DATE: May 1, 2001

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SUBJECT: NAVCIITI Quarterly Report

RE: - Project 2.0Visualization HCI and Collaboration
- Task 2.1: Command and Control Visualization
SOW 2.1.3: Demonstrate CAVE displays to interpret NUWC acoustic results, April 01
SOW 2.1.4, Evaluate and modify CAVE display interfaces for NUWC acoustic model, July 01

Background: Our objective is to provide a distributed collaborative network of graphical and device independent tools in a shared virtual environment which can be used by Command and Control (C&C) personnel to gain a strategic advantage. Specifically we focus on the mission critical C&C interpretation of acoustic undersea data from towed arrays for the Naval Undersea Weapons Center (NUWC) using the CONRAY simulation models. These simulation models can be extended to "real-time" data acquisition systems. Under the direction of personnel from NUWC and the Naval Research Laboratory (NRL) we have identified a working prototype which we have successfully incorporated into our Device Independent Virtual Environment Reconfigurable-Scalable-Extensible (DIVERSE) tool that works in stereo in the (C)AVE Automated Virtual Environment (CAVE), Immersive Work Bench (IWB), Immersive Desk (I-Desk), desktop workstation simulator, and Head Mounted Display (HMD) systems at the Virginia Tech Center for Virtual Environments and Visualization (CVEV). Hence the idea of "DIVE" (Device Independent Virtual Environment). The DIVE in DIVERSE provides the basis for collaborative C&C.

Activities redefined during previous quarter: On February 5, 2001 NUWC, NRL and VT agreed to coordinate efforts the following task break down.

NUWC: (POCs Ken Lima, Ann Silva, Lauren Mathews, Richard Shell)
- Develop a geometric method for determining points of intersection for complex conical angles.
- Develop 3-D Eigenray Manifold 'ray trace' algorithms that employ 3-D reflection, sound-velocity profiles and propagation loss models.
- Create multiple scenarios that will test operator effectiveness.
- Make 3-D displays equivalent to Mark II block 1C combat system displays for 2-D vs. 3-D comparison testing:
    - Determine what combat system information should be displayed on the 3-D canvas
    - Update and finalize the form of the information bezel
- Set up software to read in common navy databases.
- Coordinate NUWC and NRL efforts and interact with VT as required.

NRL: (POCs: Larry Rosenblum, Robert King)
- Integrate the information bezel with the DRAGON software - bezel should turn on and off from keyboard or I/O device.
- Ensure control devices operate properly with all software and scenarios - adjust control device parameters as required.
- Integration of NUWC code into the DRAGON software.
- Documentation of DRAGON software
    - Diagram of DRAGON component interaction.
    - Quick guide to code modification of elements pertinent to visualization
    - Organized copy of source code
    - Dragon presentation at NUWC

VT: (POCs: Ron Kriz, John Kelso, Fernando das Neves)

- Explore optimization techniques to permit the code to run faster
- Explore optional enhancements to the current code for incorporation into the DRAGON software such as:
  - Create a bathymetry contour following grid that maps to the bottom
  - Create bottom following vessel tracks.
  - Create the ability to lay generic texture maps of information such as navigational charts, bottom type, gravity maps, etc. on bathymetry.
- Explore alternative devices and interaction techniques to improve selection and analysis of data subsets.

Discoveries, Accomplishments, Test Results:

- SOW 2.1.3 required that the CAVE be operational before July. The CAVE floor with motion platform was completed February 16, 2001. The CAVE became operational March 26, 2001.
- Added bathymetry coordinate grid. This grid follows any geometry and can dynamically change the distance between lines.
- Corrected miscellaneous bugs. One of them made the cones to appear at the wrong time step.
- Added top grid and coordinate labels around grid.
- Modified time to change step dynamically. It is also now possible to go back in time by accelerating time backwards, and stop the clock to analyze a uniqe position. In general, now time can be in the simulation.
- Modified interface. Now almost all parts of the visualization (all grids, coordinate, layers etc) can be made visible or hidden at will.
- Started integration with NUWC panel code via sockets, to isolate interface from visualization.
- Explored ways to write a single code base that at the same time allows object selection to work in the CAVE and the workstations.

Plans for Next Quarter:

- *SOW 2.1.4, Evaluate and modify CAVE display interfaces for NUWC acoustic model, July 01.*
- *SOW 2.1.5, Design Digital Ship CAVE Interfaces (DSCI) for simulation of ship under fire, June 01*

NUWC will coordinate NUWC and NRL efforts and interact with VT as required. VT will maintain regular communications with NUWC regarding the development of these new subtasks.

Outstanding Issues: SOW 2.1.5*: Design Digital Ship CAVE interface (DCSI) for simulation of ship under fire, June 01*. The software integration of MIX with the Digital Ship requires not only the existence of a Digital Ship Lab (DSL) Application Programming Interface (API), but DSL-API documentation as well. At this point an API does not exist. Year Three Task 2.1 was redefined as Task 2.1(a) and a new Task 2.1(b) was created to rewrite the DIVERSE API in OpenGL. Task 2.1(a) will use the OpenGL API to create an OpenGL CONRAY/MIX simulation that will work on-board a submarine HP workstation running the HP-UX operating system. When a DSL API becomes available we can integrate CONRAY/MIX at that time.

Successful development of a working Command & Control (C&C) model, "MIX", between NUWC, NRL and VT has resulted in raising new questions in the development of C&C models that scale across heterogeneous VE systems. This activity has now extend to an FNC project were CONRAY will be deployed on a submarine. At the February 7, 2001 meeting at NRL we discussed issues related to future C&C models and concluded that Performer based code such as DRAGON and DIVERSE must be changed to OpenGL . But OpenGL presently lacks a scenegraph such as Inventor/VRML. We at VT believe these are also important issues that will need to be addressed in NAVCIITI year-3 C&C projects, if these same models are to prove useful to the current C&C community. From this collaboration it is clear that future C&C software architecture must be determined by hardware, software, and other technical issues and limitations. A visual summary of key components of CONRAY simulation model in its current status is shown in Figure 1.

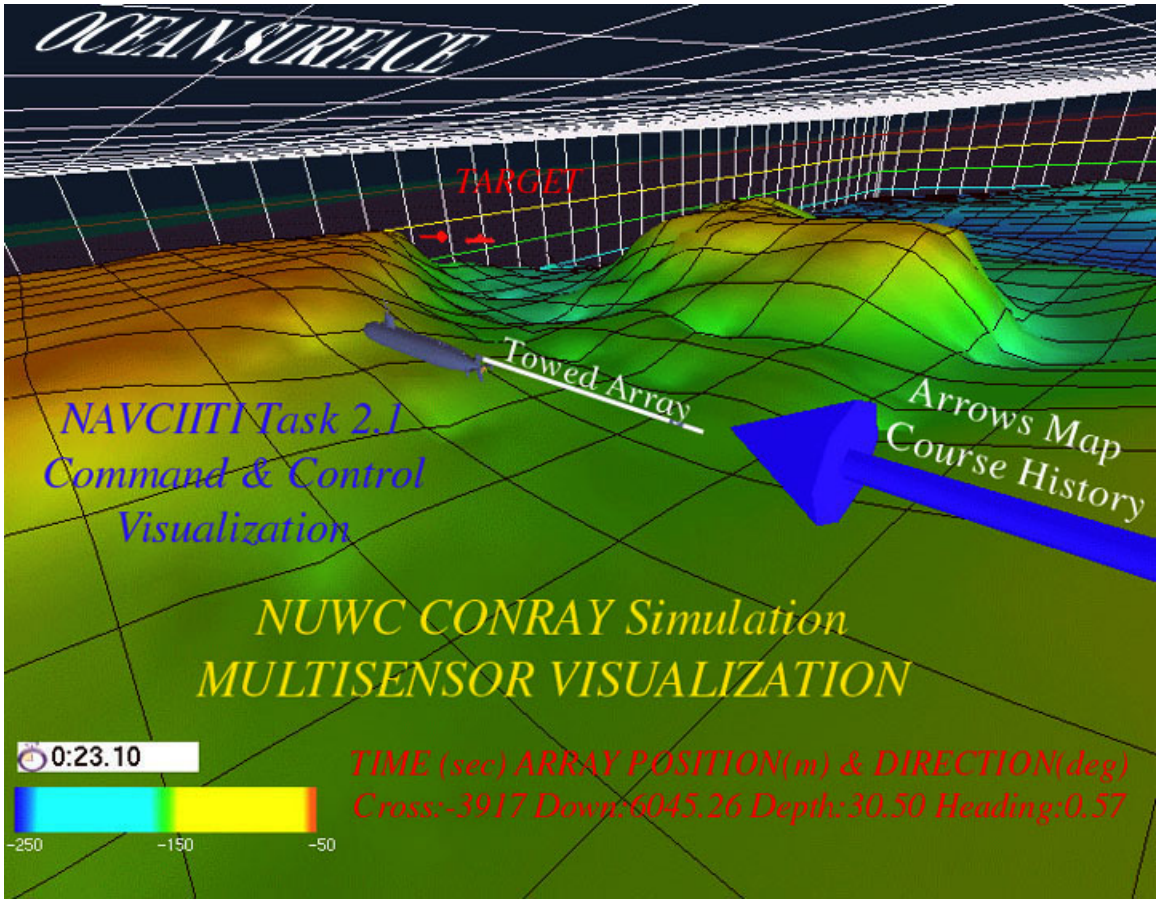

Figure 1. Visual summary of key elements in current DIVERSE-based NUWC CONRAY model