



Intelligent, Immersive Training

Increase Proficiency
and Reduce Cost





OVERCOMING THE TRAINING DILEMMA

As today's armed forces confront insurgency, civil unrest and new forms of asymmetrical warfare, training has never been more important. Warfighters need to be prepared for entirely new and evolving challenges. Unfortunately, today's training facilities are hampered by the formidable fixed costs of complex, location-based infrastructure; the high operating costs of live role players; and day-to-day inconsistency. Scarcity also incurs scheduling headaches and travel costs, as personnel fly in to undergo training at a few, centralized facilities.

Intelligent, Immersive Training systems being pioneered by SRI International Sarnoff promise to overcome these limitations in the near future. SRI Sarnoff is a world leader in real-time video processing, introducing augmented reality innovations that led to the virtual first down marker seen by millions of football fans.

Exclusive SRI Sarnoff technologies supplement or replace human role players with computer-generated actors and objects—avatars—superimposed onto the real scene. In this way, Intelligent, Immersive Training promises to transform the way we teach everything from Military Operations on Urban Terrain (MOUT) to forward artillery spotting and vehicle repair. And instead of flying trainees to a central facility, the facility can come to them.

SRI Sarnoff has developed prototype systems for three areas of Intelligent, Immersive Training:

- *Mixed Reality*
- *Augmented Reality*
- *Behavior Analysis*

All three combine exclusive SRI Sarnoff technology with readily deployable, commercial off-the-shelf components to dramatically lower costs while boosting proficiency.

Augmented Reality

Augmented Reality from SRI Sarnoff works via video/optical see-through glasses or smart phones, enabling trainees to see the real world and computer-generated avatars simultaneously. This is immersive, pulse-pounding, on-the-ground training, where avatars react to trainee behavior in a closed loop. Infrastructure-free, the system can be rapidly deployed for exercises indoors or out, day or night.

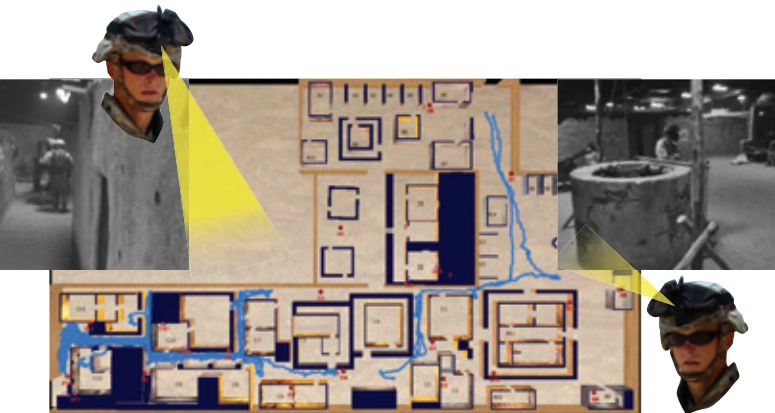


// AUGMENTED REALITY FOR MANUEVER

AMBUSH IN THE PASTURE

The sun beats down on the dusty pasture 200 meters from the village where insurgent activity has been reported. The combat team is talking to computer avatar civilians who appear on video goggles. Suddenly shots ring out from avatar insurgents, firing from behind a low stone wall. Helmet-mounted sensors capture the position and pose of each team member to an accuracy of 5 cm and 0.1 degree. Weapon-mounted sensors capture trigger pulls. Artificial Intelligence enables the avatars to react and adapt to trainee actions in real time. Computer capture of the entire exercise enables vivid, detailed after-action reporting.

Augmented Reality



Helmet-camera based 3D tracking

Helmet-based tracking of trainees for day/night, indoor/outdoor operations

- Automatically tracks trainee position, accurate to 5 cm using exclusive SRI technology
- Tracks trainee pose, accurate to 0.1 degree of angle, with unique SRI technology
- Wireless transmission of helmet video and audio
- Easy mounting on any night vision goggle (NVG) helmet mount

Scenario-based, closed loop training

- Avatars react to trainee actions through artificial intelligence
- Repeatable and scriptable, with unlimited variation
- Degree of difficulty automatically adjusts as performance improves

Weapon tracking

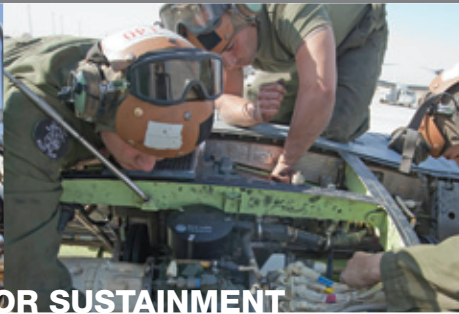
- Exclusive SRI technology automatically estimates weapon pose via external markers or weapon-mounted camera
- Accurately determines hits and misses through tight coupling between weapons shots and avatars, using technology developed by SRI



// AUGMENTED REALITY FOR FIRE SUPPORT

INTERCEPTING THE CONVOY

It's midnight on the artillery range. The forward observer receives a report of a hostile caravan moving north on the river road. Augmented reality shows the real scene with superimposed computer avatars: houses, cows and parked cars. These avatars can appear in "plain" eyesight via a helmet-mounted display or through telescopic binoculars. As the observer scans the horizon, the avatars maintain their correct locations in the field of view. Soon, six unmarked SUVs that fit the description of the report appear at a distance of 4 kilometers, moving with urgency and kicking up dust. The observer calls in real or simulated aerial, mortar or artillery fire. Real or simulated explosions reveal that the first rounds fall short. After adjustments, the targets are taken out.



// AUGMENTED REALITY FOR SUSTAINMENT

REPAIRING PLANES, SHIPS, AND VEHICLES

A specialist goes to work in a real hangar on a real fighter engine. Sensors mounted on her helmet detect where the specialist is and which way she's looking. As a voice on headphones gives instructions, superimposed graphics identify each part and animate each required action. As tools are required, the goggles superimpose the correct tool in the correct orientation. As she completes each task, she says "check" and the training moves on to the next instruction.

Occlusion reasoning

- 3D reasoning renders avatars realistically in the 3D environment—behind walls, in houses, even walking among the combat team—using a process developed by SRI

Distributed system

- Supports multiple trainees
- Each trainee can see the same avatars in the same 3D locations
- Each trainee can see the same interactions
- Avatars not limited to a single screen or location

Compact, low cost

- Infrastructure-free: rapidly deployable
- Reduces trainee travel costs
- Compact, helmet-mounted monocular and stereo glasses
- Currently based on commercial, off-the-shelf 6 DOF (degrees of freedom) tracking
- Roadmap to custom 10-watt processing package



Left stereo image



Estimated left disparity map



Inserting virtual characters using 3D reasoning

Comprehensive database of local terrain

- Exclusive SRI technology for automatic construction of 3D model and landmark database
- Uses data from light detection and ranging (LIDAR) and robotic video
- Makes the system readily deployable anywhere

Mixed Reality

Mixed Reality from SRI Sarnoff uses video projection to place computer-generated people, objects and effects onto the walls of indoor training facilities. The system accurately tracks both trainees and their weapons throughout the facility, capturing video from a network of pan-tilt-zoom cameras and recording their behavior for after-action review (AAR).

Accurate tracking of trainees and weapons

- Tracks trainees by integrating data from GPS, RFID and video cameras
- Captures head and weapon orientations automatically using inertial measurement units (IMUs) and trigger pull sensors

Comprehensive real-time video monitoring

- Fully automatic pan-tilt-zoom camera control using SRI Sarnoff's Active Coordinated Tracking Vision (Act-Vision™) subsystem
- Video tracking throughout the facility with automatic handoff between cameras
- Automatic camera assignment based on visibility, resolution and activity
- Operator can manually select trainee groups to follow them automatically

Mixed reality environment

- Intelligent interactive avatars and real role players
- Opposing force or civilian avatars projected onto interactive screens
- Avatars react to trainee actions using data capture and behavior sensing systems
- Artificial intelligence enables avatars to act according to programmable beliefs, attitudes and intentions

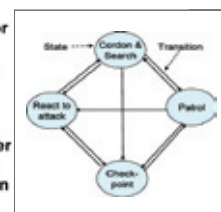


HOUSE TO HOUSE

The location: an indoor training facility near San Diego. The feeling: pure Afghanistan. In an immersive exercise, a team of trainees searches house to house, looking for weapons and contraband. Beyond each doorway, a different scenario unfolds. A mix of live role-players and computer-generated avatars projected on the facility walls are either talkative or silent, cooperative or hostile. As team members master the basic challenges, the scenarios automatically become more challenging. And the entire exercise is automatically scored and recorded for detailed after-action review.



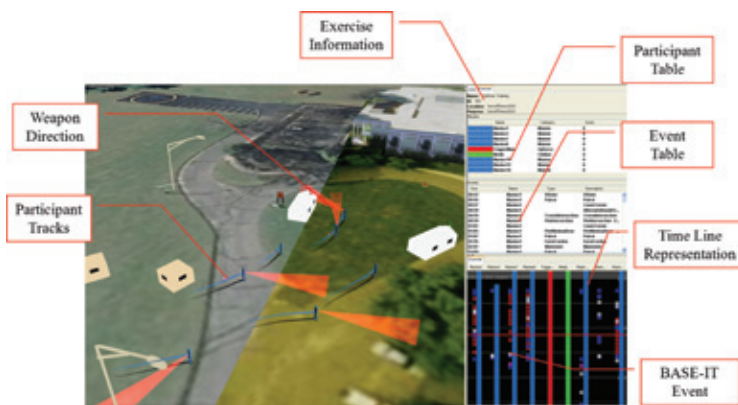
Multimodal capture system



Real-time sensing and analysis

Behavior Analysis

Behavior Analysis provides real-time sensing and automated analysis of trainee actions, for powerful, closed-loop training exercises. The system automatically categorizes individual and team behaviors, enabling you to track the states and tasks of trainees in real-time. At the end of the exercise, the system automatically generates a list of items for debriefing and after-action review.



Smart after-action review (AAR) with 3D iconic display

- Synchronized play of videos and iconic tracks and events on 3D site model using L-3 Praetorian Video Flashlight™ and SRI Sarnoff 3D Iconic Map Display
- Sort, seek, search and play events
- Visualize debriefing items on timeline: events, individual tracks, weapon, and head poses
- Display performance

Automated behavior analysis and performance evaluation

- Assess performance at individual and team level based on tactics, techniques and procedures (TTP)
- Enable fast and effective AAR
- State/task-based performance computation leverages behavior analysis

Scenario-based, closed-loop training

- Machine-understandable representation of training scenario and TTP
- Computer-generated avatars react to trainee actions



Interface with other training systems

- L-3 Tactical Video Capture Systems (TVCS i.e. Praetorian system) for video capture, video and data storage, transmission, retrieval, and display of video overlaid on 3D models
- SAAB Instrumented-Tactical Engagement Simulation System (I-TESS) for laser engagement system, shot data transmission, and for marking and signaling trainee casualty
- InterSense inertial navigation system for tracking trainee head and weapon orientations
- Zebra/MSSI ultra-wide-band RFID tracking system
- DARPA/Total Immersion Software RealWorld® for rendering and control



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SRI International

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