Eye-Gaze-Controlled Telepresence Robots for People with Motor Disabilities

Eye-gaze interaction is a common control mode for people with limited mobility of their hands. Mobile robotic telepresence systems are increasingly used to promote social interaction between geographically dispersed people. We are interested in how gaze interaction can be applied to such robotic systems, in order to provide new opportunities for people with physical challenges. However, few studies have implemented gaze-interaction into a telepresence robot and it is still unclear how gaze-interaction within these robotic systems impacts users and how to improve the systems. This paper introduces our research project, which takes a two-phase approach towards investigating a novel interaction-system we developed. Results of these two studies are discussed and future plans are described.

Head and gaze control of a telepresence robot with an HMD

Gaze interaction with telerobots is a new opportunity for wheelchair users with severe motor disabilities. We present a video showing how head-mounted displays (HMD) with gaze tracking can be used to monitor a robot that carries a 360° video camera and a microphone. Our interface supports autonomous driving via way-points on a map, along with gaze-controlled steering and gaze typing. It is implemented with Unity, which communicates with the Robot Operating System (ROS).
Impact of task complexity on driving a gaze-controlled telerobot

Robotic telepresence systems promote social interaction between geographically dispersed people. Gaze interaction is regarded as a common control mode for severely paralyzed people (Minakata et al., 2018). Gaze interaction with telerobots provides a new opportunity for people with limited mobility. The possibility of gaze-controlled, floor-driving robots has been shown in a prior study (Tall et al., 2009). The quality of eye tracking has been shown to be sufficient for gaze interaction in a bed scenario (Hansen et al., 2011). Situation awareness (SA) plays an important part in telepresence and a high level of understanding of the environment the telerobot is navigating through must be provided (Endsley, 2000). SA is also a primary basis for performance (Endsley, 1995). However, for this kind of gaze-controlled telepresence, it is still unclear how task complexity impacts users' performance and their SA. Thus, the main research question of this study is: what is the impact of task complexity when driving a gaze-controlled telerobot with a virtual reality head-mounted display (VR HMD)? A total of 10 participants took part in our experiment (five with a low-complexity task vs. five with a high-complexity task). The dependent variables of interest were, eye movements, position of telerobot, and correctness of answers about information collected during the test. A subjective measure was also collected on experience of comfort and fun. A VR HMD with gaze tracking was provided for each test person to control a robot that carries a 360-degree video camera. The two groups of participants were asked to drive the gaze-controlled robot along two pre-set paths with different complexities. Following the driving test, each participant was interviewed. With log data and screen recordings captured during the experiments, our analysis results include users' eye movement behaviours, telerobots' deviation from pre-set paths, number of collisions, and accuracy of answers about information collected during the test. We present out findings in terms of differences between the two groups.

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