Computer Science Department

Professor Kay G. Schulze
Chair

During the 2003-2004 academic year, the Computer Science department faculty did significant research in the areas of software engineering, robotics, computer algebra, networks, graphics, and intelligent tutoring. A number of midshipmen independent research projects were conducted. Midshipmen also participated in summer internships at the Naval Research Laboratory (NRL), the National Security Agency (NSA), the Naval Warfare Development Center (NWDC), the Naval Computer and Telecommunications Area Master Station Atlantic (NCTAMS LANT), and the Fleet Numerical and Oceanography Center. Two Bowman Scholar Program research projects were also completed. The Computer Science faculty continues to attract grant money and research opportunities from both government and commercial sources.

Sponsored Research

Practical Computing with Semi-algebraic Sets via Cylindrical Algebraic Computation

Researcher: Assistant Professor Christopher W. Brown
Sponsor: National Science Foundation (NSF)

The purpose of this research was to develop algorithms and produce programs that are able to perform practical symbolic computations with semi-algebraic sets. The primary tool for this was Cylindrical Algebraic Decomposition (CAD), which provides a data-structure for explicitly representing semi-algebraic sets. CAD is a powerful and general tool, which has been implemented several times and has already shown itself to be of more than just theoretical value. However, the consensus in the literature is that interesting application problems cannot be solved by current CAD programs within a reasonable amount of time and space. The three principal goals of the project were to extend the theory of CADs to deal efficiently with the types of semi-algebraic sets that arise in applications, to produce efficient algorithms and programs that compute with CADs, and to promote the use of CADs to solve problems in other disciplines.

Imitation Learning of Goal Sequences in Mobile Robots

Researcher: Assistant Professor Frederick L. Crabbe, IV
Sponsor: Office of Naval Research (ONR)

Most studies of imitation learning in robots or other artificial agents concentrate on enabling a robot to learn to repeat individual low-level actions made by a teaching agent. This project continued to expand imitation learning to enable a student robot to learn to identify and perform sequences of high-level sub-goals, each made up of multiple low-level actions. For example, a student agent would follow a teacher agent as the teacher performed a task in order to learn to perform that same task. When the teacher completed each sub-goal in the sequence, the student learned the purpose of each sub-goal as well as when to perform it in the sequence. Work focused on enabling a learning robot to segment the stream of motor commands performed by the teaching robot into conglomerate actions. The learning robot used Bayesian techniques to determine the relative probabilities of various motions in order to determine if one action had ended and another had begun.

High Energy Laser Weapons: Modeling and Simulation (Phase II, Modeling Development)

Researcher: Associate Professor Donald M. Needham
Sponsor: The High-Energy Laser Joint Technology Office

Development of one or more end-to-end simulations of laser system performance and effectiveness is fundamental to the goals of the High Energy Laser Joint Technology Office's (JTO) modeling and simulation (M&S) program. One such simulation prospective follows the physics and engineering of a ship's energy starting with energy conversion from the ship's fuel through electrical power generation, electrical generation of laser light, beam transport, etc, and ending with target damage assessment. A fundamental step, proposed by this research, in the process of developing a domain-reusable, end-to-end high energy laser simulation, was to examine an existing model, and focus on the identification of a software system architecture designed to support the inclusion of modeling components needed for the various portions of an end-to-end simulation. The steps in this process included acquiring a suitable high energy laser model, and developing an architecture that isolated and minimized couplings between the software components that implemented the model. Analysis of the resulting architecture focused on increasing its potential for domain-specific reuse so that suitable models for the remaining portions of the end-to-end simulation could be smoothly integrated. Additionally, this work provided guidance to high energy laser modelers on developing software components that implement their models so as to ease integration of their models within an end-to-end simulation.

The Andes Project

Researcher: Professor Kay G. Schulze
Sponsor: Office of Naval Research (ONR)

Classical physics is a prerequisite for virtually all university-level study of science and technology, yet is notoriously difficult for students to learn. The Andes project is an intelligent tutoring system that is intended to be used as a "homework helper" for students taking General Physics courses. This year the project concentrated on expanding the number of problems in the system, particularly in areas traditionally covered in a second semester Physics course.

A Particle System Method for Quantifying Cardiac Ejection Fraction

Researcher: Assistant Professor David J. Stahl, Jr.
Sponsors: Office of Naval Research (ONR) and Naval Academy Research Council (NARC)

This research first required porting an existing physically-based modeling, visualization and physical simulation environment previously developed by the researcher, from its UNIX/SGI implementation to a Windows/PC implementation. Second, an existing volumetric model of a human left ventricle was improved to permit blood pool introduction and ejection. This required data conversion and modification to produce an anatomically correct myocardium model with a left atrium, aorta, and associated valves suitable for use in the simulation system. Third, the particle system model was revised to allow temporally changing internal model representations to permit the modeling of cardiac valves that open and close. Finally, simulations were run to demonstrate the ability to measure cardiac ejection fraction with this approach.

Independent Research

An Investigation into Compromise Actions in Behavior-Based Robotic Systems

Researcher: Assistant Professor Frederick L. Crabbe, IV

This project examined the nature of compromise actions in behavior-based systems. Using Value-Iteration to approximate solutions to the Bellman equation, it determined the comparative advantage to selecting compromise actions when pursuing two appetitive goals. It then used Information Gain to determine in what scenarios compromise behavior provided the greatest benefit.

Md5deep

Researcher: Captain Jesse Kornblum, USAF

This research continued the development of md5deep, a cross-platform set of programs that computes MD5 message digests or SHA-1 message digests on an arbitrary number of files. The programs run on Windows, Linux, FreeBSD, OS X, Solaris, and should run on most other platforms. Md5deep is similar to the md5sum program found in the GNU Coreutils package, but it has several additional features.

Midshipman Research Course Projects

Evolutionary Software Development and Simulation for an Urban Search and Rescue Robot

Researcher: Midshipman 1/C Jeffrey Pinney, USN
Adviser: Assistant Professor Frederick L. Crabbe, IV

The goal of this project was to use genetic algorithms (GA) to develop controls for an already existing robot. These controls are complex and perform certain functions that accomplish pre-defined search and rescue obstacles. Genetic algorithms were needed because the complexity was too great to accomplish the controls kinematically. Computer simulation was used in conjunction with the GA for testing. The simulation for testing was completed, and the groundwork for the GA was put in place. In the future, the GA will be used to develop a controller that effectively controls the robot to perform all the tasks necessary to be an urban search and rescue robot.

Collaborative Networked Environments for Military Training

Researcher: Midshipman 1/C Keith G. Labbe, USN
Adviser: Major Mark J. Lennerton, USMC
Sponsor: Bowman Scholar Program

The research undertaken in this proposal was a joint venture with the Naval Postgraduate School (NPS). Once a secure Virtual Private Network (VPN) connection was established and tested locally, a connection with NPS was established. This connectivity provided and served as a test bed in determining VPN functionality in meeting the needs for continued collaborative Virtual Environment (VE) and information technology (IT) research. A commercial off the shelf (COTS) desktop VE was initially used to test issues such as bandwidth requirements/availability, latency, and barriers to collaborative communication and coordination. Once established, customized and scaled, bicoastal collaborative sessions were connected to explore performance in pursuit of collaborative goals. Additional collaborative sessions were conducted throughout to gain a better understanding of the human factors involved in using VEs.

High Energy Laser Modeling and Simulation Framework Evaluation

Researcher: Midshipman 1/C Erik C. Eckstrand, USN
Adviser: Associate Professor Donald M. Needham
Sponsor: Bowman Scholar Program

This research centered on the modification of an existing software architecture framework that provided the communication backbone between high energy laser propagation models. IT evaluated whether one component of an end-to-end software simulation framework, such as a laser's wave front propagation component, could be modified or replaced to allow for the inclusion of emerging lasing codes, and assessed the impact of such changes on the rest of the simulation framework. This project contributed to the High Energy Laser Joint Technology Office's efforts by incorporating an existing laser propagation model into the Northrop Grumman High Energy Laser Simulation (HELSEEM) framework, and examined the feasibility of incorporating legacy laser propagation codes into the HELSEEM framework. The specific incorporation process was detailed, with particular attention given to problems likely to be encountered by developers of subsequent laser propagation codes. Lessons learned from the incorporation process, as well as recommendations for the improvement of the process, were identified and discussed.

Embedded Systems for Stealthy Unmanned Aerial Vehicles (AUVs)

Researchers: Midshipman 1/C Joseph Duchesneau, USN, Midshipman 1/C Erik C. Eckstrand, USN, Midshipman 1/C Aaron Foster, USN, Midshipman 1/C Stephen Lawless, USN, and Midshipman 1/C Ryan Rippeon, USN
Adviser: Associate Professor Donald M. Needham
Sponsor: Department of Defense (DoD)

This research project was an interdisciplinary one conducted by students in computer science, aeronautical engineering and mechanical engineering majors. The project consisted of the design and construction of stealthy unmanned aerial vehicles (UAVs). The computer science students were assigned two to a UAV team, and focused on software system development and interfacing for the physical UAV components. Through the efforts of Dr. Larry Birckelbaw of the Naval Academy's Aerospace Engineering Department, the Department of Defense (DoD) provided funding for the midshipmen to build stealthy UAVs from the ground up. The teams used stealth-coated (radar absorbing or deflecting) materials, bought commercial components (autopilots, radar emission detectors, etc), altered the pre-packaged software drivers, and in some cases created new source code to make the UAV components behave as needed.

Each student focused on particular sub-topics of the project: Midshipman Duchesneau: Software Systems for Control Surface Actuation; Midshipman Eckstrand: Autopilot System Integration; Midshipman Foster: Software Augmentation for Autopilot Systems; Midshipman Lawless: Infrared and Radar System Interfaces; and Midshipman Rippeon: Component-based Embedded Software Architectures.

YP-TDS: A Tactical Data Simulator for Naval Academy Yard Patrol Craft

Researcher: Midshipman 1/C Jeffrey P. Wilcox, USN
Adviser: Assistant Professor David J. Stahl, Jr.

The Yard Patrol Craft Tactical Data Simulator (YP-TDS) is an inexpensive, custom built hardware and software system using commercial-off-the-shelf components that is capable of providing a multi-terminal tactical display similar to existing systems aboard commissioned warships. It has the potential for use in the educational environment at the United States Naval Academy. Own-ship position received via the global positioning system (GPS) and simulated contact data generated from a combat simulation scenario were displayed in real time, allowing YP-TDS to be used for student afloat instruction aboard sea-going training craft.

YP-TDS WAN: A Wide-area Network to Support Battle Simulation

Researcher: Midshipman 1/C Jeffrey P. Wilcox, USN
Adviser: Assistant Professor David J. Stahl, Jr.

The YP-TDS project completed in the fall semester represents an initial effort towards embodying the concept of Network Centric Warfare within the afloat training environment at USNA. It met its limited initial objective. A tool was created at minimal cost, using COTS hardware running midshipman-designed and implemented software, which appeared suitable for training use. Additional work remained, however, to fully exploit this system. The YP-TDS WAN project improved and extended the system by networking multiple YP-TDS equipped vessels. YP-TDS with this wide-area capability is thus a Network Centric system, not just a single-platform asset. Achieving this required the addition of custom designed system-to-system radio communication hardware and corresponding interface software, and a User's Manual.

Publications

Journal (Refereed) Manuscripts

BROWN, Christopher W., Assistant Professor, "QEPCAD B: A Program for Computing with Semi-algebraic Sets Using CADs," *ACM SIGSAM Bulletin*, Vol. 37, No. 4, December 2003, pp. 97-108.

This paper introduced QEPCAD B, a program for computing with real algebraic sets using cylindrical algebraic decomposition (CAD). QEPCAD B both extended and improved upon the QEPCAD system for quantifier elimination by partial cylindrical algebraic decomposition written by Hoon Hong in the early 1990s. This paper briefly discussed some of the improvements in the implementation of CAD and quantifier elimination via CAD, and provided somewhat more detail on extensions to the system that go beyond quantifier elimination. The author was responsible for most of the extended features of QEPCAD B, but improvements to the basic CAD implementation and to the SACLIB library on which QEPCAD are based on the results of many people's work, including: George E. Collins, Mark J. Encarnaci'n, Hoon Hong, Jeremy Johnson, Werner Krandick, Richard Liska, Scott McCallum, Nicolas Robidoux, and Stanley Steinberg. Source code, documentation and installation instructions for QEPCAD B are all available at www.cs.usna.edu/~qepcad.

BROWN, Christopher W., Assistant Professor, "An Overview of QEPCAD B: a Tool for Real Quantifier Elimination and Formula Simplification," *Journal of Japan Society for Symbolic and Algebraic Computation*, Vol. 10, No. 1, July 2003, pp. 13-22.

This paper described the basic functionality of QEPCAD B, a system for computing with semi-algebraic sets via Cylindrical Algebraic Decomposition (CAD). QEPCAD B is an interactive command-line based program, written in C, and built on top of the SACLIB library. It extended and improved the QEPCAD system. The article focuses on using QEPCAD B to solve problems, describing the basic facilities offered by the system, and providing examples of applications of these facilities.

Conference Proceedings

FONG, Edward H.L., (Trident Scholar, Class of 2002), CRABBE, Frederick L., Assistant Professor, Adams, W., and Schultz, A. C., "Representing a 3-D Environment with a 2 1/2-D Map Structure," *Proceedings of the International Conference on Intelligent Robotics and Systems (IROS)*, 2003, pp. 2986-2991.

This paper explored the development of a two and one-half dimensional (2 1/2-D) map structure to provide an autonomous mobile robot with a more three-dimensional (3-D) model of its environment than those afforded by current map structures. The 2 1/2-D map structure was created by modifying the widely used evidence grid to store a height, along with a probability value, in each cell location to record the varying elevations of a 3-D environment. Results showed that this map structure was capable of providing an autonomous mobile robot with a representation of a limited 3-D environment that enabled it to perform obstacle detection, path planning, and to an extent, localization.

HUDOCK, Bryan M. (Trident Scholar, Class of 2003), BISHOP, Bradford E., Associate Professor (Weapons and Systems Engineering Department), and CRABBE, Frederick L., Assistant Professor, "On the Development of a Novel Urban Search and Rescue Robot," *Proceedings of the 36th Southeastern Symposium on System Theory*, March 2004, pp. 451-455.

This paper discussed the development of a novel robotic platform for Urban Search and Rescue (USAR) efforts. The main facets of this work involved the design and construction of a new robot morphology and a physical simulation to be used for developing controllers for semi-autonomous (supervisory) operation.

CRABBE, Frederick L., Assistant Professor, "Unifying Undergraduate Artificial Intelligence Robotics: Layers Of Abstraction Over Two Channels," *Proceedings of the AAAI Spring Symposium on Hands on Robotics Education*, 2004, pp. 2-7.

From a Computer Science and Artificial Intelligence perspective, Robotics often appears as a collection of often disjoint, sometimes antagonistic sub-fields. The lack of a coherent and unified presentation of the field negatively impacts teaching, especially to undergraduates. This paper presented an alternative synthesis of the various sub-fields of Artificial Intelligence and robotics, and showed how these traditional sub-fields fit in to the whole. Finally, it presented a curriculum based on these ideas.

Darken, Rudolph, Sullivan, Joseph, Commander, USN, and LENNERTON, Mark J., Major, USMC, "A Chromakey Augmented Virtual Environment for Deployable Training," 2004.

In our attempts to construct virtual environments that simulate certain aspects of the real world, several significant technical shortfalls have limited our ability to elicit human behavior in the VE that approximates human behavior in the real world. The objective of this research was to construct a training system suitable for deployed use that was low cost, had a small foot print, and could be shown to have quantitative value as a training device. This paper described a mixed reality appended trainer solution that used a Chromakey technique to mix the real environment inside the cockpit with the simulated environment outside the cockpit. This apparatus allowed the near-field environment, including cockpit displays, maps, and controls, to "pass through" while the view out the window was replaced with a virtual simulation. It described the initial experiment that determined if helicopter pilots could effectively navigate using this system and if their performance was reasonably similar to their performance in an actual helicopter. Results indicate that performance in the trainer did approximate actual performance within real world threshold values and that techniques for overland navigation used in actual flight also applied directly to navigation using the trainer.

DeLOOZE, Lori L., Lieutenant Commander, USN, McKean, Paul, Mostow, John R., and Graig, Christopher, "Simulation for Training Computer Network Operations," *Proceedings of the 8th Colloquium for Information Systems Security Education*, 2004, pp. 329-334.

Attacks on Department of Defense computer systems are a serious and growing threat. The cornerstone to the protection of these highly valuable networks is education and training. The U. S. Strategic Command is examining a new tool to train and exercise computer security to determine if the complex concepts relating to computer security can be more effectively taught by including simulations in the classroom. The simulation environment under investigation consists of both an Internet Attack Simulator and a Network Simulator. The Internet Attack Simulator has a menu of attacks that can be launched against the Network Simulator's virtual network. The system is essentially an interactive virtual cyber world which requires the student defender to implement security measures and respond to attacks. Novice computer science students and information technology professionals benefit from the visualization of cyber behavior afforded in the risk free environment that simulation provides. The simulation reinforced the lecture in both concurrent demonstrations of the principles being taught, and later, in individual practical exercises.

DeLOOZE, Lori L., Lieutenant Commander, USN, "Classification of Computer Attacks Using a Self-organizing Map," *Proceedings of the 8th Colloquium for Information Systems Security Education*, 2004, p. 365-369.

As computer technology evolves and the threat of computer crimes increases, the apprehension and preemption of such violations become more and more difficult and challenging. To date, it appears that completely preventing breaches of security is unrealistic. Therefore, we must try to detect and classify these intrusions as they occur so that immediate actions may be taken to repair the damage and prevent further harm. One attempt at classifying these intrusions is MITRE's Common Vulnerabilities and Exposures (CVE) list that provides a common name for all publicly known security weaknesses. The CVE dictionary, however, is not a taxonomy. The CVE list is organized in simple numerical order by date of acceptance. Each entry in the dictionary includes a unique CVE identification number, a text description of the vulnerability and any pertinent references.

Creating a Self-Organizing Map (SOM) using the text description allowed us to order attack profiles with common features in the same general area of the output space. Attacks in the general neighborhood of one another

should be able to be mitigated by similar means. Plotting attacks on a SOM also enabled us to visually examine the placement of an attack relative to the four common classes of attacks (Denial of Service, Deception, Reconnaissance, and Unauthorized Access). Many attacks have features in common with more than one of these classes rather than corresponding directly to a single class. This research developed an effective technique to classify new attacks using a unique taxonomy, which broke down threats into the four general categories, and the SOM created by the baseline CVE descriptions.

McMAHON, Margaret M., Assistant Professor, NEEDHAM, Donald M., Associate Professor, and DATKO, Joshua B., (Trident Scholar, Class of 2002), "Performance of a Jini-Based Ad Hoc Network Authentication Scheme," *Proceeding of the 16th International Conference on Parallel and Distributed Computing Systems*, 2003, pp. 442-447.

Ad hoc networks provide a dynamically reconfigurable network infrastructure where entities can participate at will. Jini technology can be used to implement an ad hoc network, and to permit a user to enter the network and become a client of services without *apriori* knowledge of either the existence of the network or its services. However, Jini lacks security provisions for authenticating users of the network. Traditional Public Key Infrastructure (PKI) approaches to authentication in an ad hoc network are static and cumbersome. An alternative approach that employs PKI in a dynamic manner, consistent with the rapidly changing nature of ad hoc networks, can provide the basis for such ad hoc authentication.

This paper presented an implementation of an algorithm that provides a foundation for secure, ad hoc joining of a distributed, mobile, wireless network. The approach was based on incorporating the use of a dynamic PKI approach with the Jini architecture. It described the Java-based implementation of a certification authority hierarchy that supported our authentication process, and analyzed the performance of our implementation. We also examined the influence of the Remote Method Invocation Daemon (RMID) in the performance of our implementation.

NEEDHAM, Donald M., Associate Professor, McMAHON, Margaret M., Assistant Professor, and DATKO, Joshua B., (Trident Scholar, Class of 2002), "Ad Hoc Network Authentication: A Jini-based Approach," *Proceedings of the International Conference on Wireless Networks (ICWN'03)*, 2003, pp. 549-553.

Ad hoc networks implemented with Jini technology permit users to enter a network, and become clients of services, without *apriori* knowledge of the network or its services. Although traditional Public Key Infrastructure (PKI) approaches to authentication are generally static, we employed PKI in a manner consistent with the dynamic nature of ad hoc networks. This paper presented an algorithm that provided a foundation for secure, ad hoc joins in a distributed, mobile, wireless network. Our approach incorporated the use of a dynamic PKI approach within a Jin-based architecture. We discussed a Java-based implementation of a certification authority hierarchy that supported our authentication process.

NEEDHAM, Donald M, Associate Professor, SIMPSON, M., ENS, USN and WHITTEN, B., ENS, USN, "Putting Interdisciplinary Software Engineering into Practice, A Java-based Embedded System Controller," *Proceedings of the International Conference on Software Engineering Research and Practice (SERP'03),* Volume II, 2003, pp. 707-713.

Embedded applications provide unique exposure to software development by allowing software engineers to incorporate analysis and design techniques with their knowledge of operating systems, hardware interaction and programming level concurrency constructs. This paper presented the design and development of a multi-threaded Java-based control system. We analyzed the impact of team software development, examined design decisions made from the perspective of software reuse, evaluated the effectiveness of Java for programming embedded systems, and considered the effect of course sequencing on team development projects.

WILCOX, Jeffrey P., Midshipman 1/C (USN), and STAHL, David J., Jr., Assistant Professor, "YP-TDS: A Tactical Data Simulator for a Naval Academy Yard Patrol Craft," *Proceedings of the 37th Midwest Instruction and Computing Symposium (MICS).* (Electronic publication and recipient of the "best undergraduate student paper" award).

The term *Network Centric Warfare* (NCW) describes the operational environment of the U.S. military in the 21st century: linking dispersed battlespace entities to achieve combat effectiveness through information superiority.

The evolutionary transformation bringing NCW theory to practice within the U.S. Navy is called *ForceNet*: the "architectural framework for naval warfare in the information age that integrates warriors, sensors, networks, command and control, platforms, and weapons into a networked, distributed combat force."[1]

The U.S. Naval Academy (USNA) conducts hands-on midshipmen training in basic navigation, seamanship, and ship handling aboard a fleet of 172 ton, 10 ft draft, Yard Patrol Craft (YP). Notably absent, however, is the use of these vessels to expose students to afloat operations in the context of a tactical battle situation. While recognizing that YPs were not designed for this purpose, and that the best quality training is accomplished aboard commissioned warships at sea, significant training value is possible if the YP is configured to *simulate* a tactical environment. The YP Tactical Data Simulator (YP-TDS) is an inexpensive, commercial-off-the-shelf hardware and software system for simulating sensors, platforms and weapons in real-time. The system integrates real students and real shipboard sensors with simulated weapons, sensors and ships by means of a multi-terminal command-and-control tactical display with appearance and functionality similar to that of existing warship systems – but intended for use aboard non-commissioned, non-warship vessels in an educational environment. Viewed as a *ForceNet* component, YP-TDS represents an initial effort at embodying the concept of NCW in afloat training at the Naval Academy.

YP-TDS provides a TCP/IP local-area network linking multiple PC hosts in a client-server arrangement, with each host displaying an on-screen chart of local waterways. Own-ship position obtained via GPS and a simulated contact position generated by YP-TDS software are overlayed on the nautical chart. Simulated contacts can be detected with simulated sensors, contacts can be classified (neutral, friendly, etc.), contact information such as course, speed and range can be displayed, and simulated weapons can be launched. As the real/simulated tactical picture changes, displays are updated in real time. YP-TDS terminals located in various parts of the ship can be assigned different functions. One terminal may be configured to display a side elevation view of the YP craft for use as a damage control status board. This display can be updated with the status of major ship systems and spaces, either automatically by the system software according to a scripted scenario, or manually by a casualty drill coordinator monitoring and controlling the execution of a training exercise. The display may be marked, for example, to indicate the presence of smoke, fire and water in a space.

YP-TDS software was designed and implemented in its entirety by a midshipman. It was developed in C/C++ using Microsoft Visual C++, WinSock2 networking, the Allegro graphics API, POSIX pthreads multithreading, and the NMEA1083 serial GPS protocol. As a senior capstone research project, it drew upon knowledge learned from across the entire CS curriculum, including courses in programming, data structures, networks, operating systems and graphics.

[1]*ForceNet: Turning Information into Power*, VADM Richard W. Mayo, USN, and VADM John Nathman, USN, U.S. Naval Institute Proceedings, February 2003.

Book Chapter

NEEDHAM, Donald M., Associate Professor, Caballero, R., Demurjian, S., Eickhoff, F., Mehta J., and Zhang, Y., "A Reuse Definition, Assessment, and Analysis Framework for UML," a chapter in Advances in UML/XML Based Software Evolution, H. Yang (ed.) IRM Press, accepted for publication.

Software engineers seeking to improve design reusability stand to benefit from tools that precisely measure the potential and actual reuse of software artifacts to achieve domain-specific reuse for an organization's current and future products. In this book chapter, we examined a formal framework for reusability assessment of development-time components and classes via metrics, refactoring guidelines, and algorithms. We considered the reuse definition, assessment, and analysis of a UML design, prior to the existence of code. We included dependency tracking in use case and class diagrams in support of reusability analysis and refactoring for UML. We discussed the integration of these extensions into the UML tool Together Control Center to support reusability measurement from design to development.

Presentations at Professional Meetings and Conferences

BROWN, Christopher W., Assistant Professor, a software demonstration of: "QEPCAD B: Computing with Semi-Algebraic Sets," International Symposium on Symbolic and Algebraic Computation, Philadelphia, PA, August 2003, (winner of the best software award).

CRABBE, Frederick L., Assistant Professor, "Representing a 3-D Environment with a 2 1/2-D Map Structure," International Conference on Intelligent Robotics and Systems (IROS), Las Vegas, NV, 2003.

CRABBE, Frederick L., Assistant Professor, "Unifying Undergraduate Artificial Intelligence Robotics: Layers Of Abstraction Over Two Channels," AAAI Spring Symposium on Hands on Robotics Education, Stanford University, Palo Alto, CA, 2004.

KORNBLUM, Jesse, Captain, USAF, "Hacker Court," Blackhat Conference, Las Vegas, NV, July 2003 and Tysons Corner, VA, October 2003.

LENNERTON, Mark J., Major, USMC, "Exploring a Chromakeyed Augmented Virtual Environment for Viability as an Embedded Training System for Military Helicopters," HMT-166 Meeting, Camp Pendleton, CA, March 2004.

McMAHON, Margaret M., Assistant Professor, "Implementing a Jini-based Ad Hoc Network Authentication Scheme," 16th International Conference on Parallel and Distributed Computing Systems, Reno, NV, August 2003.

NEEDHAM, Donald M., Associate Professor, "Applying Software Engineering Techniques to the Assessment Process," Best Assessment Processes VI Symposium, Terra-Haute, IN, March 2004.

NEEDHAM, Donald M., Associate Professor, "Ad Hoc Network Authentication: A Jini-based Approach," International Conference on Wireless Networks (ICWN'03), Las Vegas, NV, June 2003.

NEEDHAM, Donald M., Associate Professor, "Putting Interdisciplinary Software Engineering into Practice: A Java-based Embedded System Controller," International Conference on Software Engineering Research and Practice (SERP'03), Las Vegas, NV, June 2003.

SCHULZE, K. G., Professor, WINTERSGILL, Mary C., Professor, (Physics Department), SHELBY, Robert N., Professor Emeritus (Physics Department), and TREACY, Donald J., Professor (Physics Department), "Does It Matter How Students Solve Physics Problems?," 127th American Associate of Physics Teachers, Madison, WI, August 2003.