Implementing New Control Schemes to Improve User-Robot Interaction

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Abstract

Virtual reality (VR) systems attempt to create realistic environments that users can interact with. When designing VR systems it is important to minimize any discomfort or disorientation users may experience. To address this concern we implement control schemes that help orient users. Figure 1 demonstrates the robot and VR system used for our research.

Figure 1. Devices used in our VR based interface. On the left is the robot operating system, turtlebot. On the right is the VR system, Oculus Rift.

Introduction

Modern VR systems provide dedicated hardware systems for user interaction. Such devices include joysticks, force balls/tracking balls, controller wands, treadmills, and motion platforms [1]. Figure 2 shows the relationship between VR hardware and their users.

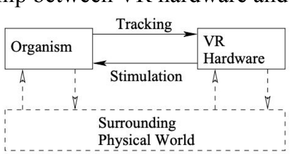

Figure 2. Components of a VR system

Last year, alumni Ian Scilipoti '19 developed a virtual reality based interface for robot navigation. He successfully created a system that could reconstruct a robot's physical environment in a VR headset. The system also allows users to move within the virtual world. In this study we will continue to improve the virtual reality system by updating and implementing new features for user interaction.

Objectives

- Implement user teleportation in virtual world
- Allow Oculus rift controllers to control turtlebot in physical world

Outcomes

We began implementing user teleportation by calculating the distance between the user and the new specified position, as seen in figure 4. This allowed us to calculate the translation vector. Next, we enhanced robot navigation by interpreting the joystick movements of the controller as three different instructions: forward, backward, or rotation Moving the joystick forward or backward would move the robot forward or backward in both the physical and virtual world. Any other direction would signify a rotation to the left or right. Figure 3 illustrates control inputs for teleportation and robot movement.

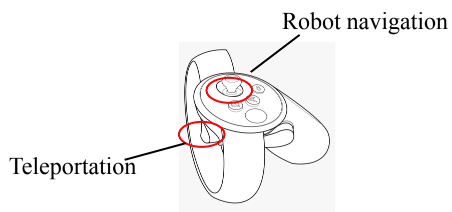

Figure 3. Demonstration of controller schemes implemented

After successfully implementing robot navigation, the turtlebot would frequently lose tracking signals. This was due to the fast and sudden movements made by the turtlebot. To fix this we reduced the movement speed of the turtlebot.

To eliminate some disorientation in the virtual world we decided to create a position tracker that translates and rotates relative to the robot's position in the virtual world. Figure 4 provides a visual representation of the position tracker in our virtual world.

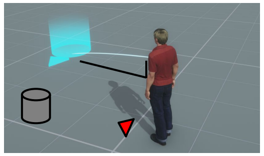

Figure 4. Red triangle represents the position tracker pointing in the direction of the robot. The blue ray points at the new position to teleport to.

By the end of our research we were able to implement user teleportation, robot navigation, and eliminate some disorientation in the virtual world. However, due to time restrictions we were unable to test our product to determine the levels of discomfort and disorientation subjects could still experience.

Future Work

- Use 3D capturing system to record and translate user movement into instructional code
- Allow user manipulation of virtual world
- Implement a user assisted re-tracking of the robot

Acknowledgments

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References

[1] Pcwta research summary, November 2017
[2]LaValle, S. M. *Virtual Reality*. Cambridge University Press, 2019