Human-Robot Interface Design Based on Gaze Gesture for Teleoperation

1. Abstract

Teleoperation is a kind of system which controls agents, e.g. robot, from a remote location through wireless signals. The system has advantages of being able to replace the human to work in dangerous and unreachable environments for reducing mission failure and avoiding life loss. The means of teleoperation are usually achieved in the way of conventional human-robot interfaces, e.g. keyboard, joystick, and mouse. However, they do not suitable for disabled operators, e.g. disabled hand, and increase the work load and mental load on operators due to simultaneous operation of a lot of HRIs by hands. Hence, a gaze-based HRI is introduced into teleoperation for solving those problems. Gaze-based HRI has two limitations, one is how to distinguish points of regard for inspection and for issued control commands, another is the continuity of orders. Here, we introduced gaze gesture into gaze-based HRI design for improve the problems.

2. Gaze Gesture

- The gaze gestures are defined as a sequences of strokes, which are the foundation of gaze gestures.
- The gaze gestures consist of single stroke (a) and complex strokes (b).
- The gaze gesture path patterns include a line, a triangle, etc.
- Dwell time and path time are important components in gaze gesture.

Fig.1 Gaze gesture strokes and gaze gesture paths.

3. Methods

Remote Station

HRI

Joystick

Scan Image

Camera

Eye Tracker

Teleoperation Station

Remote Station

HRI

Joystick

Scan Image

Camera

Eye Tracker

Teleoperation Station

3.1. Methods

- Translated directions into HRI, Pitch Region (PR), Yaw Region (YR), and Vertical Region (VR).
- Complex strokes (PR), Single stroke (YR, VR).

Fig.3 Human-robot interface design.

4. Results and Conclusion

- We invited 6 volunteers to participate the experimental test.
- The correct rate for users’ operation of different HRIs is up to 100% after 16th session.

- Perception evaluation used NASA Task Load Index (NASA-TLX)
- No significant effect on human workload and mental load used ANOVA analysis.

Fig.5 The video screenshots of UAV flying.

Fig.6 The distribution of learning curves.

Conclusion: The proposed HRI was tested and validated by controlling locomotion of UAV and a good performance was achieved. The ANOVA analysis showed no significant difference between proposed HRI with path time and all other HRIs.

Fig.4 Human-robot interface with gaze gestures.

Fig.7 Mean NASA-TLX for HRIs.