Task 2.1 Command & Control Visualization: Years 2 & 3

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Abstract:

Creating a detailed picture of a battlefield terrain, weather, and military resources is vital for the success of a military mission. In a virtual immersive environment, such as a CAVE or Immersive-Workbench, mission planners and command and control (C&C) personnel can gain a tactical advantage. Because of the inherent three-dimensional nature of immersive environments, C&C personnel can better plan the distribution of military resources on land and at sea both above and below the surface. Much of the tactical information, which is lost in a traditional map, can be accessed and used for mission planning in an immersive three-dimensional environment. This same concept of C&C can be extended for Digital Ship under fire, where the CAVE can be used for realtime damage assessment and damage control. The simulation of ship motion with a motion platform embedded in the floor of the CAVE can add to the realism of the Digital Ship. With the aid of super-computers it is also possible to include discrete simulation models of tactical systems, and ship motion, as well as physically realistic simulation models of other mission critical C&C activities such as underwater acoustic phenomena related to undersea warfare.

Visualization of Simulation Model Results—

Another mission critical C&C activity is the interpretation of acoustic data for the Navy Undersea Warfare Center (NUWC) project. Acoustic simulation models used by NUWC and meteorological simulation models used by the Navy METOC Center will generate these data sets. Again virtual immersive environments can aid in creating necessary data displays for the interpretation of complex 3D acoustic structures and other related meteorological structures.

Description of Proposed Research:

The future CAVE location in the Advanced Communications and Information Technology Center (ACITC) building has a 12'x12' opening in the floor. The CAVE will have to be upgraded to include both a ceiling and glass floor projection to extend the viewable operation for the NUWC and Digital Ship project outlined in this Task 2.1, and the simulated ship crane project outline in Task 2.5. With the CAVE floor projection in place the CAVE viewer can experience a NUWC undersea simulation of a torpedo launch or a ship-to-ship material transfer simulations. Simulation model results will be compared will actual physical scale models experiments to confirm the validity of CAVE simulations.

We will develop relationships with the Navy organizations producing the data under investigation. Acoustic simulation models used by the Naval Undersea Warfare Center (NUWC) and meteorological simulation models used by the Navy METOC Center will be identified and implemented on the CAVE computer. Simulation results will be visualized post-mortem in the CAVE. If simulation models are relatively fast, we will implement existing Web-based Java form interfaces (or other interfaces provided by the Navy labs) in the CAVE. This interactive interface will allow researchers to: 1) selectively change physical parameters, 2) submit batch jobs for simulation, and 3) obtain numerical results with graphical representations that can be viewed at the researchers desktop workstations. These same graphical file formats can then be quickly viewed in the CAVE when full immersion is appropriate. Although this process is not a "real-time" simulation/visualization interface, it will provide acoustic and meteorological researchers an opportunity to parametrically study their structure-property relationships interactively. This concept will be extended to the "Digital Ship" project where the virtual environment of a CAVE can become the C&C center for simulation of a ship under attack. Simulations of shipboard motion (see Task 2.5), tactical, damage detection, assessment, and damage control can be experienced through a model of distributed onboard sensors based on fiber-optic and wireless sensor arrays. Coordinating fire and damage control personnel, who are equipped with wearable computers, is possible with well designed collaborative awareness tools that link shipboard personnel with the CAVE C&C center.

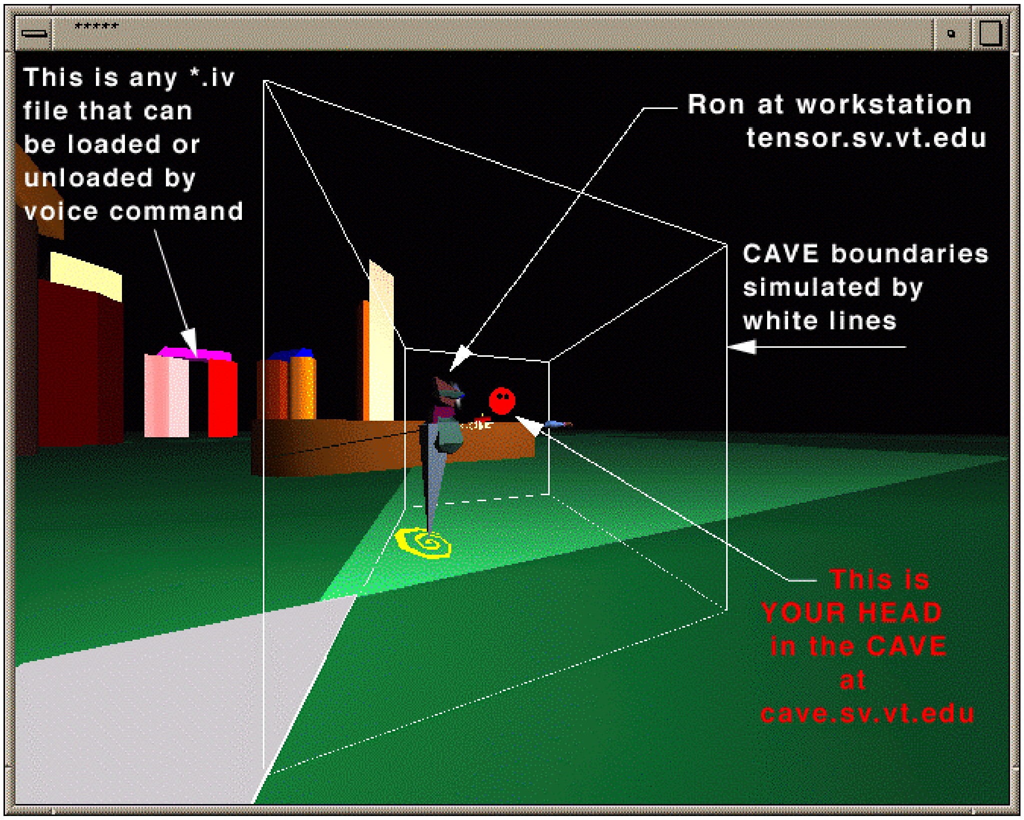

Figure X.X. Workstation flat panel display of shared collaborative space simulation of CAVE.

These collaborative awareness tools extend to other remote-site CAVEs, I-Desks, Immersive Workbenches and desktop workstations that when linked together in real-time over the network will create an integrated and collaborative environment. Delivering this shared virtual environment to remote site Head Mounted Displays (HMD), Immersive Work Benches (IWB), and flat panel displays is critical not only from an integrated collaborative viewpoint but also where space does not warrant anything larger then a HMD or flat panel display.

With both ceiling and floor projections as well as front and side wall projections, it will be possible to extend the immersive capabilities of the present CAVE to view not only crane operations (Task 2.5), but also complex 3D structures predicted by under water acoustic models. Existing 3D CAVE programs and virtual environment interfaces similar to CAVE-5D and NUWC's CTISS (Command Technology Information Support System) will be modified as necessary to study and interpret simulation results. When possible we will choose to use commercial off the shelf software.

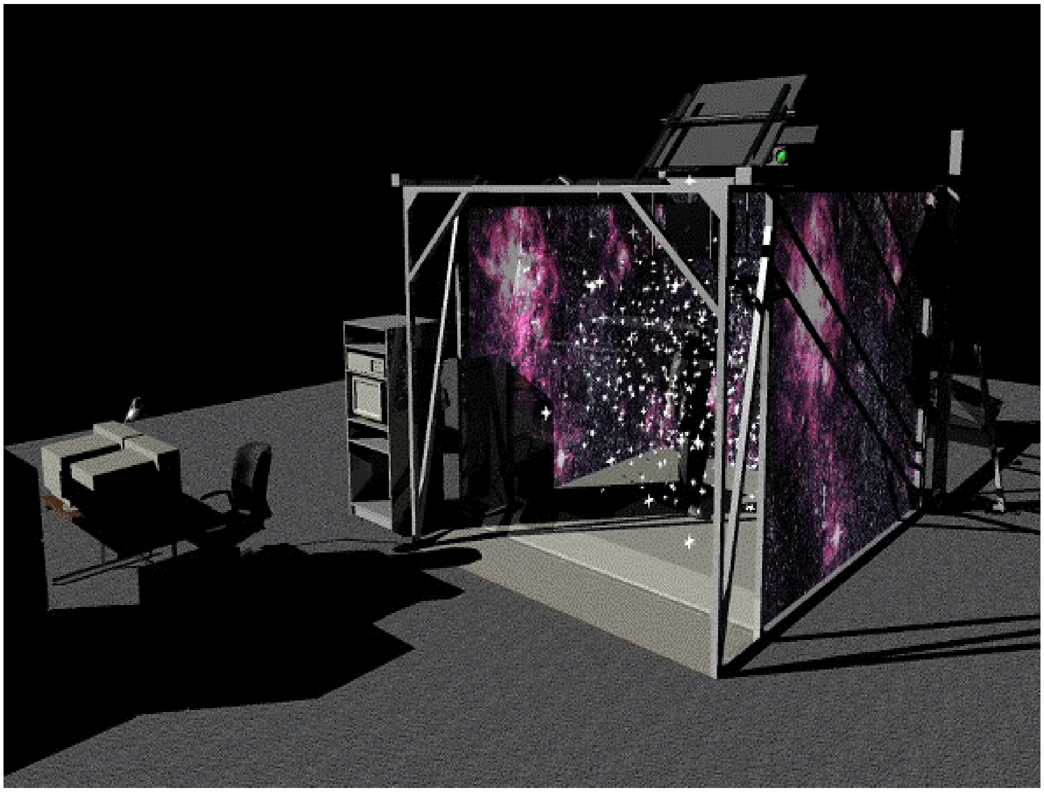

Figure x.x. Illustration of the CAVE at Virginia Tech.

Statement of Work:

Year 2:

2.1.1: Identify working simulation models used by NUWC, *June 00*

2.1.2: Design CAVE displays to interpret NUWC acoustic model results, *December 00*

2.1.3: Demonstrate CAVE displays to interpret NUWC acoustic model results, April 01

NOTE: 2.1.6: changed – METOC removed to reflect lower year two budget

Year 3:

2.1.4: Evaluate and modify CAVE display interfaces for NUWC acoustic model, July 01

2.1.5: Design Digital Ship CAVE Interfaces (DSCI) for simulation of ship under fire, June 01

2.1.6: Complete DCSI working prototype and integrate with 3-tier test bed, September 01

2.1.7: Evaluate DCSI, recommend improvement, and modify, January 02

2.1.8: Modify DCSI to run on smaller hardware: HMDs, IWBs, and flat panels, April 02

2.1.9: Through out DCSI development create collaborative interfaces to work with HMDs, IWBs, and flat panels, April 02

2.1.10: *Final report on DCSI, April 02*

Note that the construction involved in moving the CAVE will not be paid from the NAVCIITI program.

Technical Approaches:

Simulation models of under water acoustic models used by the Naval Undersea Warfare Center (NUWC) and Navy METOC data will be implemented to run on the CAVE computer during off-hours and results archived. Results will be visually analyzed in the CAVE using existing programs and virtual environment interfaces such NUWC's CTISS (Command Technology Information Support System).

The Digital Ship CAVE Interface (DSCI) will be used as a development only platform. Since we anticipate that smaller hardware devices such as HMDs (Head Mount Displays), IWBs (Immersive WorkBenches) and flat panels will be the actual ship board devices used by ship personnel. We anticipate that there are numerous existing applications created with Multigen-Paradigm Inc. Vega. Therefore we will developand Vega Immersive software to develop the Digital Ship content which can be linked with existing applications created with Vega.

Collaborative Virtual Environment (VE) tools such as CAVERNsoft and Limbo (or software provided by NRL & NUWC such as Bambo) will be used to create the collaborative interface.

Key Personnel

Ronald D. Kriz is an associate professor in the Departments of Engineering Science and Mechanics. His research interests include modeling damage development in fiber-reinforced composites and nondestructive ultrasonic and optical methods for detection of damage and monitoring degradation of properties in composites. Dr. Kriz founded the laboratory for Scientific Visual Analysis in 1990 that is now the University Visualization and Animation Group, which is a NSF NCSA-PACI CAVE Alliance Partner. The alliance uses supercomputer resources across a national grid where CAVEs are used to interpret simulation results. His research is mostly wave propagation phenomena and he also supports other CAVE related educational and research activities across the campus as part of Virginia Tech's new Advanced Communication and Information Technology Center.