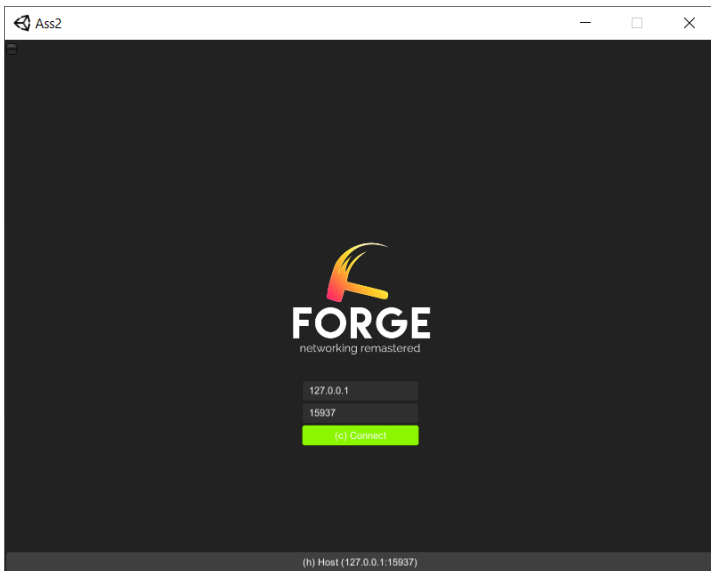


Figure 2: Unity 3D development environment for app

Also a third-party development engine Forge networking was used to facilitate the development of the server client networking environment. See images below:





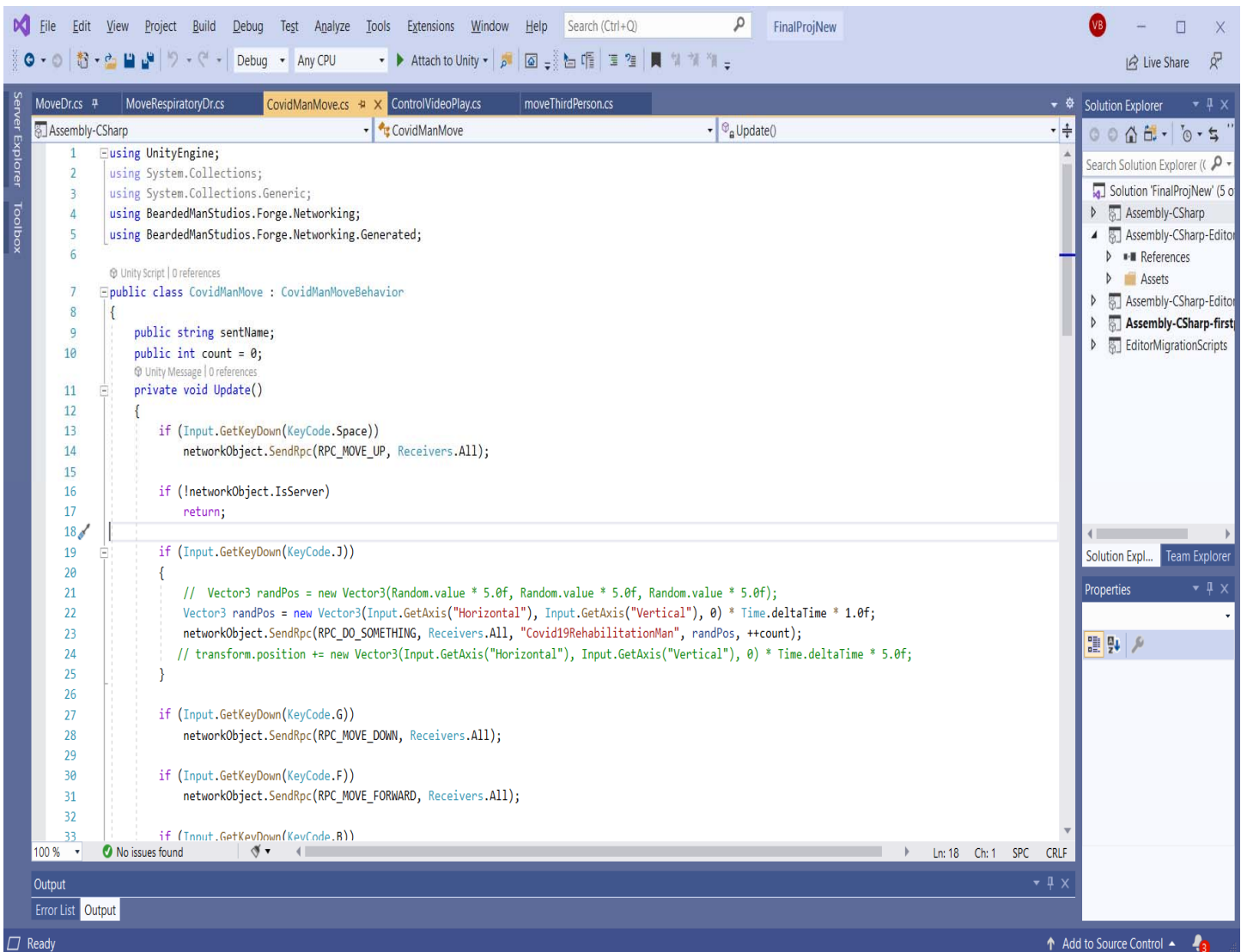


Figure 3: Visual Studio C# development environment

FUNCTIONALITY

- **Sound** – There is a sound of the video playing. There is also the start, pause and stop buttons to play video.
- **Interactively** – The user starts stops video and navigate environment
- **Animation** – Animations in the virtual environment include therapist movements, patient movements.
- **Vision** – Models from Google Sketchup, Cgtrader and 3D Max where included in the environment.
- **Avatars** – 3 Therapists, 3 nurses, 6 covid-19 patients

PROBLEMS ENCOUNTERED

There were problems encounters during the project, initial problems were use of the Network Contracting Wizard communicated some standard objects used was obsolete.

USER'S MANUAL

- **Forward:** key code F
- **Backward:** key code B
- Left: Key code L
- Right: Key code R

REFERENCES

