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SAVER TechNote

May 2023

AUGMENTED REALITY TRAINING SYSTEMS FOR FIRST RESPONDERS

Augumented Reality (AR) training systems use digital media to enhance or simulate training scenarios. The first responder community can leverage AR 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

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

Figure 1: Microsoft HoloLens 2 AR glasses

Image credit: *https://deviestore.com/product/microsoft-hololens-2/*

AR Hardware

Modern AR systems use a head-mounted display (HMD) to provide audiovisual content to the user (Figure 1). *See-through* AR HMDs use strong light sources to project images onto a transparent lens, allowing digital content to be superimposed onto real-world environments. *Pass-through* AR HMDs use HMD-mounted cameras to capture the environment, projecting an AR-supplemented live view onto the HMD screen.

HMDs include sensors to track the user's position, typically an accelerometer and cameras that 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 the user to walk around an area and have that movement reflected in the HMD view.

AR systems allow users to interact with computer-generated aspects of the environment, typically via handheld controllers, AR gloves, or voice command. Advanced systems use live hand tracking, allowing users to directly manipulate AR content without external controllers.

In addition to displays and sensors, each AR system requires a computer to store training software and generate content shown in the HMD. This hardware may be built into the HMD or reside on an external computer.

Augmented Reality Experiences

To superimpose digital content over a user's real-world view, AR software must recognize objects, determine context, and provide supplemental information relevant to the object or training situation.

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.

Science and Technology

Six-axis AR systems can anchor supplemental content to a fixed point or object regardless of the user's position, while simpler three-axis AR systems might be limited to a heads-up-display-style overlay anchored to a QR code marker. Three-axis AR systems can take the form of smartphones or tablets, rather than HMDs.

When utilized for responder training, AR systems can turn real-world locations into training areas or physical assets into training tools. An AR system might simulate an extinguishable AR fire in a real dumpster or show a mannequin impaled by an AR knife (Figure 2).

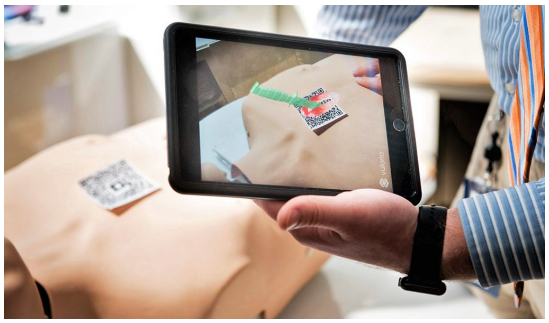

Figure 2: Three-axis system showing mannequin "impaled" by AR knife

Image credit: nursing.yale.edu/sites/default/ files/ynm_fall2019.pdf

Infrastructure

While system components and infrastructure vary based on use cases, AR is usually designed for mobile applications. Therefore, AR HMDs typically have built-in computer hardware, which enhances portability but also increases cost as compared to VR-only HMDs. For training scenarios involving multiple trainees or requiring external visualization of the trainee in the simulated environment, more complex AR setups may be required. For example, AR training systems may incorporate fixed external cameras or sensors to show users a partner's avatar from any angle or to record trainee movements.

Benefits and Challenges

Unlike VR systems, AR systems have the potential for use in real-world operations. Agencies seeking to train large numbers of personnel may find that creating custom AR scenarios is a cost-effective solution. However, if an agency only needs to train a handful of personnel, the costs involved in acquiring AR gear and creating custom content may be prohibitive. In these situations, it might be advantageous to share resources among numerous smaller agencies or to use commercial off-the-shelf scenarios from a vendor.

Since users can see their actual environment, AR systems are typically safer than VR systems when walking around a physical space. Users should take care when interacting with real-world objects that could result in physical harm. If virtual overlays are incorrectly displayed it can cause the user to not see obstacles or dangers correctly, which could result in a risk to the trainees.

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].