Virtual Targets for the Real World

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Introduction: Live-fire training keeps warfighting capabilities at peak effectiveness. However, the cost of procuring real targets—only to be destroyed—is prohibitively expensive. The United States Marine Corps (USMC) uses a variety of target proxies, such as derelict vehicles, piles of waste, and even "pop-up targets," all of which are nonreactive, stay in fixed locations from year-to-year, and often do not resemble the real targets. Trainees simply do not get the opportunity to fire live rounds at realistic-looking and moving targets. However, Augmented Reality (AR) can help by merging virtual entities with the real world for training exercises. We describe an AR system that provides virtual targets for training of USMC Fire Support Teams.

Augmented Reality: In an AR system, the user wears a tracked see-through head-mounted display with stereo headphones that is connected to a computer containing a database of spatial information related to the venue of the training exercise. By measuring the user's position and view direction in the real world, three-dimensional (3D) computer graphics and spatially located sounds are displayed to appear to exist in the real world. A miniaturized and ruggedized computer, batteries, and wireless networking make the AR system man-portable. Figure 3 shows a mobile AR prototype system. In the case of AR for training, the virtual information overlay consists of realistic 3D renderings of entities: individual combatants, tanks, planes, ships, etc.

Entities in Training: Entities in training exercises fall into one of three categories: *live* entities are real people and vehicles participating in a training exercise; *virtual* entities are human-controlled players in virtual worlds; *constructive* entities are driven by algorithms in computer simulations. AR provides a natural way for all three types to mix together. Live entities observe virtual and constructive entities through the AR system. Interactions such as shooting are conveyed from the AR system back to the constructive and virtual simulation systems.

Application of AR for Fire Support Team Training: The USMC's Fire Support Team training begins with small-scale (1:40) pneumatic mortars on a field at the Marine Corps Base, Quantico, Virginia. The purpose of this training is to hone the communication skills between the forward observer and the Fire Direction Center (FDC). In the current training plan, a forward observer visually locates targets, identifies and determines grid coordinates using binoculars and a map, and recommends a call for fire to the FDC. Once the shots are fired, the training instructor (not a part of the operational fire support team) determines the accuracy of the shots and the effect on the target: catastrophic hit, mobility hit, or no effect. The calls for fire are adjusted until the team has the desired effect on the target. Before introducing the AR system, the team fired on static and unrealistic proxy targets.

The system, based on the Battlefield Augmented Reality System,[1] was demonstrated at Quantico in October 2004. It provides a head-mounted display for the forward observer and a touch screen for the instructor, each showing virtual targets on the real range. Figure 4 shows the observer's view of virtual targets and buildings on the range. The observer can have the computer simulate a magnified view (including a reticle), similar to the view binoculars provide, to determine target identity and grid coordinates. The targets move along preset routes and are started and stopped by the instructor through a simple interface. As before, the forward observer calls for fire on the targets and a real round is fired. The instructor sees where the round lands in the augmented touch screen view and designates the effect on the target. Through a dynamic shared database,[2] the forward observer sees that effect and revises the call for fire. Figure 5 illustrates the major components of the system and steps in the system's usage. Augmented Reality was inserted into the training plan with no significant changes to the duties and actions of the participants, except that they can now fire on moving targets.

The virtual targets for training were well received by the mortar trainees and instructors at Quantico; however, rigorous studies and measurements of effectiveness are yet to be done. The system can also insert virtual terrain and control measures into the display, and both capabilities were preliminarily tested at Quantico. Future plans include refining the system, taking it to a full-scale live fire range such as the Marine Corps Air Ground Combat Center, Twentynine Palms, California, and completing a Semi-Automated Forces (SAF) interface for more intelligent targets.

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FIGURE 3
Mobile Augmented Reality (AR) prototype system.

FIGURE 4
Observer's view of virtual targets and buildings on the range.

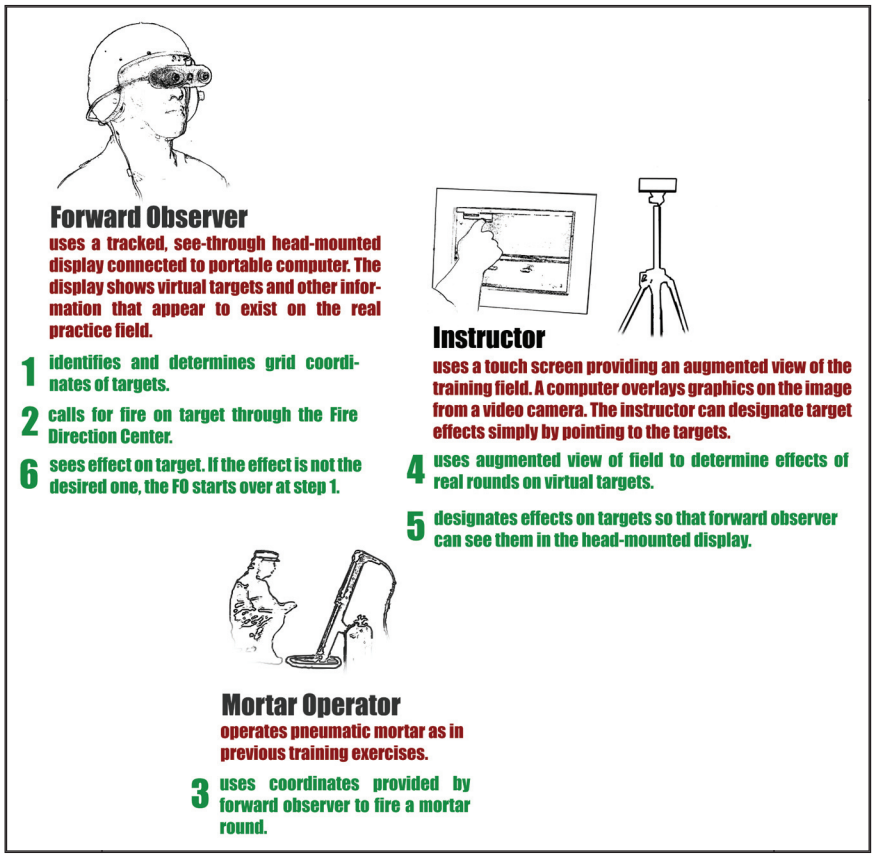

FIGURE 5
Augmented Reality (AR) system's major components and steps in the system's usage.

References

[1] S.J. Julier, Y. Baillot, M. Lanzagorta, D. Brown, and L.J. Rosenblum, "BARS: Battlefield Augmented Reality System," in *Proceedings of the NATO Information Systems Technology Panel Symposium on New Information Processing Techniques for Military Systems*, Istanbul, Turkey, October 2000.

[2] D. Brown, S.J. Julier, Y. Baillot, M.A. Livingston, and L.J. Rosenblum, "Event-based Data Distribution for Mobile Augmented Reality and Virtual Environments," *Presence* **13**(2), 211-221 (2004).