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SAVER TechNote

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VIRTUAL REALITY TRAINING SYSTEMS FOR FIRST RESPONDERS

Virtual reality (VR) training systems use digital media to enhance or simulate training scenarios. The first responder community can leverage VR technology to create reproducible, customizable, and immersive training in a safe, engaging, and interactive environment. This technology falls under the Authorized Equipment List (AEL) reference number 04AP-08-SIMS titled Simulators.

Overview

VR and augmented reality (AR) are subsets of a continuum commonly referred to as extended reality. VR systems replace reality with an alternate digital environment, while AR training systems are designed to enhance the user's environment with supplemental information. These systems give agencies the ability to train large numbers of responders in routine, dangerous, or uncommon situations in a realistic and safer manner. This TechNote focuses on VR training systems for first responders. A separate TechNote focusing on AR training systems is available in the SAVER Document Library.

VR Hardware

Modern VR systems use a head-mounted display (HMD) to provide audiovisual information to the user (Figure 1). *Standalone* HMDs contain all the computer hardware required to generate a VR experience within the HMD and typically have lower quality graphics and lower refresh rates than *computer-connected* HMDs, which require a link to an external computer with a compatible graphics card. *Computer-connected* HMDs can be wired or wireless and can produce highly immersive experiences with realistic graphics. Wireless Gigabit adapters can provide the bandwidth of *cable-connected* HMDs but allow the freedom of movement of *standalone* headsets.

Figure 1: Meta Quest 2 VR Headset

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HMDs include sensors to track the user's position, typically an accelerometer and onboard or external infrared beacons or cameras to correct for "drift" (error in the position estimated by the accelerometer). A three-axis HMD tracks the yaw, pitch, and roll of the HMD and changes the user's view accordingly. Six-axis HMDs add X-, Y-, and Z-axis tracking, allowing users to walk around an area and have that movement reflected in the HMD view.

VR systems allow users to interact with computer-generated aspects of the environment, typically via handheld controllers, VR gloves, or voice command. Handheld controllers and VR gloves can typically provide haptic feedback to the user. Advanced systems use live hand tracking that allows the user to directly manipulate VR content without external controllers or gloves. Live hand tracking cannot provide haptic feedback. First responder VR training systems may integrate specialized controllers, such as medical instruments, fire nozzles, or weapons.

The U.S. Department of Homeland Security (DHS) established the System Assessment and Validation for Emergency Responders (SAVER) program to inform emergency responder equipment selection and procurement decisions.

Under the Science and Technology Directorate, the National Urban Security Technology Laboratory (NUSTL) manages the SAVER program, which – with the participation of emergency responders – performs objective operational assessments of commercially available equipment.

SAVER knowledge products provide information about equipment that falls under the DHS Authorized Equipment List (AEL) categories and focus on two questions for the responder community: "What equipment is available?" and "How does it perform?"

To explore the full library, visit SAVER online at www.dhs.gov/science-and-technology/saver-documents-library.

For additional information on the SAVER program, email NUSTL at NUSTL@hq.dhs.gov.

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These may be real tools replicated in the HMD view or inert replicas ("digital twins") with simulated function.

Virtual Reality Experiences

VR systems create an entirely computer-generated environment including audiovisual content; however, some VR systems also offer scent and/or tactile feedback (Figure 2). For example, VR firefighting simulations incorporate the smell of smoke or use "heat suits" to simulate thermal exposure. Because they obstruct users' views of the real world, most VR systems limit trainees' freedom of movement, but some systems use HMD-mounted cameras to switch to a live view of the environment when users approach hazards in the training space to safely enable mobility.

Figure 2: VR Fire Training

Image credit: Virtually There

VR systems allow for complete control over training content. Instructors can safely put students into simulated dangerous or uncommon circumstances and repeat the experience as many times as required for trainees to refine their skills. Some VR training programs allow instructors to see what the student sees and interact with them in the virtual world to record their actions or give them real-time feedback.

Infrastructure

VR is used in controlled spaces. VR HMDs typically have external computer hardware, which reduces mobility and may decrease cost. To train users simultaneously or view trainees' avatars in a simulation may require more complex VR setups. VR training systems can incorporate fixed external cameras or sensors to show users a partner's avatar, denote bullet "impacts," or record trainee movements while executing a tactical room-entry scenario.

Benefits and Challenges

Unlike AR systems, VR systems obscure users' views of their surroundings. This limits their potential use in real-world operations. When using VR technology, users should be cautious of real-world objects. Improper rendering of safety boundaries or other users' avatars can pose a risk to trainees.

Agencies seeking to train large numbers of personnel may find that creating custom VR scenarios is a cost-effective solution. However, if an agency only needs to train a few users, the costs involved in acquiring VR gear and creating custom content may be prohibitive. In these situations, it might be advantageous to share resources across agencies, or to use commercial off-the-shelf scenarios from a vendor.

Cybersecurity Considerations

Introducing any software into an environment carries potential risk if the software has exploitable security flaws. Because AR systems also serve as data gathering and storage systems, users should be aware of relevant federal, state, and local laws and regulations surrounding data security and privacy.

A comprehensive cybersecurity policy should be in place to help protect the integrity of the virtual training software, such as the Federal Bureau of Investigation's Criminal Justice Information Services Security Policy.

Relevant Standards/Regulations

The Institute of Electrical and Electronics Engineers (IEEE) has launched the IEEE P2048™ Working Group, identifying 12 areas for standards development related to AR/VR technology. [1] Special consideration must be given to systems used in emergency medical response training, as these may be impacted by the Health Insurance Portability and Accountability Act of 1996 (HIPAA).

References

[1] "Standards for the Virtual World!" Trivedi Y. Institute of Electrical and Electronics Engineers (IEEE), June 2017. [Online]. Available: https://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=7992921. [Accessed 12 January 2023].