Development of a Novel Communication System to Facilitate Navigational Guidance for Operators in Emergency Situations

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Abstract

Operators facing the reduced sensory input and stress of unfamiliar emergency situations – such as when a structure fire or chemical spill occurs – can suffer from disorientation and cognitive tunneling effects, hindering their abilities to solve problems and navigate to safety. To aid operators in these situations, a communication system is currently being developed to facilitate the relay of navigation instructions quickly, reliably, and in a manner that requires minimal cognitive effort for both the sender and receiver of the instructions. This system achieves these advantages via two primary design features: gesture-based encoding of navigation instructions by the “sender” (e.g., move the hand to the left to instruct “go left”) and spatialized vibrotactile display of the instructions for the “receiver” (e.g., a pattern of vibration presentations from left to right across the back communicates “move to the left”). This paper will introduce the relevant theory and applications motivating the development of this display, and will highlight an experiment that analyzed the effects of both instruction encoding methods and display modality on a simple navigation task for cooperating dyads. In this experiment, one participant (the “director”) viewed another participant (the “actor”) from an elevated position above an obstacle course and communicated navigation instructions to the actor who then navigated the course. Three communication methods were compared: verbal instructions via a two-way-radio, vibrational signals activated by way of a laptop interface, and vibrational signals activated via a natural gesture system. Course completion time and accuracy data were collected, as well as subjective interface preference data. Results suggest that vibrotactile displays are more effective than verbal communications for simple, speeded navigational communication and that natural gesture methods facilitate quicker message encoding. The gesture-vibration display was also most preferred by communicating dyads. Future research directions will be discussed, such as investigating how well the system can support more complex forms of navigation instructions (e.g., “up and then right”) and the integration of video to capture the actor’s perspective and support orienting the director when the two cannot see each other. The feasibility of adapting research prototypes for commercial safety equipment will also be discussed.