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Advanced Imaging, Simulated Terrorist Attacks: Virtually Risk-Free

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ADVANCED IMAGING

Simulated Terrorist Attacks: Virtually Risk-Free

The Anti-Terrorism Force Protection Program allows the miltary to rehearse defensive tactics from a first-person point-of-view.

An image from the Non-combatant Evacuation Operation (NEO) Scenario, similar to an operation that occurred in Port-au-Prince, Haiti, when U.S. Marines were sent in to secure the U.S. Embassy and evacuate non-essential personnel. The old Del Monte Hotel, now called Hermann Hall, is visible—complete with interior spaces and fully textured. The original building model was constructed by John Locke of the MOVES Institute and translated into X3D by Captain Claude "Odge" Hutton, USMC and Jeff Weekley. This image was generated and processed using the Cortona plug-in (for Internet Explorer) and Adobe Photoshop.

by Leonard A. Hindus

The guided missile destroyer was visiting a foreign port. The captain, a highly decorated, battle-hardened veteran, scrupulously followed Navy regulations, setting up a defensive perimeter of crewmen in motorized launches that patrolled the area 24 hours a day.

Without warning, a sleek speedboat raced toward the Naval vessel. The launches moved to intercept but were no match for the smaller craft, which was loaded with explosives. It zipped past the defenders and rammed the destroyer.

Had this been an actual attack, it would have cost the lives of American crewmen and inflicted millions of dollars in damage to the ship.

In simulation, however, such disasters can be reversed—a luxury not afforded to ship commanders in the field. Through repeated rehearsals, a captain can adjust his defensive strategy and intercept virtual attackers before they reach their targets.

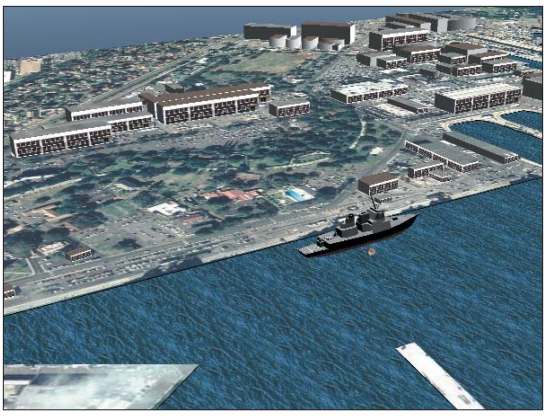
The Anti-Terrorism Force Protection Program is a 3D simulation project developed by Dr. Don Brutzman and the SAVAGE Group (Scenario Authoring and Visualization for Advanced Graphical Environments) at the MOVES Institute (Modeling, Virtual Environments and Simulation), located at the Naval Postgraduate School in Monterey, CA. In this X3D, XML and Agent-based simulation—named "the U.S.S. *Cole* Scenario" after a Navy ship that was attacked and damaged in the manner described above—users can rehearse various terrorist attacks from a first-person point-of-view.

"You can realistically assess defensive tactics and see what would or would not protect the ship from attack," Brutzman told *Advanced Imaging*. "You can replay dangerous 'what-if' scenarios and the risks are only virtual."

VIRTUAL WORLDS FOR SMART SUBMARINES

"We started creating virtual environments because that was the only way to test-program autonomous underwater vehicles (AUVs)" Brutzman explained. "Once an AUV is launched, it's on its own. If there is a flaw in the programming, there's no predicting what it might do. It is tremendously difficult to observe, communicate with and test underwater robots, because they operate in a remote and hazardous environment."

To that end, Brutzman's team needed to create a realistic underwater virtual world that might comprehensively model all salient functional characteristics of the real world, and in real-time. This virtual world was designed from the perspective of the robot, enabling realistic AUV evaluation and testing in the laboratory. "Robots don't need imaging to navigate; people need imaging to under-



An Anti-Terrorism Force Protection Agent simulation, based on an aerial image of Pearl Harbor. The buildings, X3D models geo-rectified with the aerial imagery, appear in the simulation as they actually do at the boat basin. All models were built and integrated into the virtual world by Lt. James Harney, USN. This image was generated and processed by Jeff Weekley using the Xj3D Open Source Browser and Adobe Photoshop.

stand the robot's logic," said Jeff Weekley, a senior designer with the MOVES Institute. "3D real-time graphics are our window into the virtual world."

Visualization of robot interactions within a virtual world allows for sophisticated analyses of robot performance that are otherwise unavailable. Sonar visualization permits researchers to look over the robot's shoulder or even see through its eyes to understand sensor-environment interactions intuitively.

Despite the virtual trappings, this is serious business, as demonstrated in *AI*'s March 2003 issue ("Modeling & Simulation: Hollywood Fulfills Military Needs," Rich Handley, p. 10). "This is not a video game," Brutzman stressed, "but a real-world simulation. It not only has to look real... it has to *be* real." He added, "We need to model the real world in as much detail as possible." This is vital, as the Navy wants to be sure the AUVs tested in simulation at the MOVES Institute will behave the same way in the open ocean.

NPS AUTONOMOUS UNDERWATER VEHICLE (AUV) WORKBENCH

As a result of this research, the NPS Autonomous Underwater Vehicle (AUV) Workbench is now publicly available. A flyer, poster and self-installer can be found at *http://terra.cs.nps.navy.mil/AUV/workbench*.

The flyer states, "The NPS AUV Workbench supports physics-based AUV modeling and visualization of vehicle behavior and sensors in all mission phases. Animation is based on vehicle-specific hydrodynamics that can be configured to model arbitrary vehicles. Models defined in X3D and VRML relying on IEEE Distributed Interactive Simulation Protocol (DIS) allow visualization across networks utilizing custom software or off-the-shelf Web browsers. Virtual environments facilitate control algorithm development, constant testing, mission generation and rehearsal, and replay of completed missions in a benign laboratory environment."

BUILDING A VIRTUAL WORLD VIEWER

The benefits don't stop there, though. "Once you develop tools for creating virtual environments," Brutzman said, "the applications are almost limitless." A good graphics toolkit for building a virtual world viewer has many requirements to fill. Rendered scenes need to be realistic and rapidly rendered, permitting user interaction. The tools need to be capable of running on both low-end and high-end workstations. Graphics programmers must have a wide range of tools to permit interactive experimentation and scientific visualization of real-world datasets.

The ability to read multiple data formats is also important when using scientific and oceanographic datasets. Scientific data format compatibility can be provided by a number of data function libraries that are open, portable, reasonably standardized and usually independent of graphics tools. Viewer programs need to be capable of examining high-bandwidth information streams and large archived scientific databases. The ability to pre-process massive datasets into useful, storable, retrievable graphics objects will be particularly important as we attempt to scale up to meet the sophistication and detail of the real world. Standardization of computer graphics and portability across other platforms, Brutzman pointed out, are also desirable but historically elusive. X3D solves this.

Simulation software should be able to take advantage of the Internet and run virtual environments remotely, according to Brutzman. "History has taught us that virtual worlds often outlast the proprietary hardware and software they were designed on." To achieve these goals, the MOVES Institute has been involved in the development of several open standards. These include XMSF and X3D.

XMSF

The Extensible Modeling and Simulation Framework (XMSF) is defined as a set of Web-based technologies, applied within an extensible framework, enabling a new generation of modeling and simulation (M&S) applications to emerge, develop and interoperate. Specific subject areas for XMSF include (a) Web/XML, (b) Internet/networking and (c) modeling and simulation (M&S). XMSF information can be found at *www.movesinstitute.org/xmsf/xmsf.html*. XMSF-based Web services are sufficiently powerful for all types of modeling and simulation.

X3D

Extensible 3D (X3D) is the ISO-approved next-generation open standard for 3D on the Web. It is an extensible standard that can easily be supported by content-creation tools, proprietary browsers and other 3D applications, both for importing and exporting. X3D not only replaces VRML, but also provides compatibility with existing VRML content and browsers. Existing VRML content will be played without modification in any X3D browser, and new X3D content can be read in to existing VRML applications.

X3D addresses the limitations of VRML. It is fully specified, so content will be fully compatible. It is also extensible, which means that X3D can be used to make a small, efficient 3D animation player, or to support the latest streaming or rendering extensions. It supports multiple encodings and APIs, so it can easily be integrated with Web browsers through XML or with other applications. In addition to close ties with XML, X3D is the technology behind MPEG-4's 3D support. X3D information can be found at *www.web3d.org*.

Don Brutzman is right. With the proper tools for creating virtual environments, the applications truly *are* nearly limitless. ◆

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Port Perils

The President of the United States has just ordered a Navy task force to San Luis Rey, the principal port of the island of Monterey, at the request of their government, to help protect their nuclear power plant. Until a recent change in government, Monterey had been strongly anti-American. As a result, no one currently in the Navy has ever sailed into this port. To make matters worse, this is a particularly tricky port with rocks and reefs and strong cross-currents.

During approach, forward-looking SONAR reveals an uncharted rock. At the same time, a terrorist with a rocket-propelled grenade launcher is spotted on a nearby hill. What can the captain do to save his ship? "Let's send in the robots first next time," someone suggests as they change the parameters of the Virtual Port program for the next run.

The Virtual Port is a 3D computer simulation proposed by Don Brutzman, PhD., an associate professor at the Naval Postgraduate School (Monterey, CA). The captain and crew are stationed in a full-scale bridge mock-up in an immersive 3D virtual environment. They can sail into port day or night and under all possible weather conditions. In addition to old bridges and such natural hazards as reefs and rocks, they can face attacks from shore-fired rockets and high-speed boats loaded with explosives. By the time the task force is ready to sail, the captains and their crews might know the port like they had been sailing there for years.

"We have all the tools we need to create a virtual tactical immersive environment for any port in the world," Brutzman told *AI*. "All we need is funding and a year or two to integrate the data and create the environments. Our NPS team foresees a day when Navy crews can call upon a library of virtual ports to practice deployment anywhere in the world." ◆