OPTIMIZING AEROBOT EXPLORATION OF VENUS

Kevin Sean Ford-Lieutenant, United States Navy
B.S., Florida State University, 1989
Master of Science in Operations Research-March 1997
Advisor: Robert F. Dell, Department of Operations Research
Second Reader: James N. Eagle, Undersea Warfare Academic Group

Venus Flyer Robot (VFR) is an aerobot—an autonomous balloon probe—designed for remote exploration of Earth's sister planet in 2003. VFR's simple navigation and control system permits travel to virtually any location on Venus, but it can survive for only a limited duration in the harsh Venusian environment. To help address this limitation, the following was developed: (1) a global circulation model that captures the most important characteristics of the Veunsian atmosphere; (2) a simple aerobot model that captures thermal restrictions faced by VFR at Venus; and (3) one exact and two heuristic algorithms that, using abstractions (1) and (2), construct routes making the best use of VFR's limited lifetime. This modeling was demostrated by planning several small example missions and a prototypical mission that explored numerous interesting sites recently documented in the planetary geology literature.

INTERNETWORKING: AIRBORNE MINE COUNTERMEASURES C41 INFORMATION SYSTEMS

Steven Mitchell Graves-Lieutenant, United States Navy
B.S., United States Naval Academy, 1988
Master of Science in Information Technology Management-December 1996
Advisors: Don Brutzman, Undersea Warfare Academic Group
Rex A. Buddenberg, Department of Systems Management

Airborne Mine Countermeasures (AMCM) Command Control Communication Computer and Intelligence (C41) baseline currently consists of stand-alone tactical decision aids. Information such as aircraft position, equipment status, and abbreviated mine like contact reports cannot be transferred in any form other than voice from/to the MH-53E helicopters while conducting Airborne Mine Countermeasures operations. There are currently no methods to transfer sonar video or single-frame imagery of mine-like objects between any Mine Warfare (MIW) units in a near-real time manner. Delays lasting several hours are frequently encountered before the results of a "rapid reconnaissance" airborne minehunting mission are made available to the rest of the fleet and/or MIW community. In order to improve command and control, the AMCM Mine Warfare community must integrate all of its C41 assets onto a tactical internet.

This thesis presents a tactical internet for AMCM with an open, standards-based modular architecture. It is based on the TCP/IP network model using common protocols and interfaces. Command and control will significantly improve as this network will provide a methodology to transfer critical information between AMCM C41 assets and tactical networks worldwide. Results from a comprehensive laboratory prototype demonstration using commercial off-the-shelf (COTS) equipment are presented along with lessons learned. Laboratory results show that this system works and can be deployed for testing at sea.

REALISTIC INTERFACE AND CONTROL OF A VIRTUAL SUBMARINE MODEL IN NPSNET

Jeffrey Alan Halvorson-Lieutenant, United States Navy
B.S., University of Idaho, 1990
Master of Science in Computer Science-March 1997
Advisors: Michael J. Zyda, Department of Computer Science
John S. Falby-Department of Computer Science
Donald Brutzman, Undersea Warfare Academic Group

The current NPSNET submarine simulator is not a viable training tool because it utilizes a control panel which runs as a separate process and includes three separate tabs, one each for the Officer of the Deck, Helm, and Weapons Officer. besides lacking immersion qualities, most of the control icons and prototypes are not functional.

Our approach is to mount human entities to the submarine that can control and maneuver the submarine entity by interacting with various objects onboard the submarine. These human entities represent key members of the submarine control party including the Officer of the Deck, Diving Officer of the Watch, Chief of the Watch, Helmsman Planesman, and a second Planesman. The submarine model was improved by building a 3D Control Room and adding manipulable visual cues to represent an actual submarine control room.

As a result of this work, a group of human entities can operate a submarine in NPSNET, acting together as a watch team and maneuvering the submarine through the virtual environment. Realism has been improved by immersing a user into the virtual environment as a virtual human entity.

ANALYSIS AND COMPARISON OF SEVERAL MEASURES OF PERFORMANCE FOR PASSIVE SONAR DETECTION SYSTEMS

Caroline M. Nielson-Lieutenant Commander, United States Navy
B.A., Cornell University, 1986
M.A., Old Dominion University, 1993
Master of Science in Operations Research-September 1997
Advisor: James N. Eagle, Undersea Warfare Academic Group
Second Reader: Donald P. Gaver, Department of Operations Research

This thesis is motivated by a debate at Commander, Operational Test and Evaluation Force (COTF) concerning which Measure of Performance (MOP) would be best to use when evaluating passive sonar detection systems. COTF has used probability of detection and Figure of Merit in the past, but probability of detection as a function of lateral range is being promoted in a recent Program Executive Officer for Undersea Warfare instruction. This thesis presents a menu of potential MOPs, their definitions, methods for calculating each MOP, relationships that exist between them, and a critique of their strengths and weaknesses as evaluation MOPs. Important MOP attributes are summarized for all listed MOPs to aid in MOP selection. The thesis looks in depth at the relationship between two of these MOPs which could make calculation of the more complex measure somewhat easier. Upper and lower limits for lateral range in terms of cumulative probability of detection are established. As a final step, the thesis involves a critical analysis of an existing computer program, which computes an approximation of a lateral range curve given a list of achieved detection ranges. A recommendation is made concerning use of this program.

EVALUATING COLOR FUSED IMAGE PERFORMANCE ESTIMATORS

James S. Ogawa-Lieutenant, United States Navy
B.S., United States Naval Academy, 1990
Master of Science in Operations Research-September 1997
Advisor: William K. Krebs, Department of Operations Research
Second Reader: James N. Eagle, Undersea Warfare Academic Group

This thesis evaluated the effectiveness of sensor fusion—combining infrared and low-light-level imagery—to improve the F/A-18-target standoff range requirement. Several human performance studies have shown inconsistent results regarding the benefits of color-fused imagery. One method to test the validity of sensor fusion is to use mathematical models that simulate and predict the detection abilities of the human visual system. The mathematical models are derived quantitatively from the image statistics, while the behavior data are a qualitative measure of a human observer. This thesis developed a statistical analysis to compare and contrast these techniques to assess sensor fusion. The four models evaluated were: a Global matched filter, a Local matched filter, a Template matching filter, and a contrast-base image quality metric. Of the four models, the global matched filter produced the highest degree of correlation with the human data. The Global matched filter moderately predicted which of the single-band sensors and which of the fused sensors provided the higher sensitivities despite the characteristically different scenes. Although there are many refinements that need to be explored, the global matched filter concept may be used to evaluate and compare the many different fusion algorithms being proposed.

ROBOT WARS SIMULATION

Doreen M. Jones-Lieutenant, United States Navy
B.S., Tulane University, 1988
Master of Science in Applied Physics-June, 1997
Advisors: Gordon E. Schacher, Department of Physics
Donald Brutzman, Undersea Warfare Academic Group

Naval Postgraduate School (NPS) Combat Systems students learn about robots and autonomous weapons during group design projects in the SE 3015 course sequence. This sequence is designed to provide experience in combat systems development. The capstone project is the Robot Wars Competition, where pairs of student-designed autonomous robots battle each other. This thesis extends this competition into the arena of simulation and modeling. Our motivation is to further students' understanding of the strengths and weaknesses of computer modeling and simulation in combat systems design and testing.

This thesis creates a simulation foundation of the Robot Wars Competition. The simulation has been designed in two main parts, a C++ program that manipulates the Simbots on the playing field and generates data files of their movements, and a 3D graphical visualization that allows the user to see the Simbots in action. The C++ program uses a Simbot class to instantiate two Simbots which are composed of three basic components: base, optics and weapons. The graphics portion uses data files created in the main simulation and displays in 3D animation. The simulation correctly replicates the logical and physical aspects of the robot competition. Future research on the physical aspects of the component parts and the graphics package can be integrated with this foundation.

LOW-COST DIGITAL SIGNAL PROCESSOR (DSP) BASED TORPEDO COUNTERMEASURE WITH AUTONOMOUS TARGET MOTION ANALYSIS (U)

Martin L. Whitfield-Lieutenant, United States Navy
B.S., United States Naval Academy, 1990
Master of Science in Computer Science-June 1997
Advisors: Don Brutzman, Undersea Warfare Academic Group
Robert B. McGhee, Department of Computer Science

CLASSIFIED ABSTRACT