Task 2.1 Command & Control Visualization: Year 5

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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, Immersive-Workbench, or Head Mounted Display (HMD), 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. With the aid of super-computers it is also possible to include discrete simulation models of tactical systems as well as physically realistic simulation models of other mission critical C&C activities such as underwater acoustic phenomena related to undersea warfare. Our experience in creating prototype C&C simulation model applications in collaboration with Navy C&C researchers has positioned us to provide technical leadership in future C&C application programming interface (API) software tool development.

Visualization of Simulation Model Results—

During our second year we focused on a mission critical C&C activity that required interpretation of acoustic data for the Navy Undersea Warfare Center (NUWC) CONRAY (SubVE) project. Acoustic simulation models used by NUWC are highly dependent on physically realistic models. Again virtual immersive environments can aid in creating necessary data displays for the interpretation of complex 3D acoustic structures generated from simulation models. These models require real-time acquisition of data such as bottom bounce and heterogeneous 3D water topologies, which are unique to each tactical situation.

In our third year we generalized the development of a software Application Programming Interface (API) for C&C visualization that can be used for a variety of tactical systems. For example a variety of other C&C activities of interest to the NUWC and the Virtual Reality (VR) Lab at the Naval Research Lab (NRL) requires that reality be augmented with simulation model results. Researchers at the NRL-VR Lab are also rethinking how software and hardware technical issues will influence their future development of software APIs that can be effectively used to build applications such as the Interoperable Virtual Reality System (IVRS). IVRS developed at NRL requires a fusion of a variety of external systems to give a common tactical picture across multiple levels of the network-centric battle-space. The complexity of such systems requires usability evaluations based on formal evaluation methodology. Our second year CONRAY project has required collaboration between NUWC, NRL and VT to develop C&C tactical simulations in immersive environments which where based on NRL’s DRAGON and VT’s DIVERSE APIs.

In our fourth year we continued the development of CONRAY into NUWC FNC project called TALOSS. We also focused on developed an openGL API that would enhance the development of the TALOSS project for the FNC project. Together the underlying openGL API would facilitate data visualization and collaboration. A suite of programs can be tailored to the type of data (3D water topologies, bathymetry, metrological structures) be it multi-variate, time series, GIS, or general volumetric for future development. Focus on developing collaboration tools that will allow multiple simultaneous users to interact in a share virtual environment with features to be determined by our Navy POCs.

Description of Proposed Research:

From our experience of working with Navy C&C software application developers, our group is in a unique position to build on these existing relationships and provide technical leadership in the creation of new C&C APIs. We propose to continue to work closely with C&C projects at NUWC that require co-development of new C&C visualization software APIs that can be used in the future to build a variety of C&C applications such as TALOSS. In our fifth year we will continue to work with NUWC on completion of the TALOSS C&C simulation model application, as outlined in the February 12, 2002 quarterly report on Task 2.1. After much discussion the consensus is to ontinue to develop OpenGL-based software APIs that will allow researchers to build C&C applications across heterogeneous operating systems: IRIX, Linux, HP-UX, and Microsoft Windows. Because the specific API design and features are not yet defined we will continue to work closely with key C&C Navy personnel at NUWC as we build this API. For example Navy POCs will provide a format for future Navy data base standards.

The objective here is provide technical leadership in building a **well documented** C&C OpenGL prototype API that will extend the development of TALOSS NUWC. This API is a “glue” that will foster integration and collaboration with our Navy point-of-contact (POCs) and NAVCIITI CoPIs. As authors of this OpenGL API, we can provide technical leadership with other C&C NAVCIITI applications such as Task 2.3 Visualization and HCI. We will also work closely with NAVCIITI CoPI, Dr. Debby Hix, on usability and evaluation issues as we create this new API. Our group has already built an OpenGL DIVERSE API prototype and a release version is well underway. From this experience we justify the need for one GRAs to assist in the construction of this new API. This task are outlined below.

- Task 2.1: Implementation of DGL version of DIVERSE API for development of TALOSS
  - Implementation of DGL version of TALOSS for display in multiple Virtual Environments
  - Creation of a netted/distributed VR Environment for 3D Visualization
  - Exploitation of DGL Enhanced TALOSS Software for Simulation Based Design (SBD) Studies
  - Documentation

Statement of Work:

Year 5: Task 2.1 Implementation of DGL version of DIVERSE API for development of TALOSS

2.1.1: *Implement DGL into TALOSS: conversion strategy formulated,* ***May 03***
2.1.2: *Implement DGL into TALOSS: conversion operates in multiple VR environments,* ***July 03***
2.1.3: *Implement DGL into TALOSS: convert software to operate on Linux & SGI,* ***September 03***
2.1.4: *Software Demonstration: mult-isensor data fusion in stereo on Wall/CAVE,* ***October 03***
2.1.5: *Enhance DTK to create netted/distributed 3D Visualization compatible with TALOSS,* ***October 03***
2.1.6: *Demonstrate netted/distributed 3D Visualization on Wall/CAVE,* ***November 03***
2.1.7: *Adapt modified TALOSS to 3D models of SBD Designs: scalable/kinematic,* ***February 04***
2.1.7: *SBD demonstration of moving towed array,* ***March 04***
2.1.7: *Final report,* ***April 04***
2.1.7: *Documentation of Enhanced TALOSS software,* ***April 04***
2.1.7: *Documentation to netted/distributed software upgrade to DTK,* ***April 04***

Technical Approaches:

For task 2.1 development of the OpenGL C&C API, DGL, was developed for implementation in the CONRAY (SubVE) application, although it will designed to be an application-independent API. The DGL API depends on the DIVERSE Toolkit (DTK) API, a separate standalone package, which will be used by DGL to provide access to local and networked VE interaction devices and other utility that is not directly related to graphics. Only software modules that depend on OpenGL will become part of DGL. This separation of tasks simplifies DIVERSE development. In the past DTK was an integral part dgiPf, the DIVERSE graphics interface to Performer, which is in turn used in the current implementation of CONRAY (SubVE). DTK has been rewritten to operate independent of DGL and newly written DIVERSE graphics interface to Performer (DPF). The newly written DTK, DGL and DPF are modular. As much as possible all DIVERSE graphics APIs will augment the existing graphics API of the user's code, which will not force application programmer into using a particular design paradigm.

Key Personnel

John T. Kelso is a Senior Research Associatein the Computer Science Department at Virginia Tech. He has a M.S. in Computer Science from George Washington Univerisity (1984) and a B.S. in Mathematical Science for University of North Carolina (1976). John co-author of DIVERSE and author of the DIVERSE Graphics interface for Performer, an API that supports the creation of highly reconfigurable device-independent visualization and virtual reality applications. This API was used to help develop the current TALOSS project.

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.

Lance E. Arsenault is a Research Assistant Professor in the Computer Science Department at Virginia Tech. He has a PhD in Physics (1996) from the University of Illinois at Urbana. His current research is concentrated on the development of a real-time CAVE and motion based virtual prototyping system and the development of VE software APIs. He is a co-author of the DIVERSE project (http://www.diverse.vt.edu/) and the primary author of the DIVERSE ToolKit (DTK). Prior to working at Virginia Tech, before May 1999, he was employed by the National Center for Supercomputing Applications (NCSA) as a research programmer, concentrating on VR and engineering applications for Caterpillar Inc., in NCSA's industrial partners program. Before that he finished his physics PhD thesis in the field of nonlinear dynamics in the fall of 1996 at the University of Illinois at Urbana.