Navy Collaborative Integrated Information Technology Initiative (NAVCIITI)
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Navy Collaborative Integrated Information Technology Initiative (NAVCIITI)

This is the ninth report of the NAVCIITI program, that covers the period 18 July 1999 through 18 October 1999. This report is submitted as a quarterly report as proposed in year 2 proposal.

1. Introduction

The long-term objective of this program is to provide strong, integrated research capabilities in broad user communications testbeds, systems engineering, fiber optic sensors and transmission devices, secure and reliable wireless communications, effective user-friendly human computer interfaces, and scientific visualization to the Navy community. This initiative will improve the Navy's capabilities to support distributed computing, integrated services training, education, information dissemination, and simulation.

The multiyear program will establish a Navy Collaborative Integrated Information Technology Initiative (NAVCIITI, pronounced "NAV city") by creating an Advanced Communication and Information Technology Center (ACITC), on campus at Virginia Tech, integrating the efforts of more than 60 investigators currently under contract to the Navy by providing equipment and facilities for their effort, and using the collective capabilities of NAVCIITI to support Navy initiatives in distributed computing, integrated services training, education, information dissemination, and simulation, especially for purposes of network-centric battle management, managing and maintaining C4ISR attributes, and enhancement of the Naval intranet. The scope of the proposed program was developed as a result of discussions, and briefings with a group of Navy unit leaders.

2.0 Technical Summary

The program has now completed eleven months. Major enabling equipment purchases have been made, as outlined briefly in our fourth monthly report, and as updated in the sixth monthly report. We have now made significant research progress using this new equipment and related facilities on campus. Progress in specific areas is discussed in the following sections.

2.1 Virtual Environment (VE) hardware and software, and user-based navigation in a VE (Ron Kriz- Task 1.1.2,1.4.b1, and 1.5.1) CDRL Data Items 0001, 0002, 0003, 0018, and 0029

A complete list of VE hardware and & software for the current CAVE is located on the following web pages:

1. Hardware: www.sv.vt.edu/future/cave/hardware/hardware.html
2. Software: www.sv.vt.edu/future/cave/software/software.html

A comprehensive list of VR hardware and software vendor devices is given at CAVERNUS web page www.ncsa.uiuc.edu/VR/cavernus/. In fact, this list of systems has grown so large that it has created new problems where it is now difficult to create highly interactive systems that can accommodate the long list of APIs and devices. In response to this problem the Electronic

Visualization Lab (EVL) has created TANDEM, NRL has created PANDA, and the VT-CAVE has created JIVE. One API not shown on the list that is a very good but very costly API, is Paradigm's Vega. Recently VEGA has included a VE tool to it's GUI called Lynx and also the collaborative interactive tool called DIS (Distributed Interactive Simulation).

** NOTE: Does not include voice recognition and sound system and SGI Sirius video upgrade. These two systems will be included soon.

2) Specs for VE tactical process prototype

Since the original NAVCIITI proposal was written, the NRL VR-Lab has changed it's focus from the Dragon Battlefield Visualization System to the Battlefield Augmented Reality System (BARS) and is developing an interoperable VR system called Panda that is an extension of the Bambo software developed at the Naval Postgraduate School. This was largely motivated by the limitations on including multi-input and multi-output devices.

At Virginia Tech's CAVE we have also experienced similar limitations in developing an interactive collaborative CAVE system that we called the CAVE Collaborative Console (CCC) based on CAVERN and LIMBO that was developed at the Electronic Visualization Laboratory (EVL). In our NAVCIITI proposal we originally proposed to extend the development of collaborative awareness tools in the CCC for tactical environments, such as 2D, 3D radars, etc., but we discovered several serious flaws in the existing LIMBO software API and choose to invest our time in creating a new API that would allow the extension of new devices and other APIs in a new extensible interactive-collaborative environment that we called JIVE: www.caveslugs.vt.edu/projects/jive/

It is interesting that the philosophy behind the CCC is very similar to concepts presented in the Interoperable Virtual Reality System (Panda) web pages.

CCC: bleen.sv.vt.edu/~kcurry/ood.html
Panda: ait.nrl.navy.mil/vrlab/projects/interoperableVR.html

Whereas, Panda was based on Bambo, CCC was based on CAVERN and LIMBO. But we discovered that LIMBO also has many serious limitations to properly implement CCC for reasons similar to NRL's experience. So this summer (1999) we started our effort to create JIVE not knowing about the parallel efforts at NRL to develop Panda. It is interesting to note that EVL (for similar reasons) has created TANDEM (www.evl.uic.edu/cavern/seminars/limbos/index.html) and marketed TANDEM as a VRCO product (www.vrco.com/products/beta_products.html). The biggest difference between TANDEM and JIVE is that JIVE is open source. We have not had the opportunity to study the differences between Bambo and JIVE but these would be of academic interest only and so at this point we will continue to develop JIVE under funding from our NSF PACI grant and work with NRL's Panda and Bambo if required. Actually this would not create any problem since our collaborative awareness tools for tactical implementations are all created using Perfomer. We will wait to hear from Larry Rosenblum's group if they want us to pursue working with Panda and Bambo for the completion of FY99 funding.

We have just learned that our efforts will take a large change in direction starting October 1, 1999 for FY00 funding where we will be focusing on VE scientific data visualization of sonar and meteorological 3D data. In the next few weeks, we will inquire if we should finish the tactical process prototyping or change our efforts this fall semester to start modeling 3D data visualization systems.

Comment-Recommendation: We have had many discussions with others in the VE world and we all share this frustration about co-development of similar tools such as TANDEM, JIVE, and PANDA for example. These independent efforts are mostly due to a lack of communication and there seems to be an agreement that what is needed is to create open source for CAVELibs and collaborative interface APIs such. This would facilitate the development of Panda and CCC.

3) Recommended large format VE hardware

A report from Pyramid Systems Inc. on the design of a large CAVE format is available on request. The large CAVE format is briefly described as a 20' wide x 20' deep and 10' where the ceiling, not the floor is the fourth projection screen. The projection system requires two Electrohome 9500LC Ultras per 10'x10' areas where each is polarized at 90 degrees to each other, hence eliminating the use of stereo shutter glasses. The total number of projectors required for the 20'x20'x10' with a 20'x20' ceiling would require 20 projectors which constitutes the eighty percent of the total cost of the entire system. The total cost was quoted at $620K. Twenty projectors would require a 10 Infinite Reality Pipe SGI ONYX-2 with at least 12 nodes. Such a computing system is called a Reality Monster which costs approximately $1M. Together, the large CAVE with computer would approach $2M. The benefits of the large format CAVE would allow more participants to experience the immersive environment. Due to the cost alone when compared with the second year budget it is not advised to purchase the large format CAVE.

2.2 Communications Testbeds (Jeff Reed, Charles Bostian, Brian Boyle--Task 1.2.1), CDRL Data Item 005

While many software radio architectures have been suggested and implemented, there remains a lack of a formal design methodology that can be used to design and implement these radios. The first year's work provides a unified architecture for the design of soft radios on a reconfigurable platform called the Layered Radio Architecture. The layered architecture makes it possible to incorporate all of the features of a software radio while minimizing complexity issues. The layered architecture also defines the methodology for incorporating changes and updates into the system. An example implementation of the layered architecture on actual hardware is presented in CDRL #006 which is being submitted separately.

2.3 Wireless Communications Foursquare Element Research (Warren Stutzman—Task 1.2.2), CDRL Data Item 0008, 0009

The Virginia Tech Antenna Group modeled the Foursquare element using the FDTD (Finite Difference Time Domain) commercial code Fidelity. The computer model of the radiating element is very similar to a hardware model constructed by the Antenna Group except for differences in the substrate thickness and the ground plane. The values calculated using Fidelity Math Model. The results obtained for the Foursquare model using the Fidelity code are very similar to the real element manufactured and tested by the Virginia Tech Antenna Group. Slight differences between modeled and measured results can be attributed to differences in substrate thickness and ground plane area. The model used 30 mils substrate thickness instead of the 28 mils substrate thickness with the hardware in order to avoid using a large number of cells in the computer model. Also, the computer model used an infinite ground plane instead of a finite ground plane as used in the hardware element. However, the length of the ground plane in the hardware element is almost ten times that of the radiating element, approximating an infinite size condition.

2.4 Systems Engineering Framework for Issue Driven Measurement (Richard Nance, - Task 1.3.1), CDRL Data Item 0011, 0012

Our work over the past two months has been to get our Distributed Systems Laboratory in an operational status. That has proved to be more difficult than we had hoped (but about the same as expected). This laboratory will enable us to be a major player in the Virtual Operations Networks project in Year 2.

As for Year 1 (Software Quality Measurement), we have examined and reviewed four candidate frameworks: (1) Practical Software Measurement (PSM), (2) the SEI Capability Maturity Model, (3) the Objectives/ Principles/Attributes (OPA) framework, and (4) an approach based on subject matter experts applying aspects from all of the others. We believe this last approach to offer some major advantages, and we are intending to suggest this in the future system applications. We are in the process of setting up a meeting with Dr. William Farr and Ms. Sherry Barker of NSWCDD to discuss our approach and the potential for applying the work to a Navy project.

2.5 Guidelines for design of user-based navigation in a VE, and data collection from eye-tracking (Deborah—Task 1.4b.1),CDRL Data Item 0023, 0024

The Center for Human-Computer Interaction has two areas of responsibility in the first year of the NAVCIITI program: The first area is in design rationale, an intersection between human-computer interaction (HCI) and software engineering. We are investigating the proactive use of design rationale in software development, specifically focusing on the management of usability rationale in a scenario-based design process through use of claims analysis, and including refinement and dissemination of such methods for analyzing usability and domain object tradeoffs in Naval software designs, prototypes, and systems. Our task in this area is to prepare a textbook for the methodology, and to support Naval software and system development.

The second area of responsibility for the Center for Human-Computer Interaction is in computer-supported collaborative work (CSCW). We are investigating the development and application of collaborative multimedia conferencing software for education and other group work activities. We are extending our virtual school software framework integrating shared notebook, whiteboard, chat, visualizations, simulations, video conferencing, etc.

We have continued to make good progress on our technical tasks. An upper level textbook on the management of usability rationale in a scenario-based design process through use of claims analysis is complete. We have begun work on a lower-level textbook, which presents scenario-based system development as part of the undergraduate computer science curriculum in software engineering and human-computer interaction. Addison-Wesley, Morgan-Kaufman, MIT Press, Prentice-Hall, John Wiley and Lawrence Erlbaum Associates have expressed interest in publishing this text, based on reviews of a chapter-by-chapter outline. Chapters 1-6 and 9 are now complete, and are being used in as text materials in CS3724 "Introduction to Human-Computer Interaction" in the Fall 1999 semester. Fourteen chapters are planned. Based on this material, we proposed, and have now been invited to provide, a full-day tutorial on scenario-based design for the 2000, ACM CHI Conference, the top international conference in human-computer interaction.

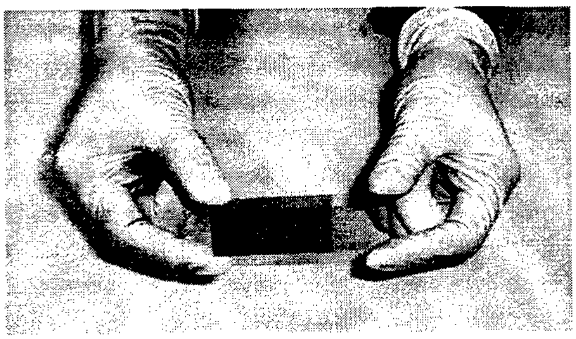
We have also made progress on several fronts in developing a system to support collaborative learning and planning interactions. We are focusing on developing and evaluating the Virtual School, a Java-based networked leaning environment emphasizing support for the coordination of synchronous and asynchronous collaboration. The Virtual School integrates communication tools such as video conferencing, shared whiteboards, chat, and email. Currently, we are developing several new collaborative page types for shared notebook, investigating off-the-shelf component reuse, experimenting with a set of synchronous and asynchronous awareness tools, and developing a comprehensive evaluation methodology to assess the usability and usefulness of such environments. To test new tool development and further explore the evaluation framework, we are continuing to implement the system in a number of new contexts. Investigating a range of different cooperative work types under varying synchronous and asynchronous modes is allowing us to expand our understanding of how the tools are used in real contexts and how to evaluate them under these conditions. For example, in one new environment the tools are being used for teaching instead of peer-to-peer collaboration, and in another case we are analyzing asynchronous only mentoring.

2.6 Fiber Optic Sensors and Transmission Devices (R.O. Claus, Carvel E. Holton—Task 1.4b.3), CDRL Data Item 0027

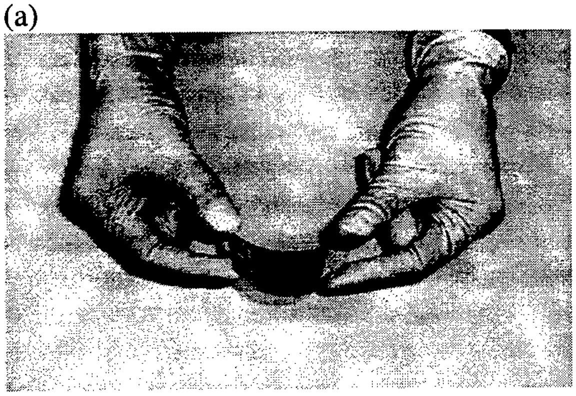
This section briefly reviews accomplishments made on this NAVCIITI program task during this period. Tests of Mechanically-Flexible Display Arrays Formed by ESA Processing During the program months, we have mechanically tested the robustness of the mechanically flexible opto-electronic display demonstrator article that has been described in detail in prior monthly reports. The display element was formed through the self-assembly of PPV and other molecular precursors, using the process detailed in those reports. The objective of our mechanical testing has been to investigate how flexing may degrade the performance of either the mechanical actuation behavior of the thin films, or the optical light emitting properties. First, as shown in

Figure 1, ESA-formed active polymer thin films on mechanically flexible ITO-coated polyester substrates were repeatedly bent by hand to form U-shaped geometries, but without creasing.

Measurements of several properties prior to and after flexing, including UV-vis absorption, film thickness as measured by multi-wavelength ellipsometry, and simple visual observation, were used to observe potential variations in material quality. No variations were observed for six samples flexed as shown for 50 cycles. Atomic force microscope images obtained prior to and after flexing did not display any differences.



(a)



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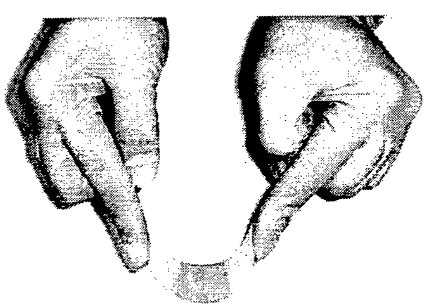
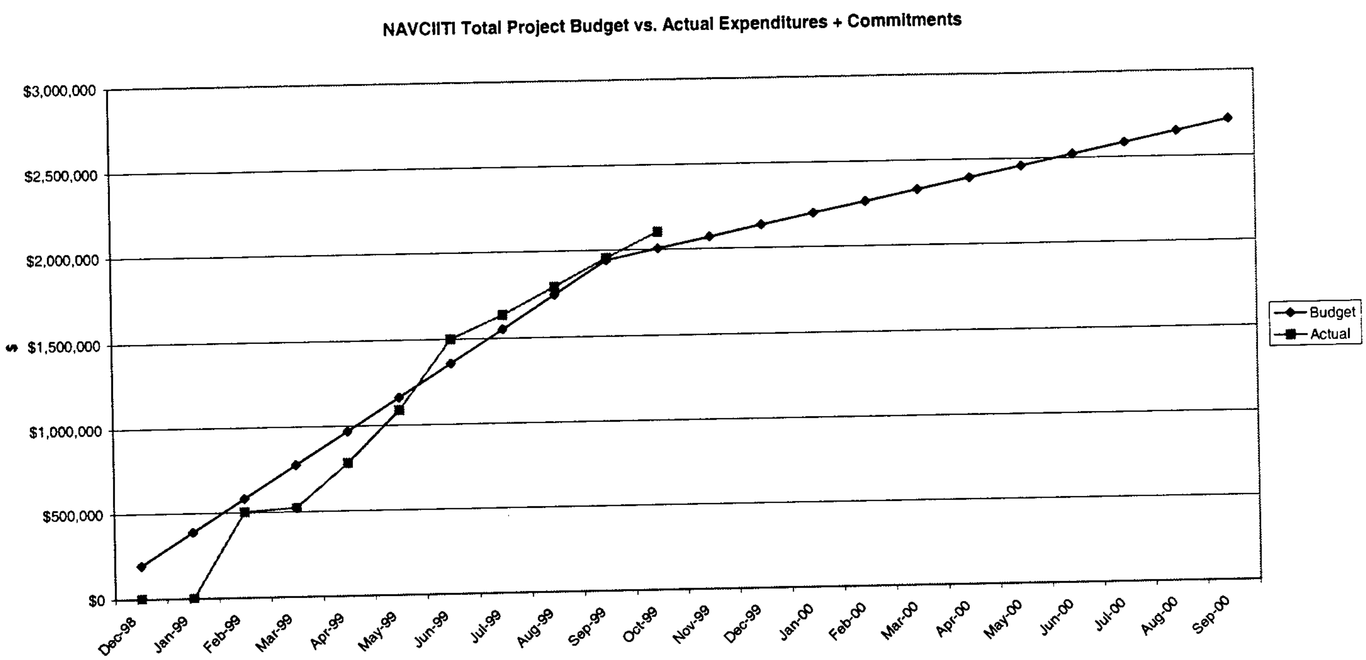


(c)

Figure 1. Mechanical Testing of Active Device Polymer Formed by ESA Process on Flexible Polyester Substrate

3.0 Financial Status



The expenditures and commitments through the month of October are noted on the graph above.

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