Multimodal VE for Health and Safety Training

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1. Introduction

Virtual Environments (VEs) can offer potential benefits to Occupational Health and Safety (OHS) training, such as increasing trainee engagement, understanding the consequences of incidents, exposure to high-risk scenarios in a safe environment, and ensuring competence before experiencing the real environment (Webber-Youngman & van Wyk, 2013; McMahan et al., 2010; Nickel et al., 2015). However further work is needed to develop and prove the effectiveness of VEs for OHS training, and to see whether multimodality can address concerns over the realism of some of the behaviours some people demonstrate in the VE (Smith & Trenholme, 2009). This demonstration will present the current prototype of a multimodal VE for OHS training, focusing on the use case of a fire safety training scenario within a workplace environment.

2. Multimodal Virtual Environment

The prototype was based on training requirements specified by industry partners and has been developed iteratively with user feedback. Formative usability studies in combination with studies of smell and heat perception informed the design of the system, including approximately 40 user study sessions in total to date.

Figure 1. Configuration of hardware (left) and virtual training environment (right) for the demonstration.

The current prototype VE has been developed for studying user behaviour and effectiveness of training. It was created in Unity and is displayed through an HTC Vive head-mounted display. Vive controllers are used for navigation and interaction. Olfactory feedback is provided by a fragrance diffuser (SensoryScent 200) with a smoke fragrance for this use case, and thermal simulation is provided by three 2KW infrared heaters. Sound is presented through standard noise isolating stereo headphones to ensure immersion and to prevent possible confounds of hearing the activation of diffusers and fins prior to feeling smell and heat.

The diffuser and heaters are wired into an Arduino microcontroller and are triggered by events in the VE (i.e. user approach to fire). Infrared heaters were chosen to provide a realistic sensation of radiant heat that may be experienced in the vicinity of a fire (Wareing et al., 2018). Synchronisation and control of heat are improved by the addition of metal fins that open and close, meaning that changes in heat experienced by the user can correspond directly with VE events, without the delay of heaters warming up or cooling down.

3. Research and application

An initial study (nearing completion) investigates whether feedback modalities affect validity of behaviours in the VE. Behaviours with and without thermal and olfactory simulation are compared. Participants are engaged in a task when a fire is triggered to start in the VE and an alarm sounds to cue evacuation. During evacuation, participants encounter hazards (fire and smoke), which could affect their actions and navigation of the building. We explore the impact of multimodality on time to act, reaction to fire hazards, route, and subjective perceptions of risk and experience. A second experimental study will compare the effectiveness of (1) traditional training (slide presentation), (2) a vision-only VE, and (3) a multimodal VE for two training scenarios being developed with industry partner input: fire safety training and response to chemical leak in a vehicle disassembly task. Knowledge uptake, motivation to train and attitude towards OSH will be compared. The prototype will be refined with industry and stakeholder feedback to optimise practicality and usability for workplace training contexts, and acceptability of the technology will be evaluated. This will include analysis of barriers to adoption of VR-based training solutions and recommendations to overcome these issues. This research will produce evidence-based guidance on the use of VR in OSH training.

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