U.S. DEPARTMENT OF ENERGY | OFFICE OF ENVIRONMENTAL MANAGEMENT

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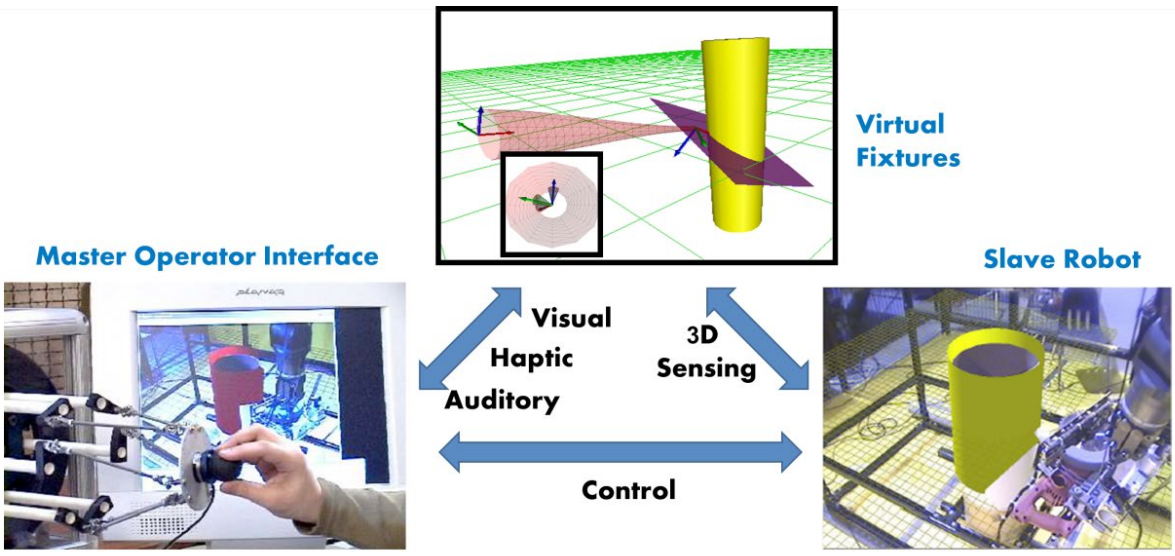
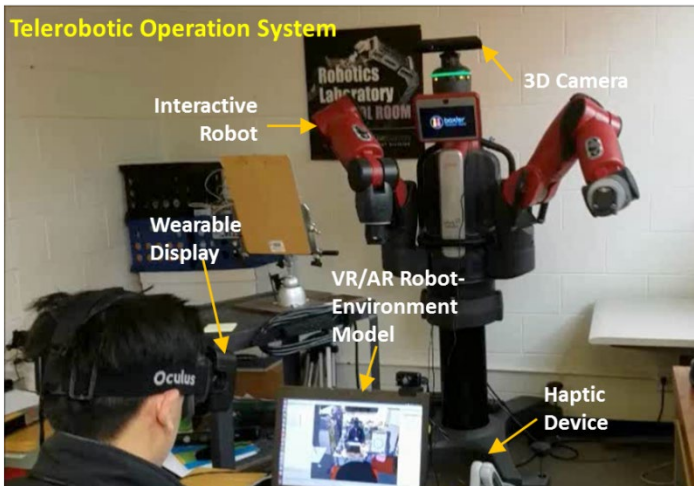
Argonne National Lab 3D Reconstruction, Augmented-Reality, and Telerobotic Operation



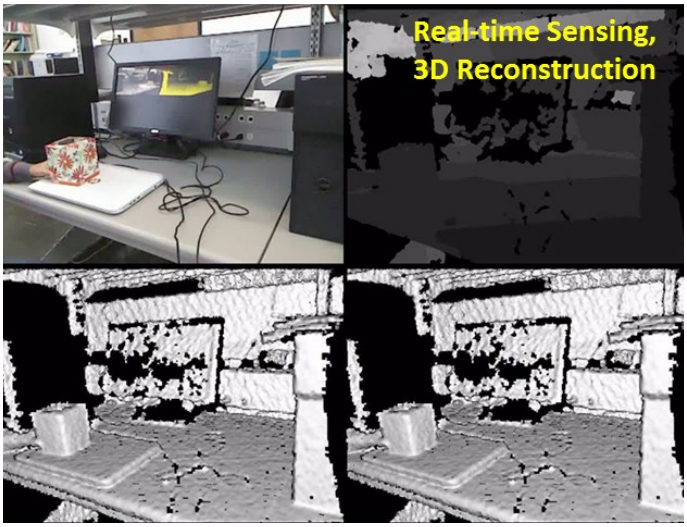
Overview

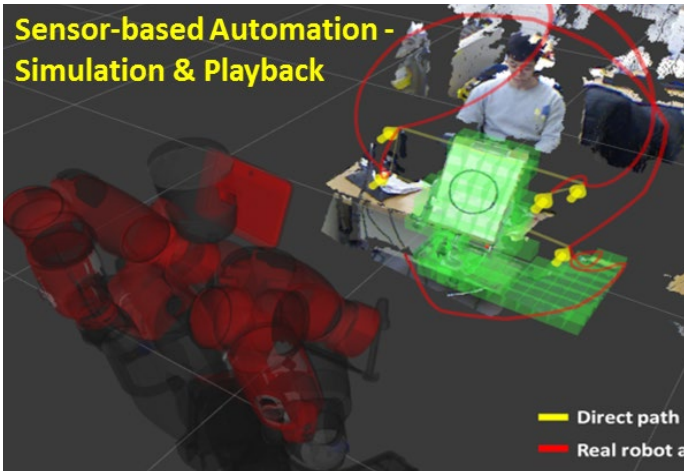
This technology demonstrates an immersive operator interface for intuitive and efficient teleoperation of robotic systems. For operations in highly radioactive and potentially hazardous environment of nuclear applications, remotely operated robot systems are required. Currently, they are either operated through manual teleoperation or automated operation, which have limitations in terms of efficiency and reliability, respectively. To this end, a new remote operation method is proposed incorporating augmented reality technology so as to make it possible to deploy simple and robust robots and perform precise and dexterous manipulation under remote operation. Rather than trying to improve functionality through greater robot complexity, innovation is being directed at the operator interface.



Concept

The main innovation in the proposed method is the concept of 'virtual fixtures' for multi-modal perceptual augmentation of artificial geometric surfaces which serves to guide the human operator during commanding teleoperation. Such a perceptual overlay, when placed precisely, can relieve the operator's mental burden during manual teleoperation to realize more precise and efficient operation. Also, compared to automatic operation, the new method preserves human-in-the-loop control ensuring safer and more reliable performance. Instead of inducing automatic motion, automation is replaced with passive virtual surfaces, and it is the responsibility of the human operator to feel and use them to safely execute the robot motion.





Description

The R&D scope addresses the integrated development of an enhanced teleoperation system incorporating:

- **3D Sensing and Reconstruction:** utilizes 3D cameras and constructs a 3D geometric model of the environment. Compared to the state-of-the-art technology, the presented 3D reconstruction has greater spatial precision and dynamic object tracking capability, which enhances the precision of manipulation tasks in a dynamic environment.
- **Augmented Reality-based Teleoperator Interface:** consists of generation of virtual surfaces of various geometries and dynamic characteristics, as well as consistent perceptual overlay in camera, robot and operator hand control spaces.
- **Teleoperation Testbed:** is demonstrated with a human-interactive dual-arm robot system operated under Robot Operating System (ROS).

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