TELEOPERATION OF MOBILE MANIPULATORS

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ABSTRACT

Mobile manipulators provide larger working spaces and more flexibility than standard manipulators by introducing mobility. Through teleoperation, they can be applied to a variety of areas such as hazardous material handling, outer space exploration, explosive ordnance disposal, etc.

Inspired from application requirements, there are four major challenges in the system including modeling and control of mobile manipulators, teleoperation of multiple mobile manipulators, modeling human teleoperator in teleoperation system and communications between human teleoperator and mobile manipulator. Therefore, this study aims to address these challenges.

For modeling and control of mobile manipulators, the motion control accuracy of the end-effector is a problem for the existing methods due to the system dynamics differences. This is an important impact on the efficiency of teleoperation. To address this issue, we introduce an online motion distribution method and an online coordinated control method which could significantly improve the end-effector accuracy and teleoperation efficiency.

For teleoperation of multiple mobile manipulators, the system stability under random communication delays and unexpected events is a major problem for the existing methods. To address this issue, we propose a non-time based teleoperation and coordination method. A non-time perceptive reference is designed as a new reference to replace the time in the system.
modeling and control. Through this design, the system stability under random communication delays and unexpected events could be ensured.

For modeling human teleoperator in teleoperation system, there are no existing models for the human teleoperator and the teleoperation efficiency and safety are always subject to the operation status of the teleoperator in teleoperation. To address this issue, we propose a concept named quality of teleoperator (QoT) to represent the teleoperator and incorporate it into the modeling and control of the teleoperation system. Through this design, the teleoperation efficiency and safety could be improved under various operation status of the teleoperator.

For communications between human teleoperator and mobile manipulator, the existing methods of using joysticks are neither efficient nor intuitive. Therefore, we introduce the natural language as a new communication manner. However, the existing natural language control methods could not online handle unexpected events in the environment and robotic system. To address this issue, a new natural language control method and a new robot planning and control method are designed to online handle such unexpected events.

The proposed methods are all implemented on our developed MSU mobile manipulators. The experimental results demonstrate and validate their effectiveness and advantages.

Publications

Published and Accepted Publications


• J. Liu, **Y. Jia** and N. Xi, "Identification of Road Surface Conditions Based on Laser Scanning," *IEEE Conference on Robotics and Biomimetics (ROBIO)*, 2013, pp. 2476-2481.


Submitted Publications
