

# Improving Immersion in VR Threat Simulations through Interaction and Behavioral Design

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We present a set of targeted design improvements to enhance immersion in virtual reality (VR) threat simulations based on the VRThreat Toolkit for Unity. Our work is motivated by the observation that immersion in VR critically depends on the plausibility of agent behavior, interactions, and environmental responses, which together drive the sense of presence.

We observed limitations in the VRThreat Toolkit in agent behavior, user interaction, environmental responsiveness, and visual design that reduced perceived realism. To address these issues, we introduced (1) more expressive threat agent behavior, including reactive attack cycles and animation-based feedback, (2) a two-step object interaction task to increase user engagement, (3) dynamic environmental elements that respond to nearby threats, and (4) visual refinements to strengthen threat perception. In addition, we evaluated performance across environments to ensure stable frame rates, a key requirement for maintaining immersion in VR.

We conducted a pilot user study ( $n = 6$ ) using a within-subjects design, where participants experienced both the original and modified scenarios. Participants rated the immersiveness of individual components (e.g., interaction, agent behavior, environment, and threat response) on a 5-point Likert scale. Results indicated a consistent preference for the modified scenario, with participants rating every component as more immersive than its original counterpart. The mean immersion score across all components increased from 2.37 (original) to 3.43 (modified). Qualitatively, observations and participant feedback suggested that participants felt more threatened by the more immersive threat agent.