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BODY TILT IMPACTS OPERATORS' PERCEPTION OF REMOTE OBJECT'S ORIENTATION

Abstract

Robotics and teleoperation are at the heart of space exploration and inhabited missions.Yet the current literature does not fully explain how the body tilt of human operators interacts with their perception of remote objects' orientation. In such extreme environments, human factors analysis is paramount for the safety of daily operations as the tilted body of the operator may modulate their situational awareness of the remote-controlled robot. The objective of this study is to evaluate the effect of an operator's body tilt on their perception of remote object orientation in virtual reality. We hypothesize that incongruencies between two reference frames generate inter-sensory conflicts leading to degraded performance.

Seventeen participants performed the experiment while seated on a motion platform and equipped with a virtual reality headset. Their body was roll-tilted at 3 possible angles ($0°$; $\pm 20°$) while they were presented with a remote object, oriented at 3 possible angles ($0°$; $\pm 20°$). They performed the subjective visual vertical (SVV) test to estimate the room's vertical and then estimated the orientation of a monitored remote object. We compared the accuracy of their visual perception, response confidence levels, and motor response accuracy and reaction times.

Results show significant effects of both body tilt and object orientation. Body tilt decreased participants' confidence levels in their vertical perception and increased their response times (SVV). Moreover, body tilt and object orientation bothdecreasedsubjects‘ confidencein their response of object orientation perception; the confidence was further decreased when both operator and object were tilted. Independently of their orientation, subjects had lower motor response accuracy and increased reaction times when the object was tilted to the right. When the object was centered ($0°$), we did not observe any decrease in motor response accuracy.

Overall, our results suggest that body's and remote object's orientations both impact response times and confidence concerning their own orientation and that of the monitored object. Hence, due to inter-sensory conflicts, body tilt impacts operators' confidence in their visual and somatosensorial perceptions, which, we believe, can affect their overall situational awareness during teleoperation. While further investigation is required, this study paves the way towards new research on the interaction between body orientation and teleoperation performance for safer space applications.