



Figure 1: Mixed reality represents a continuum from the real world on one end to a completely immersive simulated environment (virtual environment) on the other end. Along the continuum are augmented reality, the incorporation of virtual objects in the real world, and augmented virtuality, the incorporation of real objects in the virtual world. We are exploring the application of mixed reality in medical training.



Figure 2: VR headset view of our virtual reality training module for CT-guided liver.

Immersive, Mixed Reality Medical Education Platform



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Patient safety relies on trainees gaining technical skills and knowledge prior to patient contact. The challenge for all types of procedural training is hands-on experience. Achieving technical proficiency requires practice and repetition, but gaining early experience with new procedures on actual patients risks patient safety.

Hands-on simulation learning has been used to train physicians after classroom teaching and before patient exposure. Although some programs have been successful, the technology has not been widely adopted due to steep costs, space needed for the hardware, limited ability of simulators to adapt to variable clinical scenarios, and rapid evolution of computer technology discouraging one-time capital investments that can quickly become outdated.

Mixed reality (MXR) is an alternative to simulators that represents a cheaper, more flexible solution and has been increasingly accepted and applied in medical training. MXR involves the use of a headset with a screen in front of the user's eyes and headphones that provide surround-sound effects to immerse the user in a simulated environment.

In our MGB MXR lab, we are developing and validating a library of MXR training modules for all types of technical procedures. The modules immerse trainees in a realistic environment and allow them to repeatedly practice procedural steps and technical skills at any time and any place. Our next evolution is to explore building a fully immersive space—a "medical holodeck"—for team training.