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Utilization of ROS in Human Support Robot (HSR)

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Abstract: Robots have played a big part in our lives and can be utilized through numerous methods currently in the world. Robots without understanding simple instructions maybe a problem for users who are currently using and running robots in their lifetime. Inthis project, the main focus will be mostly on the virtual robot which is the HSR Robot (Home Service Robot), and how to control it fully online. This project will mostly use the software Unity 3D and ROS Noetic as its core mechanics in helping thetask of correctly controlling the robot through virtual means. At the end of this project,the virtual robot should be able to understand basic instructions imputed and controlled by the user. The result of the experiments is explained in this paper.

Keywords: Home Service Robot, HSR Robot, Unity 3D, ROS Noetic

1. Introduction

In recent years, service robot research has gotten a lot of interest [1]. Service robotsaid humans by completing jobs that are unclean, boring, far away, dangerous, or repetitive. They're usually self-contained and/or controlled by a built-in system, with manual override possibilities. The word "service robot" isn't defined in a technical sense [2]. In most circumstances, such as nursing homes and businesses, people expectrobots to assist them with a variety of activities, such as taking orders and delivering drinks, greeting and escorting visitors, or just cleaning up [3]-[4]. A service robot must have human-like information processing and the underlying mechanisms for dealing with the actual world to achieve this aim, including the capacity to converse with humans, learn the knowledge needed to execute tasks and adapt to a changing environment.

With the recent pandemic, the use of home service robots should be greatly utilized since this can restrict movement or the need to be close to someone else [5]. The service robot will be run and programmed with ROS. ROS (Robot Operating System)is frequently utilized by robot programmers since it is becoming more popular for robotsoftware development [6]. The Robot that is used in this project is called the HSR Robot [7]. Two major international robotic competitions, the Robo Cup Home Domestic Standard Platform League (DSPL) and the World Robot Summit have accepted the HSR as

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a standard platform [8]. The HSR, which has been available to the public since 2017, was used by 33 universities in eight nations by 2018 [9].

In this project, the full usage of ROS Noetic that can be used to control the virtual robot can be applied. This project is tried to improve from its predecessor by implementing the HSR robot to be more effective and time sufficient in understanding their given instruction before executing itperfectly. Doing this can save time and work since it will have made the job much faster and more efficient.

2. Materials and Methods

In this section, there are 2 main stages that can lead to the project's success by acknowledging each software function and purpose.

2.1 Virtual HSR Robot System Block Diagram

The main criteria in most of the projects are inputs, the control unit and outputs. The input of this project is the robot module, the control unit is the robot controller in ROS Noetic and the output is the virtual robot display that can be viewed in Unity 3D. The use of Wi-Fi and the Rosbridge server is key to transmitting data. Figure 1 shows the block diagram of this project.

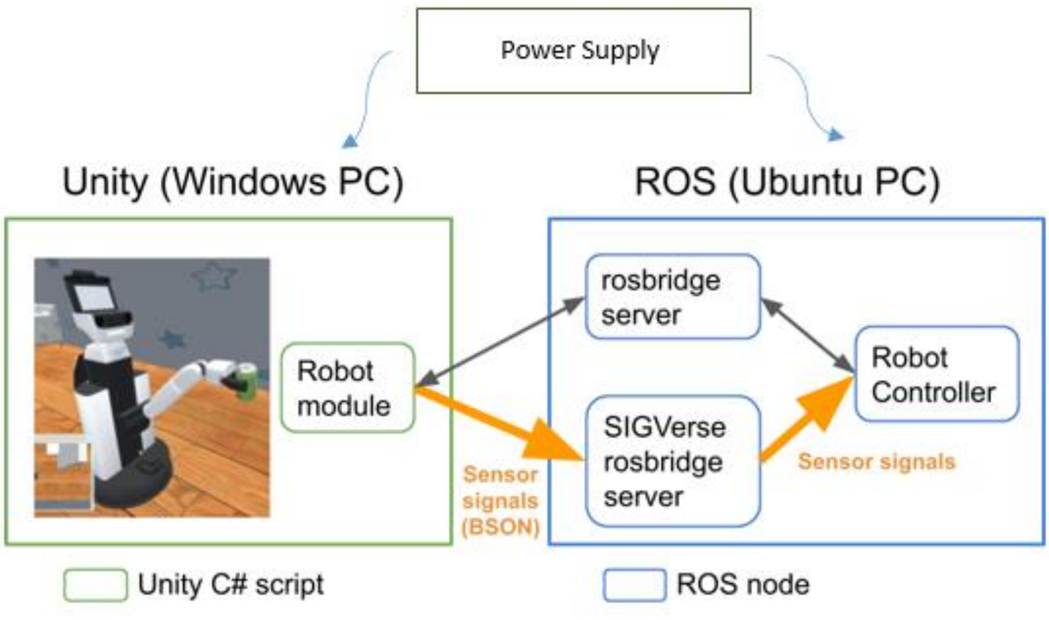

Figure 1: Block Diagram between Unity 3D and ROS Noetic

2.2 Methods

The suggested system employs a working virtual HSR robot that can be assigned simple tasks while giving full control to the user to control it in the virtual space. Figure 2 shows the process flow. The robot module can be adjusted through the Unity 3D software. The scene of the HSR robot can also be played from the application. While with the use of ROS Noetic, the use of the catkin commands will be key in opening the robot controller. In order to connect both platforms, the Unity 3D is integrated with ROS Noetic through SIGVerse ROSbridge server so that both PC are linked in the same server withthe same ROSbridge IP Address. It sends sensor signals to the Robot controller which can be configured through ROS Noetic through Ubuntu and then back to the robot module to execute the task in real-time. The task can be executed through simple keyboard instructions that will control the virtual robot in real-time using HSR teleop key. Figure 2 shows the process flow of the project:

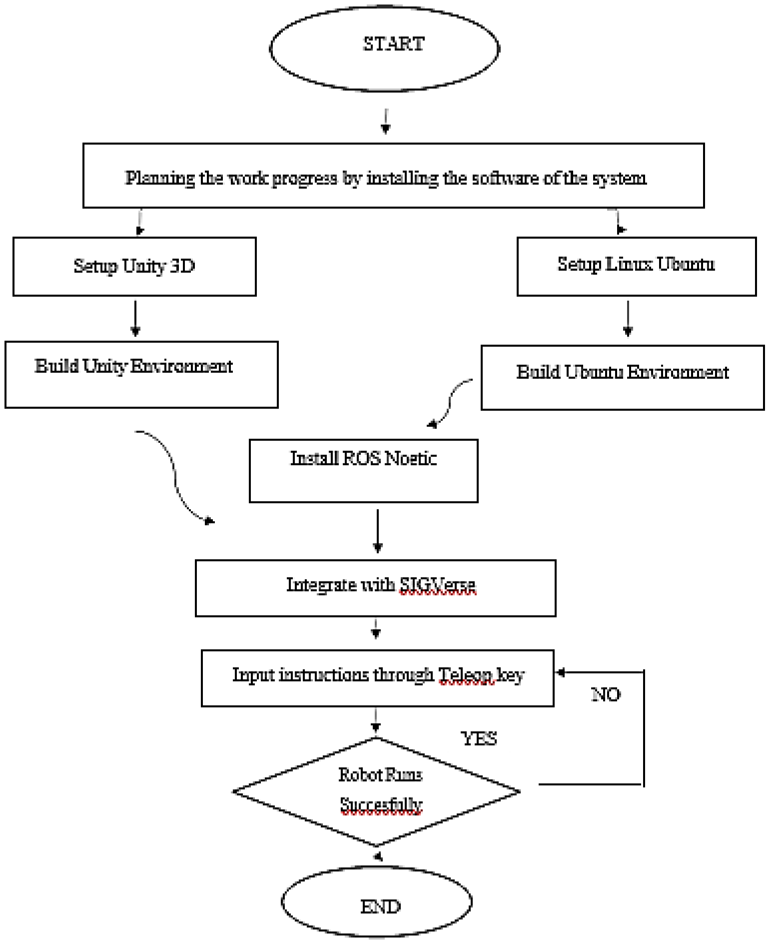

Figure 2: Process Flow of the Project

2.3 Integration between Unity 3D and ROS Noetic

The use of the SIGVerse Rosbridge server will be key in connecting both software IP addresses. Figures 3 and 4 show the connection of the server.

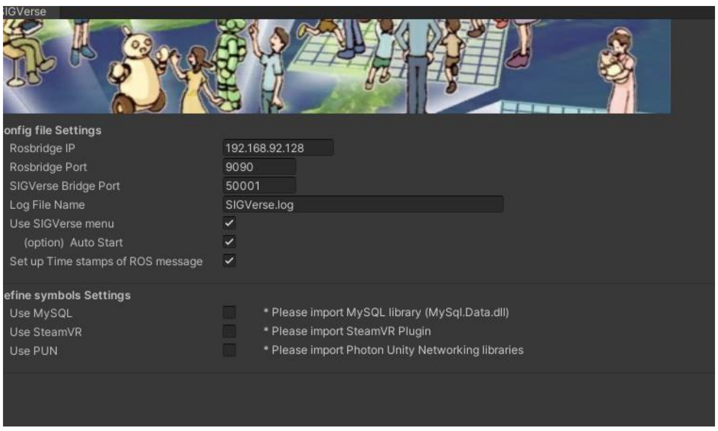

Figure 3: RosBridge IP has been set in Unity 3D

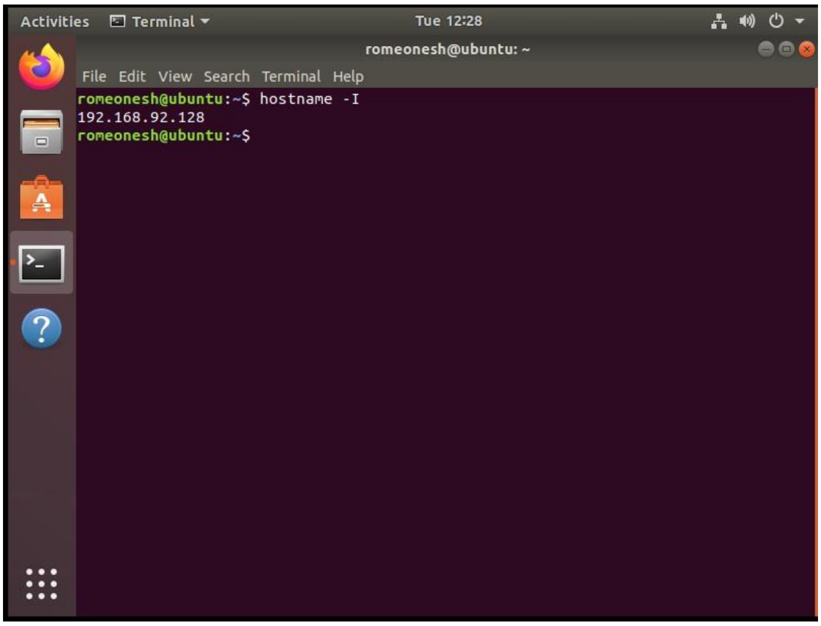

Figure 4: Given Rosbridge IP in Ubuntu

3. Results and Discussion

Figures 5-11 show the results from the virtual HSR Robot simulation. It consists of 2 different experiments that have been conducted to see the efficiency of the HSR Robot. Besides that, it also consists part to show the part where the user has to launch the teleop key.

3.1 Result

Figure 5 shows the initial condition of the virtual HSR Robot pre-simulation:

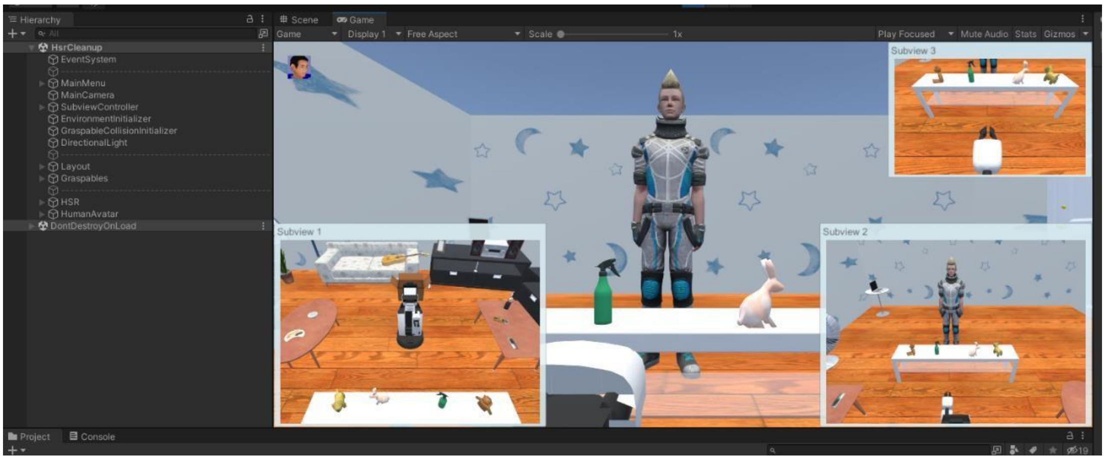

Figure 5: Initial condition of the virtual HSR Robot

After opening teleop key as shown in Figure 6 with the use of ROS Noetic and then Figure 7 shows the operation between the initial condition and the teleop key which act as the microcontroller side by side so the user has easier access in controlling the robot real time since the user has to observe the environment while having full control of the virtual HSR Robot.

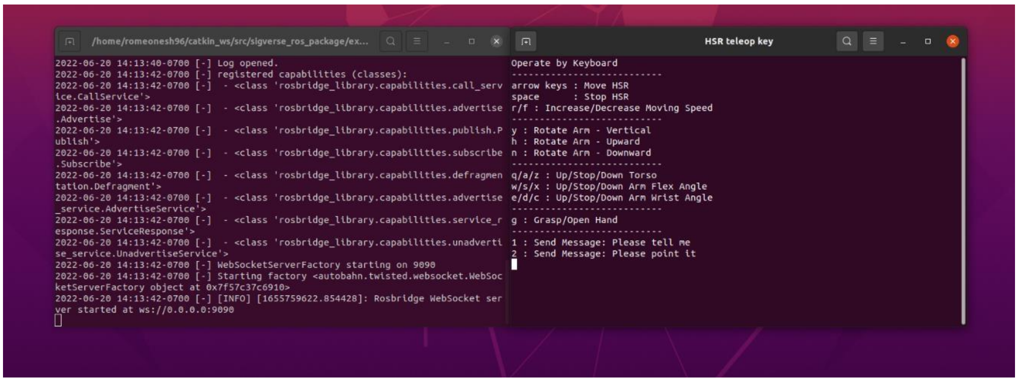

Figure 6: Teleop key terminal

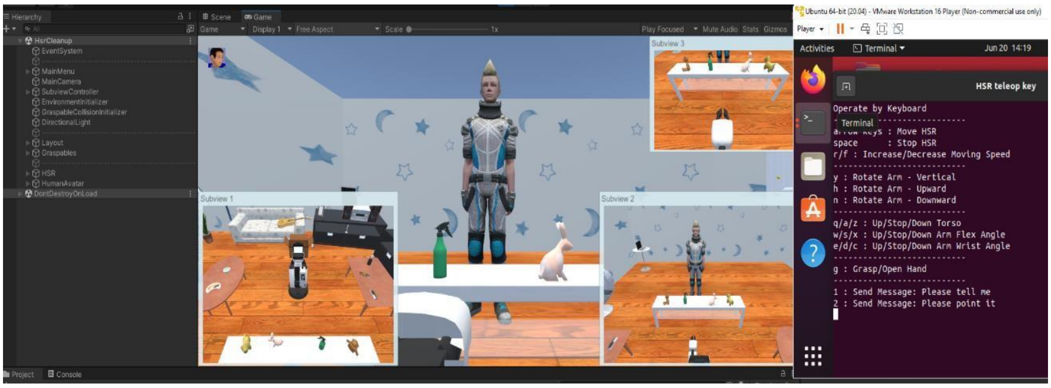

Figure 7: Unity 3D and Teleop key side by side for easier control

This demonstration showcases the experiment for the project testing. Experiment 1 will show the virtual HSR Robot moving a teddy bear from point A to point B and the experiment shows the virtual HSR Robot moving a green spray bottle from point A to point C.

Experiment 1 shows the teddy bear moving from point A which is the long white table to point B which is the small brown round table which is situated at the right of the robot's perspective. Figure 8 shows the virtual robot grabbing the teddy bear from point A and Figure 9 shows the virtual HSR Robot is heading towards its destination in point B. The time taken for this experiment to conduct is all self-controlled meaning the virtual HSR robot is manually controlled by the user so the time taken varies for each individual.

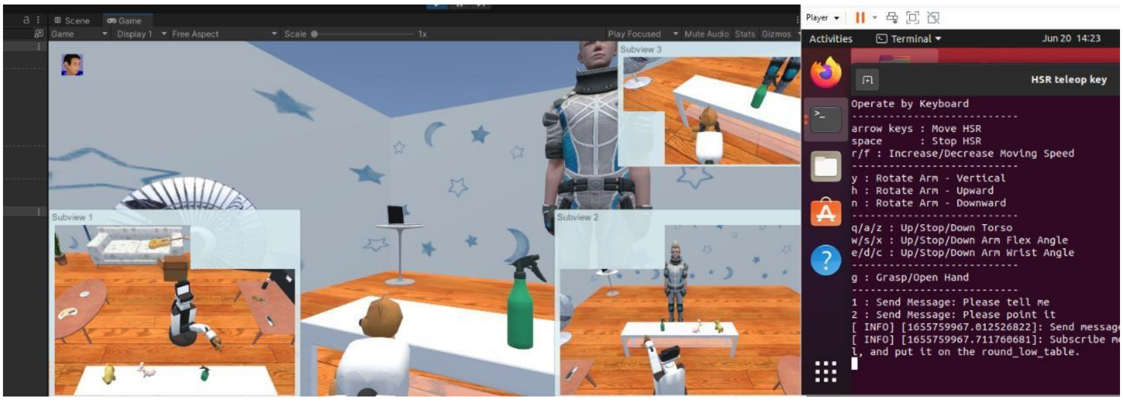

Figure 8: Grabbing the teddy bear from point A

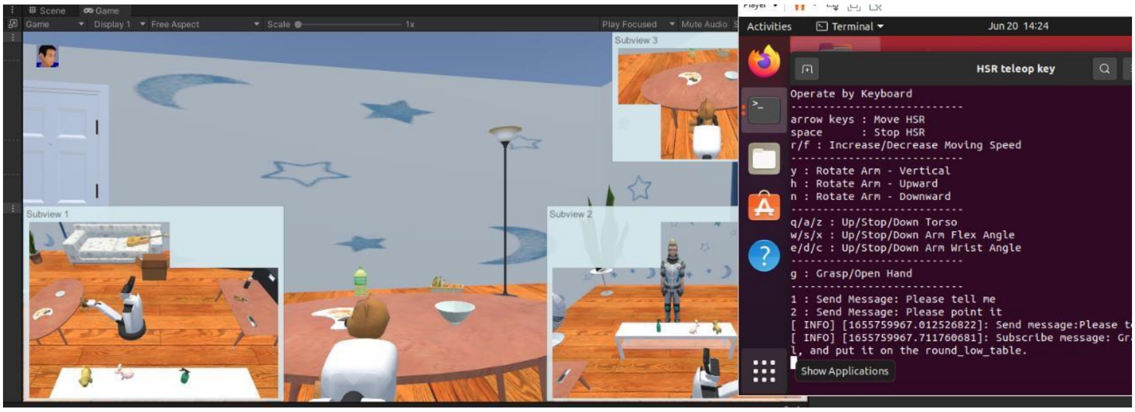

Figure 9: Moving towards point B with the teddy bear

Experiment 2 shows the green spray bottle moving from point A which is the long white table to point C which is the small brown box behind the robot. Figure 10 shows the virtual robot grabbing the green spray bottle from point A and Figure 11 shows the virtual HSR Robot heading toward its destination in point C. The time taken for this experiment to conduct is all self-controlled meaning the virtual HSR robot is manually controlled by the user so the time taken varies for each individual.

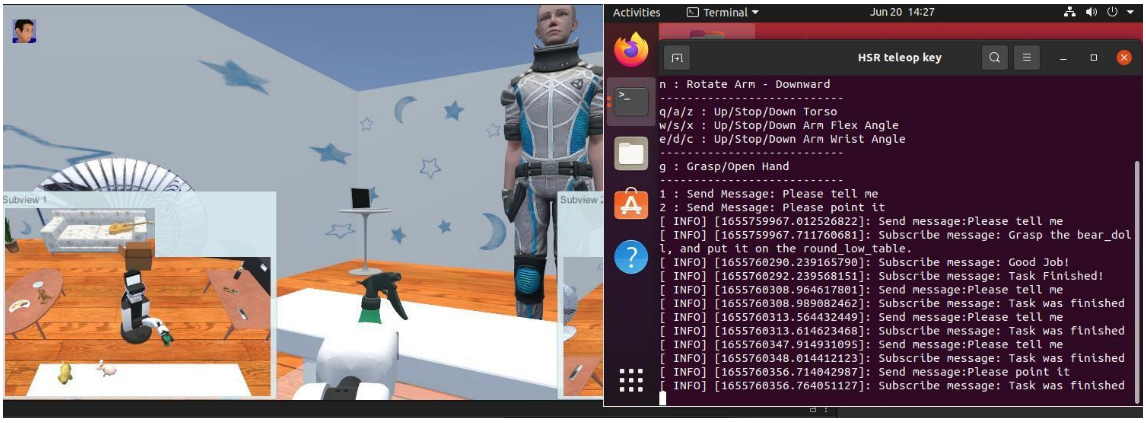

Figure 10: Grabbing the green spray bottle from point A

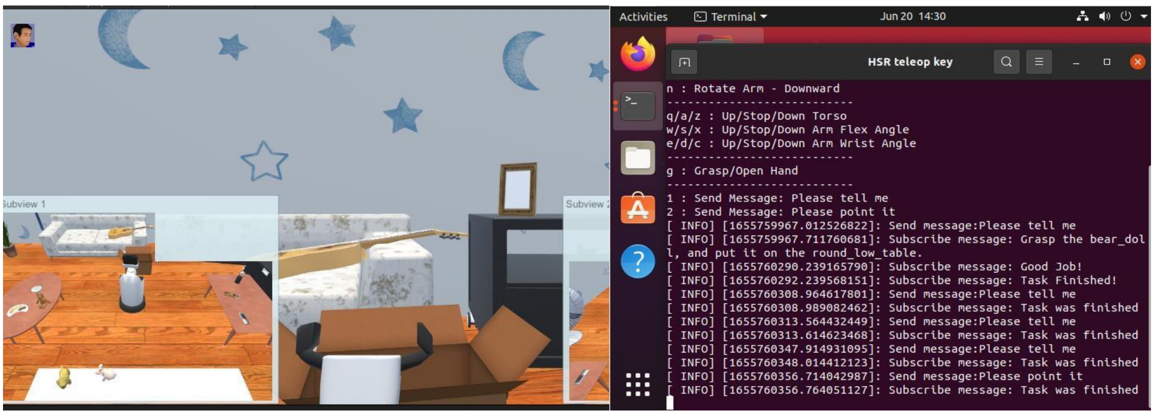

Figure 11: Moving towards point C with the green spray bottle

4. Conclusion

The virtual HSR robot was a huge success in the end. From this project, the user can learn a lot about human resource robots. The usage and work with the above software such as Unity 3D, Linux Ubuntu and ROS Noetic will further enhance the user skill. From this project, It can be shown the importance of this software in Virtual Robot simulationand programming. Furthermore, the importance of ROS should be highlighted in this project since it makes the controlling of the virtual robot much easier to control. Moreover, with the help of SIGVerse, integration between Unity and Linux Ubuntu is made easier and faster. A total of 2 experiments were carried out and both of them have been completed successfully with the virtual HSR robot fully able to control by the user to give out exact directions and tasks.

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