Telepresence for Robotic Supervision Based on Virtual Reality

luis Arias, , *luis.aac29890@gmail.com,*

***Abstract*—Virtual Reality is one of the remarkable technology that is presented nowadays and for future.**
The immersion into virtual place for such as: video games, teleoperation, telepresence are some of paradigms studied for years in robotics discipline.
This article presences, how is possible the immersion into remote place through virtual reality App. This work is going to be used of Unity an Gazebo-ROS for telerobotic case.

***Index Terms*—VR, Telerobotic, Telepresence, inmersion, Robotic.**

I. Introduction

To be into a fantastic place sounded as fantasy 10 year ago, but we are witnesses of how in this new technology era it is possible.
Application for video game to be immersed into fantastic place is real. You will agree with me in that VR is more remarkable for video games. However, this technology is going to be presence in our society for different areas. I mean, V.R will presence in: industry, home, office, construction, games, remote works, etc.

Virtual Reality or VR for short, is the promise of future technology, that will make possible to be immersed into either virtual environment or remote places just through data transmission.

For robotic is a challenge makes possible VR application, in my point of view. This actually a lot of data transmission, accurate and others features. Let me give you one example: For medicine, the most famous robot called "Da Vinci" is a complex system that make realistic surgery remotely (this is one video supplied: **https://www.youtube.com/watch?v=QksAVT0YMEo**

In this article I am going to board Virtual Reality for robotic technology.

For state of the art, there are a huge researches about VR applied to solve different problem in the real life.

Carl M and Tim W (2019). present the collaborative Virtual Reality Neurorobotics Lab, which allows multiple collocated and remote users to experience, discuss and participate in neurorobotic experiments in immersive virtual reality.

Ankur B. and Sridhar S. prenset their tobotic surgical simulator (RoSS) system as means of training for Da Vinci Surgical System, where developed a two handed 6 DOF virtual reality trainer for adquiring basic sill sets that are needed to performa surgery using Da Vinci Surgical System.

Zhenliang Z. and Benyang C. propose the concept of inverse virtual reality IVR, and describe the details about the definition, structure and implementation of a typical IVR system. The parallel living environment is proposed as a typical application of IVR, which reveals that IVR has a significant potential to extend the human living environment.

Benjamin V. and Adrien V. present the paper called "Towards Robot Arm Training in Virtual Reality Using Partial Least Squares Regression" examine how a robotic arm can be trained using Coloured PetriNets (CPN) and Partial Least Squares Regression (PLSR).

Jingxing Z. presents the natural human-robot interaction in virtual reality telepresence systems. The goal of this research project is to meet these challenges, and contribute to the development and evaluation of novel telepresence system and interactive behaviours in 360 degrees virtual environments with a focus on full-view telepresence, spatial perception, locomotion, usability and motion sickness.

In this article will be presented the robotic telepresence application for supervision into remote place, and for that reason it will be divide in 4 parts.

1) Mobile Robot Description 2) Communication 3) Validation 4) Conclusion

A. Mobile Robot Description

2 wheeled mobile robot is one of no non-holomonous driver-robot, this robot matemathically is modelled as this cartesian equations:

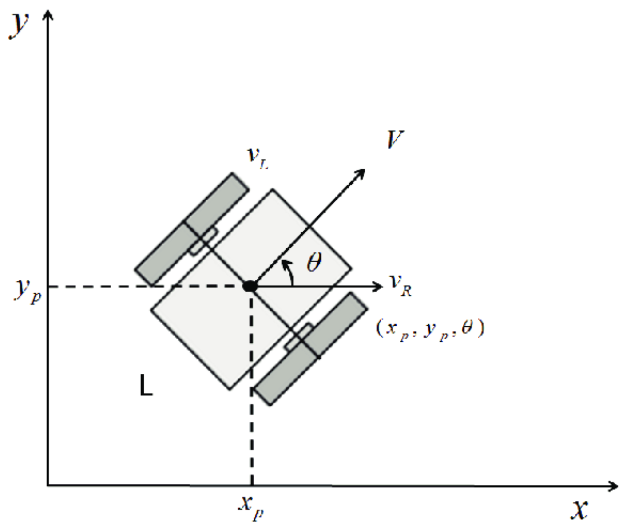
$$dx = v(t)cos(\theta(t))dt \tag{1}$$

$$dy = v(t)sin(\theta(t))dt \tag{2}$$

$$d\theta(t) = w(t)dt \tag{3}$$

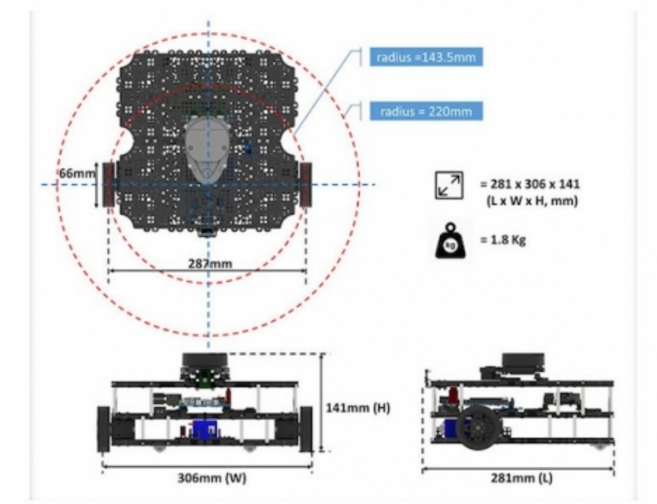
$$V_r = \frac{2v + wL}{2R} \tag{4}$$

$$V_f = \frac{2v - wL}{2R} \tag{5}$$



The solution for control could be designed using from basic PID controller untill Fuzzy neuro-fuzzy controller.

1) Turtlebot Robot: This robot is the third version of turtlebot and is called ”Waffle”. This is a 2 wheeled robot designed for navigation, and is more useful in education for research. This figure shows you waffle robot.



For more detail you can find information into ROS official Website.

2) Communication: The communication is really impotant for telepresence, the efficiency data tranference is crucial for application especially where for examples accurate, latency, big data are really important.

For this paper was used R.O.S as a robotic platform, gazebo simulator and unity as remote client.

3) Robotic Operating System: Robot Operating System (ROS or ros) is robotics middle ware (collection of software frameworks for robot software development). Although ROS is not an operating system, it provides services designed for a heterogeneous computer cluster such as hardware abstraction, low-level device control, implementation of commonly used functionality, message-passing between processes, and package management. Running sets of ROS-based processes are represented in a graph architecture where processing takes place in nodes that may receive, post and multiplex sensor data, control, state, planning, actuator, and other messages.
Despite the importance of reactivity and low latency in robot control, ROS itself is not a real-time OS (RTOS). It is possible, however, to integrate ROS with real-time code.
The lack of support for real-time systems has been addressed in the creation of ROS 2.0, a major revision of the ROS API which will take advantage of modern libraries and technologies for core ROS functionality and add support for real-time code and embedded hardware.

4) Gazebo: Gazebo is an open-source 3D robotics simulator. Gazebo was a component in the Player Project from 2004 through 2011. Gazebo integrated the ODE physics engine, OpenGL rendering, and support code for sensor simulation and actuator control. In 2011, Gazebo became an independent project supported by Willow Garage. In 2012, Open Source Robotics Foundation (OSRF) became the steward of the Gazebo project. OSRF changed its name to Open Robotics in 2018.

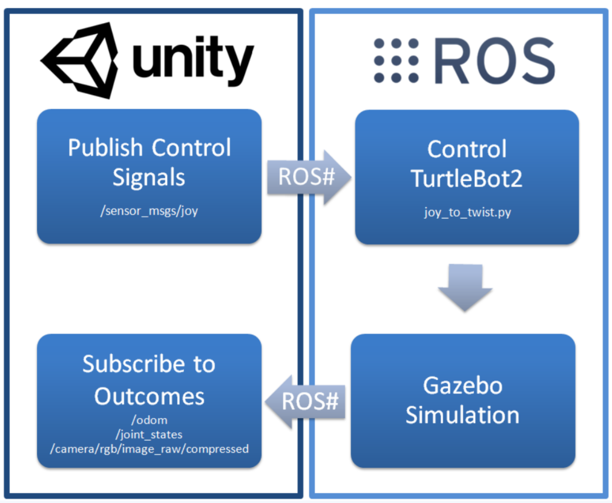
Gazebo can use multiple high-performance physics engines, such as ODE, Bullet, etc (the default is ODE). It provides realistic rendering of environments including high-quality lighting, shadows, and textures. It can model sensors that ”see” the simulated environment, such as laser range finders, cameras (including wide-angle), Kinect style sensors, etc.

ROS GAZEBO

5) Unity: Unity is a cross-platform game engine developed by Unity Technologies, first announced and released in June 2005 at Apple Inc.’s Worldwide Developers Conference as a Mac OS X-exclusive game engine. As of 2018, the engine had been extended to support more than 25 platforms. The engine can be used to create three-dimensional, two-dimensional, virtual reality, and augmented reality games, as well as simulations and other experiences. The engine has been adopted by industries outside video gaming, such as film, automotive, architecture, engineering and construction.

Several major versions of Unity have been released since its launch. The latest stable version, 2019.4.1, was released in June 2020.

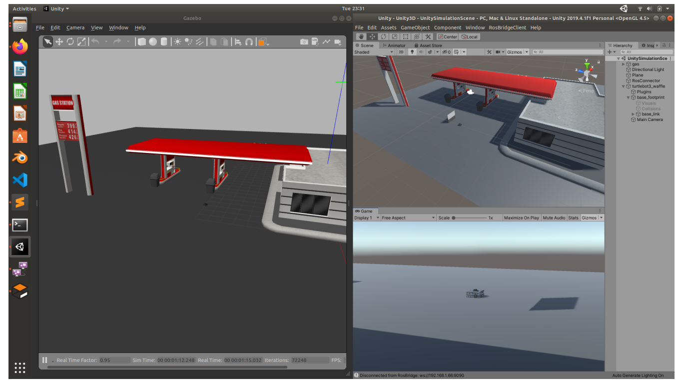
ROS and Unity are communicated using RosBridge as package for ROS and ROSsharp for unity.



B. Validation

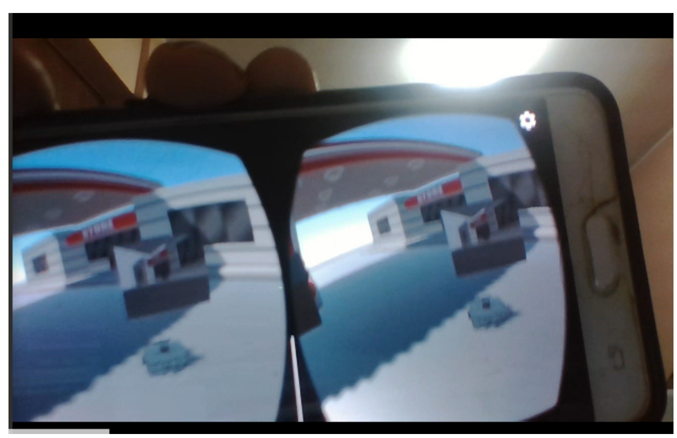
The interaction for virtual reality for this article was done with ROS melodic an gazebo 9. Where is launched the gazebo environment and spawned turtlebot3. In unity the urdf file was imported. When unity starts, the unity robot reacieve data from ROS and moves as gazebo robot moves, at the same time image from gazebo is sent and displayed into unity. This unity client was exported into Android App and validate.

In this paper was used a Android application for cardboard VR.

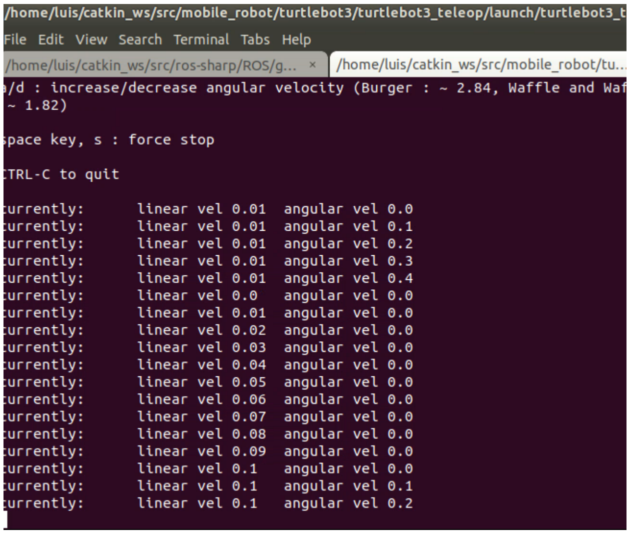


To validate the data transmission for visual users. The real scenario that is gazebo, in this case, two people immersed into.
For remote client (unity app in android), the human are displayed as screen panel into the virtual environment.

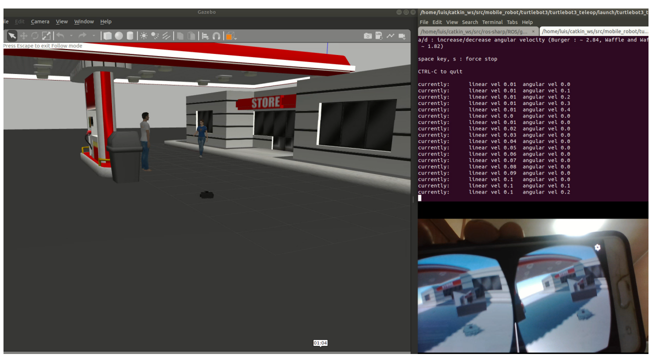
The information of gazebo and ROS is received in VR android App.



To simulate the robot movement the operated was launches as node in ROS. This simulate the robot motion for telepresence.



Finally, the result shows a fluent transference of data, but how I mentioned before, this is a big deal and has to be taken into account.



II. CONCLUSION

- For this article was presented virtual reality for robotic as well as the state of the art.
- Was used ROS as robotic platform and communication package for VR.
- Gazebo was used that simulate the real world and real robot, ROS and gazebo together make a powerful tool for robotic applications.
- Unity as game engine for VR was used and displayed into Android device.
- This VR was made for cardboard virtual reality headset.

REFERENCES

[1] Carl. M, The Collaborative Virtual Reality Neurorobotics Lab, IEEE Conference on Virtual Reality and 3D User Interfaces, 2019.

[2] Ankur B., RoSS: Virtual Reality Robotic Surgical Simulator for the da Vinci Surgical System, Symposium on Haptic Interfaces for Virtual Envorinments an Teleoperator Systems , 2008.

[3] Zhenliang Z, Inverse Virtual Reality: Intelligence-Driven Mutually Mirrored World, Conference on Virtual Reality and 3D User Interfaces , 2018.

[4] Benjamin V., Towards Robot Arm Training in Virtual Reality Using Partial Least Squares Regression, IEEE Conference on Virtual Reality and 3D User Interfaces, 2019.

[5] Jingxin Z., Extended Abstract: Natural Human-Robot Interaction in Virtual Reality Telepresence Systems,ICRA, 2012.

[6] N. Hua, Static Gait Control for Quadruped Robot , IEEE Conference on Virtual Reality and 3D User Interfaces , 2018.