Identifying Virtual Technologies for USMC Training

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Virtual Environments (VE) provide safe, low-cost training opportunities for many different tasks. However, the actual training benefits achieved, and thus the true cost-benefit ratio, depends on many variables. One of these variables is the interface system used to control the trainee's movement within VE. Efficient, intuitive interfaces allow the trainee to focus on the skills and knowledge to be acquired, while awkward systems require the user to concentrate on performing basic actions (such as avoiding furniture). Most commercial producers of VEs do not test their systems for training effectiveness. Instead they use devices, such as joysticks, that users accept even when they are inferior control devices.

The Warfighter Human-System Integration Laboratory (WHSIL) and the Immersive Simulation Laboratory (ISL) are jointly developing an empirically based mapping between interface technologies and the requirements of desired training objectives. A challenge to the validity of this effort is the pace of technological development. Arguably, system-specific evaluations become obsolete when new technologies are made available. To overcome this limitation, WHSIL and ISL are pursuing experiments designed to identify the underlying principles that determine interface effectiveness. The current focus of this effort is the evaluation of VE systems that were designed to train dismounted infantry Close Quarters Battle (CQB) tactics in urban terrain.

Three control interfaces are being tested in these studies: a standard joystick; Gaiter, invented by ISL, in which the full body and replica rifle are tracked; and a rifle-mounted joystick system that tracks the rifle and upper body position. With the standard joystick, all translations are made by pushing the stick in the desired direction of movement; rotations are achieved by twisting the joystick in the desired direction of rotation. In Gaiter, users make translations by raising their legs in the desired direction of movement once for each step taken (basically, walking in place), while rotations are made by rotating their bodies as they would in the real world. In the rifle-mounted joystick system, users make translations by pushing the thumb-joystick mounted on the replica rifle in the desired direction of movement, while rotations are made by rotating their body as they would in the real world.

A pilot study was conducted to confirm that users could navigate effectively using these systems. Volunteers followed a computer-generated avatar through a large warehouse and through an office space with a narrow hallway and several rooms. This study found that these systems supported precision movement in the warehouse, but that for those tracking the position of a replica rifle carried by the user, moving through doorways was difficult when the weapon was not carried correctly. Thus, from a purely data-driven perspective, people using a standard joystick exhibited better performance when in the office space. However, from a training perspective, these results indicate that the interfaces tracking a real-world (replica) rifle actually reinforced good CQB weapon handling techniques.

More recently WHSIL and ISL completed a study to determine whether the increased proprioceptive/kinesthetic feedback offered by systems like Gaiter, and to a lesser extent the system using the rifle-mounted joystick, enhanced the user's ability to maintain awareness of his/her relative position and orientation within a VE. In this study, participants had to complete a series of tasks that included moving to the location where an object was recently viewed or rotating in place by a specific angle—without visual feedback. An additional maze navigation task with visual feedback was conducted to determine whether proprioceptive/kinesthetic information was necessary for this type of task. In this maze task, volunteers moved through a short series of rooms and hallways and then were asked to indicate where they stood relative to the start location.

Results from the maze task indicated that when visual cues were present, a standard joystick was associated with performances as good as, or better than, the two body-tracked interfaces. In a task where users viewed a target and then sought to move to it in the dark, users consistently overshot the target by a factor of about two using Gaiter, and were more accurate with both joystick-based interfaces. This suggests that users of Gaiter misperceived the mapping from their real-world walking-in-place actions to their virtual movement: in-place steps were interpreted as half-steps. In contrast, accurate rotations required interfaces that provide more proprioceptive/kinesthetic information than the standard joystick. These experiments have led ISL to develop "Pointman," a new way of providing a proprioceptive sense of course, heading, and displacement using game controls.

In CQB training scenarios, there are many instances where users may find themselves in locations with little or no visual cues—for example, unlit stairwells or when moving from well-lit to dark areas. Our data suggest that for training scenarios such as these, interfaces that provide better proprioceptive/kinesthetic information should be used. However, in other situations, a standard (and much less expensive) joystick may be sufficient.

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