Computer Science Department

Professor Patrick R. Harrison
Chair

During the 1999-2000 academic year, the Computer Science Department faculty continued to develop programs of research in several important areas including computer algebra, software engineering, enterprise computing, intelligent tutoring and Unix security. These research programs involved midshipmen who participated both during the academic year and while on summer internships. Currently, all civilian faculty have external funding through DOD or commercial funding sources. Overall, there were seven publications and nine presentations.

Sponsored Research

Intelligent Decision Aids in the Enterprise

RESEARCHER: Professor Patrick R. Harrison
SPONSOR: Office of Naval Research (ONR)

This research program is focused on intelligent components in n-tiered systems using COM+ and MTS. The goal is to develop, design and implement intelligent components that support the need for better security, query generation, data focus and transformation, knowledge reorganization, data reduction and data quality. The overarching goal is fast delivery interactive systems with fast customer response time.

During the current period, several distributed applet-based systems were designed and implemented using MTS and DCOM. This research program was completed September 1999.

Object-Oriented Support for Distributed Access to Unified Geospatial Data

RESEARCHER: Assistant Professor Donald M. Needham
SPONSOR: Naval Research Laboratory-Stennis Space Center

Digital geodesic mapping information contained in the Stennis Space Center's Charting and Geodesy Analysis Program's Geospatial Information Database (GIDB) requires frequent feature-level updating and manipulation, activities that object-oriented technology has revolutionized. This work focused on integrating multiple data types (rastor, vector, and text) into the GIDB to create a unified framework for accessing the National Imagery and Mapping Agency's (NIMA) geospatial data. Another focus was the evolution of the GIDB to a distributed database architecture to better support users in downloading NIMA data via the Internet. The Common Object Request Broker Architecture standard and the Java programming language was used to facilitate the evolution of the GIDB.

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 it 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 Physics. One of the main objectives of the Andes project is to help students at the U.S. Naval Academy understand the concepts underlying static forces, translational and rotational kinematics, translational dynamics, energy and work, and linear and angular momentum.

Independent Research

Business to Customer E-commerce System

RESEARCHER: Professor Patrick R. Harrison

Distributed applications make use of the processing power of multiple processors over a network. In a 3-tiered system, there are 3 layers of processing. The top tier, the Presentation layer, consists of the visual interface the client interacts with. The middle tier, the Business Services, processes data received from the Presentation layer and database. The bottom tier, or Data Services, accesses, stores, and updates data from the database. The three layers interact with each other to create a complete application. It is important to realize, however, that this creates a security problem-how does a tier know a validated user or tier is calling it? The need for security is paramount in distributed applications, as is the need for scalability and reliability. These issues were addressed in the application developed.

The application developed in this study was called *BuyTheBay*. The application was a 3-tiered e-commerce business-to-consumer solution. The application allowed the client to post items for sale through a web interface. The client was also able to search through a database and make purchases of items for sale by other clients. Payment was online. The application maintained database integrity, provided user validation, and ensured application security. The application was a 3-tiered system modeled on Microsoft's Distributed Network Architecture (DNA). The database was run on Microsoft SQL Server 7.0. The Data Services and Business Services were ActiveX components running in the Microsoft Transaction Server (MTS) and written in Visual Basic. The Presentation Layer consisted of a series of Active Server Pages (ASP). The Web server used was Microsoft's Internet Information Server (IIS). The client accessed the systems using Microsoft Internet Explorer 5.0. The turnaround time for web calls was under 5 seconds. Security was maintained through user validation and application validation.

Mobile Ad-hoc Network (MANET) Protocol Performance Study

RESEARCHERS: Assistant Professor Margaret M. McMahon and Midshipman 1/C Barbara Lubkin, USN

The Mobile Ad-hoc Network (MANET) Working Group is an effort within the Internet Engineering Task Force (IETF) to investigate and develop candidate standard Internet routing support for mobile, wireless IP autonomous segments. This independent research was a continuation of the work begun during a summer internship at NRL. Successful deployment of MANET technology could greatly improve the interoperability and performance of future Navy or Marine Corps tactical and afloat networks, sensor networks and robotic systems. Solutions for mobile routing are undergoing both continuing academic research and early prototype experimentation. A major problem for future Navy and Marine Corps networks is that standard Internet-based protocol infrastructures are not designed to work well under mobile or stressed wireless conditions. These are conditions typical in the battlespace. MANET wireless routing solutions offer a mobile solution and significant technical advancement over existing, largely "static infrastructure" computer networking technology while retaining Internet-based protocol interoperability.

This research further investigated experimental and developing MANET protocols. Scientific performance investigations were made using network protocol discrete event simulation software. This involved basic software development (e.g., C, C++, perl, Tcl/tk) as well as experimentation planning and data collection. The primary objectives of this project were as follows:

1. Learn the nx2 network simulation environment and other mobile networking research tools.
2. Do a comparative study of evolving MANET protocols and features.
3. Develop, test and experiment with related software as necessary.
4. Produce a conference-type paper of the project results.

Status: The experiments have been run, and the final draft paper is in development.

Publications

BROWN, Christopher W., Assistant Professor, "Improved Projection for CAD's of R^3," Proceedings of the 2000 International Symposium on Symbolic and Algebraic Computation, pp. 48-53, (2000).

This paper presents an improved projection operator for the construction of CAD's of R^3. It is shown that, typically, it suffices to include in projection only leading coefficients (along with discriminants and resultants) rather than all coefficients. Cases in which the leading coefficient alone does not suffice can be dealt with, in a sense, even more efficiently. Generalizing the improved projection operator to dimension greater than three is a topic of ongoing research.

McMAHON, Margaret M., Assistant Professor, and H. A. Sholl, "Influence of State Size on User Models in a Network Security System", International Conference on Parallel and Distributed Computing Systems, August 8-10, 2000, Las Vegas, Nevada, pp. 495-500.

Networks are increasingly important for communicating and commerce in everyday life. Passwords can be captured at many points in network routing, allowing a masquerading intruder all the privileges enjoyed by the account owner. Even if misuse is detected, it is typically after damage has occurred. Intruders should be uncovered while attempting to gain access.

Differences between a user's current input and stored models may indicate an intruder's presence. We focus on refining the state models used in dynamic user authentication. We investigate the influence of state machine size in recognizing the presence of individuals logged into a computer system by their order of invoking UNIX commands and the timing between invocations. The decision is based on the conditional probability of the user given a string of commands and the timing between those commands. In our experiments, user models' state space was defined to include 25, 50, 75 and 100 percent of all states encountered in the training set. Results show that using a percentage of the states present in the training set, rather than selecting one value for all user models, may yield better recognition.

NEEDHAM, Donald M., Assistant Professor (co-author), "An IDL to Ada95 Mapping to Support Propagation Modeling", Proceedings of the 13th Annual ASEET symposium, (Colorado Springs, Colorado, July 26-29, 1999, pp. P-II-1-P-II-8.

Representing dynamic interdependencies between design objects is an essential part of modeling the critical software communications found in complex software systems.

This paper investigates the modeling of propagations (our term for dynamic interdependencies), which are captured using design-level triggers for specifying dynamic behavior across object types. We focus on the CORBA-compliant utilization of our propagation model to support distributed, propagation-focused applications. We develop a propagation-specific interface in IDL, and examine Ada 95 source code that meets the requirements specified by the IDL design. An example of the CORBA-compliant propagations involved in the maintenance of topological invariance in the industrial domain is examined.

NEEDHAM, Donald M., Assistant Professor (co-author), "Towards a Distributed Object-Oriented Propagation Model Using Ada95", Proceedings of SIGAda99, Redondo Beach, CA, Oct 17-21, 1999, pp. 203-210.

Representing interdependencies between the objects of an object-oriented software application requires design-time mechanisms for specifying object interrelationships, as well as software constructs for the runtime maintenance of these relationships. In this paper, we present a portion of our software engineering research environment ADAM, (short for Active Design and Analyzes Modeling), which incorporates a technique for the design-time modeling of propagations (our term for the relationships between interdependent objects). We examine the ADAM environment's support for the automated generation of Ada95 software constructs that maintain object interdependency at runtime. We focus on our propagation model's use of Ada95 tasking constructs and protected objects, with an emphasis on the source level mechanisms through which our model utilizes concurrence. We present constructs required for an Ada95 distributed propagation model that supports communication through CORBA.

SCHULZE, Kay G., Professor (co-author), "Automating CIC Communications for Reduced Manning," 1999 NRL Review, June 1999, pp 120-122.

> Verbal communications are used to coordinate team decision making in the Combat Information Center (CIC) on Navy ships. In times of stress, many people talking at once can overload the communication net. This research is an effort to identify the types of communication tasks that are best suited for automation. Originally intended to reduce communication load in larger teams, results are timely for reduced manning efforts. With smaller CIC teams, many functions currently performed by humans will have to be automated.

SCHULZE, Kay G., Professor (co-author) "Andes: A Coached Learning Environment for Classical Newtonian Physics," Selected Papers from the 11th International Conference on College Teaching and Learning (Ed.) J.A. Chambers, FCCJ, Jacksonville, Florida, April, 2000, pp. 151-162.

Presentations

BROWN, Christopher W., Assistant Professor, "Convex Hulls of Semi-Algebraic Subsets of the Plane," East Coast Computer Algebra Day, London, Canada, May 13, 2000.

BROWN, Christopher W., Assistant Professor, "Improved Projection for CAD's of R^3," The 2000 International Symposium on Symbolic and Algebraic Computation, Saint Andrews, Scotland, August 7, 2000.

HARRISON, Patrick R., Professor, "From Computing to Computer Science," Maryland State High School Programming Contest, March 11, 2000.

McMAHON, Margaret M., Assistant Professor, "Influence of State Size on User Models in a Network Security System," 13th International Conference on Parallel and Distributed Computing Systems, August 8-10, 2000, Las Vegas, Nevada USA.

NEEDHAM, Donald M., Assistant Professor, "Towards a Distributed Object-Oriented Propagation Model Using Ada95," SIGAda99, Redondo Beach, CA, October 18, 1999.

NEEDHAM, Donald M., Assistant Professor, "Design of a CORBA-Compliant Digital Mapping Database," Naval Research Laboratory, Stennis Space Center, MS, August 13, 1999.

NEEDHAM, Donald M., Assistant Professor, "An IDL to Ada95 Mapping to Support Propagation Modeling," Colorado Springs, CO, July 28, 1999.

SCHULZE, Kay G., Professor, "ANDES: A Tutoring System for Classical Physics," American Association of Physics Teachers, San Antonio, Texas, August 11,1999.

SCHULZE, Kay G., Professor, "ANDES: A Coached Learning Environment for Classical Newtonian Physics," 11th International Conference on College Teaching and Learning, Jacksonville, Florida, April 13, 2000.

SCHULZE, Kay G., Professor, "ANDES: An Intelligent Tutor for Classical Physics," Symposium on New Information Technologies and Liberal Education, Greenville, South Carolina, May 5, 2000.