Improving Teleoperated Mobile Manipulator Performance

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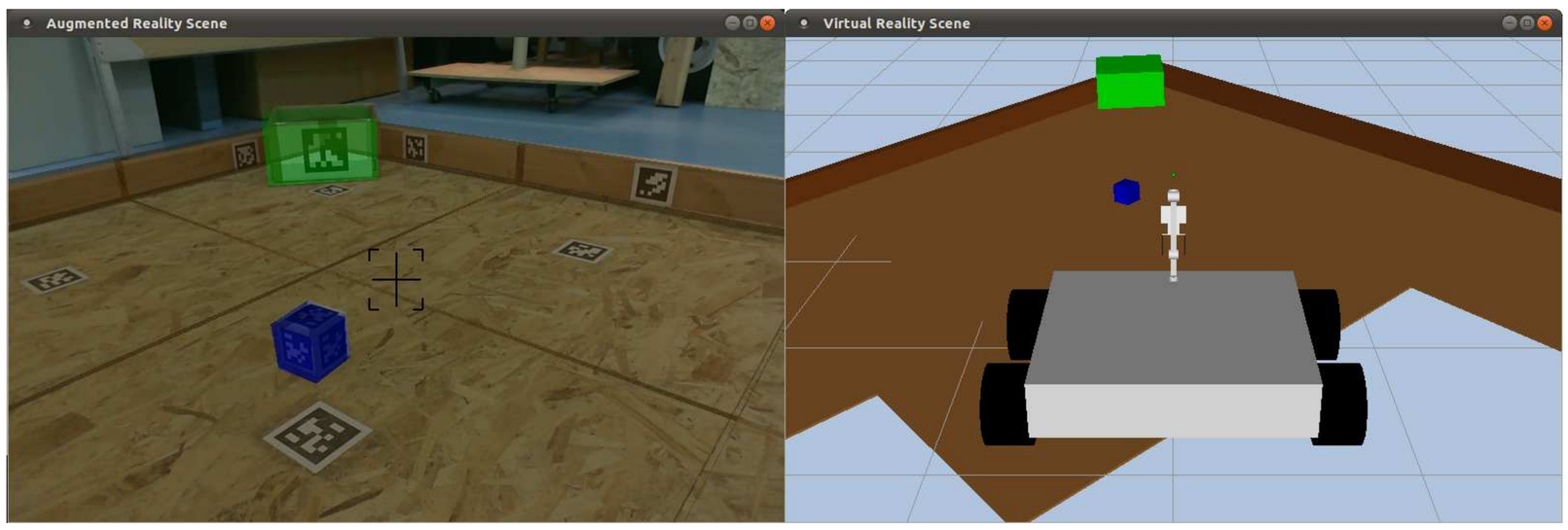
Project Overview

Despite recent advances in mobile robot autonomy, teleoperation remains an integral part of many mobile manipulation tasks. In situations where it is hazardous or difficult for humans to be present, but require human judgment and decision-making skills, teleoperation is the the only option. However, due to inefficient human-robot interaction strategies, lack of user situational awareness, and system latency, even a basic mobile teleoperation task can become a very slow and difficult process. My research focuses on strategies to improve human-robot interaction for teleoperated mobile manipulation tasks using advanced visualization techniques and novel manual interfaces. I am developing and testing a user interface that uses an Augmented and Virtual Reality display as well as a master-slave manual interface to help improve the teleoperator's sense of presence in the robot workspace. I am also working to characterize the fundamental limitations imposed on robot performance due to the delays inherent in any mobile teleoperation system. I hope to apply this research in the long-term to develop a framework for increasing both the speed and ease with which teleoperated robot tasks can be performed.

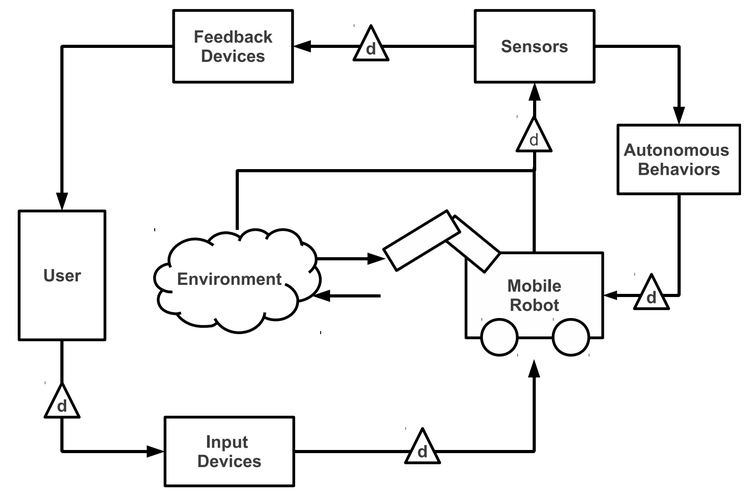
Augmented Reality User Interfaces



Augmented Reality (AR) is a technology in which real-world video data can be combined with an overlay of computer graphics, enhancing the original video feed [3]. The AR scene of this interface shows an egocentric view of the robot workspace with virtual objects superimposed over the video feed. The virtual scene of the interface is an exocentric view of the robot workspace shown from a manipulatable camera orientation.

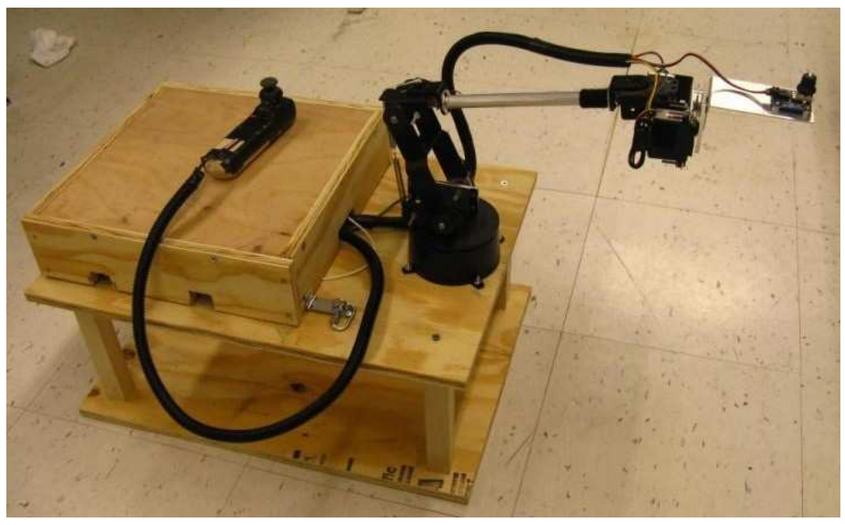
Sources of Delay

Time delay has a significant impact on user performance in teleoperation. The total time delay is a sum of delays from a variety of sources, including those due to network communication, sensing, computer processing, and human reaction time.

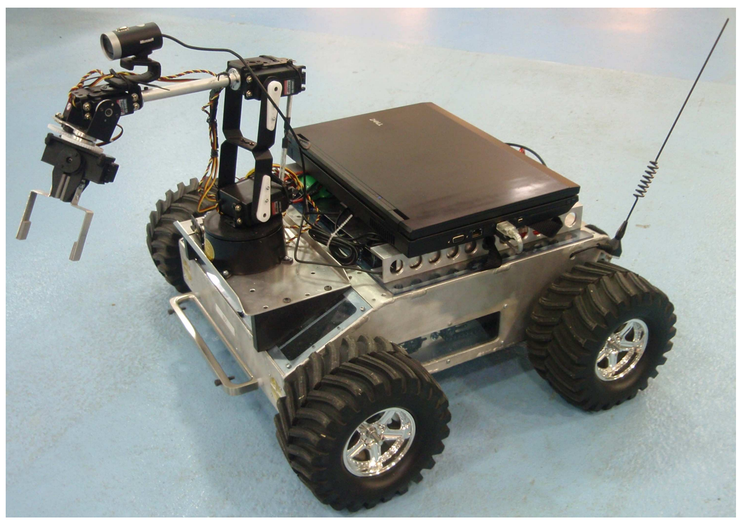


Master-Slave Manual Interfaces

Users often find it challenging to mentally map commands from some manual inputs (such as keyboard, mouse, and gamepad) to the robot arm behavior. A master-slave style manual controller can provide an intuitive one-to-one mapping from user input to robot pose, and may improve operator sense of presence during teleoperation tasks as well as decrease task completion time.



The robot arm master controller



The slave arm is mounted on a mobile robot chassis

References

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[2] S. Vozar, D.M. Tilbury, Augmented reality user interface for mobile ground robots with manipulator arms In *Proceedings of the SPIE*, Volume 7878, pp. 78780M-78780M-9, 2011.

[3] S.A. Green, M. Billinghurst, X. Chen, J.G. Vetter, Human-Robot collaboration: A literature review and augmented reality approach in design In *International journal of advanced robotic systems*, 5(1), 1–18 (2008).

Future Work

Current teleoperated mobile manipulation operations are often painstakingly slow. For robots to become a more viable tool for humans in the future, the speed at which robot-assisted tasks can be completed must be increased. In the long-term, I hope to apply results of my current research to develop a framework for increasing the speed at which teleoperated robot tasks involving driving and arm manipulation can be performed.

Acknowledgements

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