# Assessing effects of robot control mode on performance and situation awareness in a maze navigation task

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Robotic systems are proving to be assets in many civilian and military operations. Effective human interaction with robotic entities is critical to operational performance and is dependent upon the operator's ability to develop "good" situation awareness (SA) on the system, task, and environment. An important issue in the control of remotely operated vehicles is the limitation in development of SA due to impoverished sensory information, attentional resource limits, task/environmental stressors, and interface or system design faults. These problems are projected to be magnified in situations in which operators are asked to task and control multiple robots, and where autonomy is added to facilitate lower operator-to-vehicle ratios. In this study we investigate the effects of robot control mode, including conditions involving autonomous navigation, on operator performance and SA while in control two robotics systems.

Study participants were required to perform a navigation task using miniature robots equipped with small wireless cameras. They navigated the robots through two distinct maze environments using hand-help remote control devices or verbal commands. The experimental task also required subjects to monitor the status of both robots (e.g., battery level, motor functioning, communications quality and vehicle orientation) through a simulated robotics interface. Four robot control modes were investigated (between subjects) including: (1) manual serial control in which participants manually controlled two robots in serial (i.e., one after the other); (2) manual parallel control in which participants manually controlled two robot in parallel (i.e., simultaneously); (3) mixed parallel control with full automation involving manual control of one robot and supervisory control of the other robot which operated under fully automated navigation rules; and (4) mixed parallel control with semi-automation and operator decisions which involved manual control of one robot and supervision of the other semi-automated robot which required operator decision making at various decision points.

Preliminary results on performance indicate that navigation time under serial manual control (i.e., when participants operated the robots one after the other) was longer than navigation under parallel, simultaneous control. Specifically participants navigating under the full automation with navigation rules produced performance times that were on average 2 minutes faster than participants navigating under serial manual control. However, participants under the serial manual control condition were observed to produce better performance in terms of status monitoring. In fact results show that serial navigation conditions resulted in monitoring performance that was almost twice as good as that observed under parallel, automated conditions, with serial control participants correctly responding to approximately 69% of all status diagnostic checks and participants under parallel control responding to only about 35% of all diagnostic checks. These findings represent preliminary results on performance measures. We expect to complete data analysis on SA measures in the very near future and propose to also present results on SA at the workshop.