A Novel Design of Virtual Reality-Based User Interface in a Robot-Assisted Environment for User Engagement

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Introduction

- ***Manipulative robotics (MR)*** is an expanding subfield of robotics[1], especially in manufacturing, where robots interact with physical objects to achieve a goal.
- ***User interfaces (UIs)*** are a means to facilitate and support users to accomplish their goals via a set of text/graphical elements or other multimodal designs.
- In the current field of Robotics, ***physical graphical UIs are the most common method to interact with robots*** via either controller or touch screen.
- ***Virtual reality (VR)*** is an emerging technology that enables a sense of ***presence*** a virtual environment, making remote learning and work more immersive[3].

Research Questions

- **Can we design a virtual reality (VR) interface** to remotely manipulate robotic arms for authentic lab experiences to improve user engagement, learning, and productivity without prior robotics background?
- **What design elements and pedagogical cues** are needed to create such immersive and safe MR UIs/user experiences (UX)?

Three Themes in the Current Literature

The current VR design in this area is focused on developing environments and experiences to mimic and innovate user's respective workplaces based on three themes:

1) **Personalization** allows users to customize their environment to their liking using lighting, scenery, music, and room types[5].
2) **UX for controlling the robot** is designed to feel akin to an extension of the user's body. Rather than operating with a virtual control panel, users make wrist rotations to move pivot points.
3) **Cost-effective design strategies** facilitate the potential access for other institutions/businesses that do not have onsite laboratories or advanced workplaces that they can remotely access these technologies with much lower costs[4].

Proposed Study

- **Qualitative:** Users will be invited to our research lab to conduct a 1-on-1 user interaction with our VR prototype for a few user tasks with the experimental team. They will be asked to provide feedback on the efficacy of the VR platform **[Fig 1]**, room layout, and quality of customizable options.
- **Quantitative:** User performance time between different room layout types and task completion using a physical robot **[Fig 2]**.

Expected Projected Outcomes

Several potential outcomes that could stem from this project's future dissemination include:

- ***Greater accessibility:*** *With our intent to design a cost-effective VR robotics platform, we may provide access to more business sectors and workers in a hybrid/remote working mode[6].*
- ***Greater efficiency****: We plan to develop a highly customizable VR/MR environment, increasing comfort, employee satisfaction. We would expect higher user satisfaction and more efficient task completion[2][3][5].*
- ***Greater safety****: Our study implies more realistic safety cues for remote field work, thus allowing users to complete dangerous tasks safely with increased safety awareness in our VR platform[3].*

Future Development

- Allow multiple users to work with different robot types and operate on a per-session basis.
- Extend some functionality of the VR platform, such as UI elements and control methodology, to onsite users via AR.
- Personalization design to accommodate different users' needs for optimal task performance, user satisfaction, and UX.

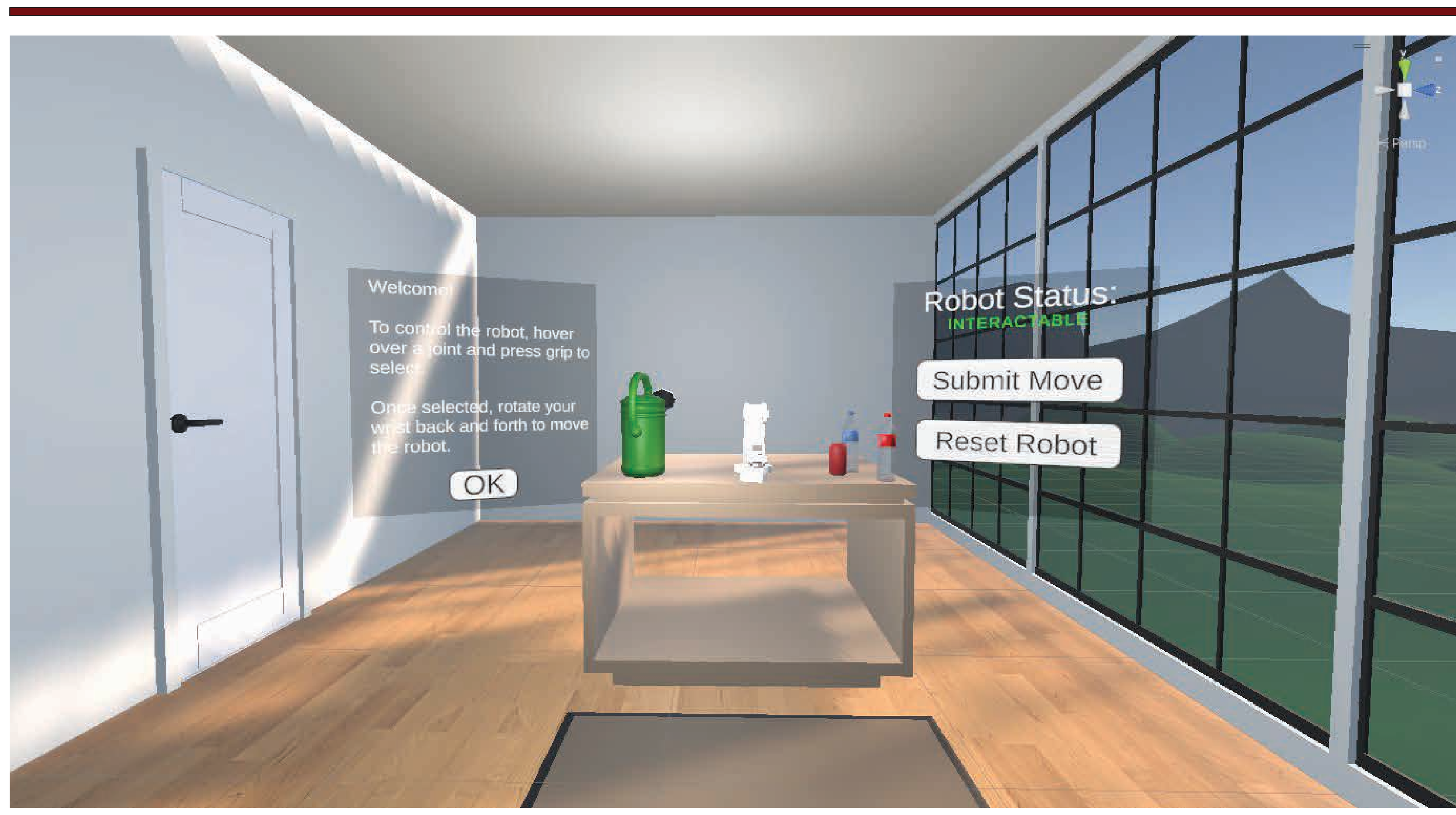

Fig 1. Initial Prototype of the Proposed VR Robotics Platform

Fig 1. shows one of the configurations for the VR remote working environment. Room type, music and ambience, and lighting will be available for users to customize.

Fig. 2 is the complex robotic arm that will be used to operate remote physical tasks based on the instruction from Fig. 1.

Fig 2. KINOVA Robotic Arm

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* Additional references available upon request

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