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NRL/MR/5510--93-7350

Information Technology Division Technical Paper Abstracts

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June 11, 1993



93-14716



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REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.

1. AGENCY USE ONLY (<i>Leave Blank</i>)	2. REPORT DATE June 11, 1993	3. REPORT TYPE AND DATES COVERED	
4. TITLE AND SUBTITLE Information Technology Division Technical Paper Abstracts		5. FUNDING NUMBERS PE - 62234N TA - RS34-C74-000	
6. AUTHOR(S) Cathy J. Wiley*		8. PERFORMING ORGANIZATION REPORT NUMBER NRL/MR/5510-93-7350	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Research Laboratory Washington, DC 20375-5320			
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) JAYCOR Office of Naval Research 1608 Spring Hill Road 800 North Quincy Street Vienna, VA 22180-2270 Arlington, VA 22217		10. SPONSORING/MONITORING AGENCY REPORT NUMBER	
11. SUPPLEMENTARY NOTES *JAYCOR, 1608 Spring Hill Road, Vienna, VA 22180-2270			
12a. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution unlimited.		12b. DISTRIBUTION CODE	
13. ABSTRACT (<i>Maximum 200 words</i>) "Information Technology Division Technical Paper Abstracts 1992" documents the accomplishments of projects at the six branches of the Information Technology Division. The six branches are: Navy Center for Applied Research in Artificial Intelligence (NCARAI) including: machine learning, intelligent decision aids, natural language, sensor-based systems, and neural networks; Communication Systems; Human-Computer Interaction; Center for Computer High Assurance Systems; Transmission Technology; and Advanced Information Technology. Points of contact are indicated for acquiring additional technical information about the projects, and an order form is provided for obtaining copies of the publications abstracted.			
14. SUBJECT TERMS		15. NUMBER OF PAGES 77	
17. SECURITY CLASSIFICATION OF REPORT UNCLASSIFIED		16. PRICE CODE	
		20. LIMITATION OF ABSTRACT UL	
18. SECURITY CLASSIFICATION OF THIS PAGE UNCLASSIFIED	19. SECURITY CLASSIFICATION OF ABSTRACT UNCLASSIFIED	20. LIMITATION OF ABSTRACT UL	

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INFORMATION TECHNOLOGY DIVISION TECHNICAL PAPER ABSTRACTS

I. Introduction

The Naval Research Laboratory (NRL) is the corporate laboratory for the United States Navy. NRL employs more than 3700 civilians to conduct research and development programs in a wide range of technical disciplines. More than 750 of these employees hold doctorates, and staff members participate extensively in national and international technical groups. In reporting on its research the laboratory annually publishes over 1000 journal articles, technical papers and reports.

The Information Technology Division (ITD) is one of the largest Divisions at NRL. The technical areas of expertise in ITD include:

Artificial Intelligence

- adaptive control software
- machine learning methods
- robotic vision and control
- natural language systems
- intelligent training systems
- reasoning under uncertainty

Software

- computer security (COMPUSEC)
- network security
- software assurance
- software specification methodology
- hard real time (HRT) computing
- adaptive software testing methods
- information security (INFOSEC)

Communications

- network simulation
- HF communications
- communication security (COMSEC)
- communications networking

Human-Computer Interaction

- metrics and evaluation
- speech communication systems
- human-computer dialog
- visualization techniques

Decision Support Systems

- prototyping techniques
- distributed decision support
- distributed simulation
- parallel processing techniques

ITD has more than 220 civilian employees organized into six branches: the Navy Center for Applied Research in Artificial Intelligence, Communication Systems, Human-Computer Interaction Laboratory, Center for Computer High Assurance Systems, Transmission Technology, and Advanced Information Technology.

II. Navy Center for Applied Research in Artificial Intelligence Code 5510

The Navy Center for Applied Research in Artificial Intelligence (NCARAI) is part of the Information Technology Division within the Naval Research Laboratory (NRL). NCARAI is engaged in research and development efforts designed to address the application of artificial intelligence (AI) technology and techniques to critical Navy and national problems. The emphasis at NCARAI is the linkage of theory and application in demonstration projects that use a full spectrum of AI methods.

The technical papers and reports of NCARAI document the accomplishments of projects in machine learning, natural language understanding, intelligent decision aids, and intelligent systems for robotic sensing and control. Innovative basic and exploratory research in these areas is made possible by NCARAI's staff of 35 individuals comprising an extraordinary cross section of AI talent from the government civilian and military sectors, visiting scientists from universities, and consulting scientists from industry. An ongoing seminar series, featuring notable scientists from academic and industrial research communities, as well as the military services, provides an excellent opportunity to exchange information and maintain awareness of current developments.

Persons interested in acquiring additional information about the reported results are encouraged to contact the relevant technical personnel for whom e-mail addresses have been provided.

MACHINE LEARNING

Title: Using Genetic Algorithms for Concept Learning

Author(s): K. A. De Jong, W. M. Spears, and D.F. Gordon

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gordon @aic.nrl.navy.mil

Citation: to appear in Machine Learning Journal

Date: 1993

AIC Report No.: AIC-92-001

Abstract

In this paper, we explore the use of genetic algorithms (GAs) as a key element in the design and implementation of robust concept learning systems. We describe and evaluate a GA-based system called GABIL that continually learns and refines concept classification rules from its interaction with the environment. The use of GAs is motivated by recent studies showing the effects of various forms of bias built into different concept learning systems, resulting in systems that perform well on certain concept classes (generally, those well matched to the biases) and poorly on others. By incorporating a GA as the underlying adaptive search mechanism, we are able to construct a concept learning system that has a simple, unified architecture with several important features. First, the system is surprisingly robust even with minimal bias. Second, the system can be easily extended to incorporate traditional forms of bias found in other concept learning systems. Finally, the architecture of the system encourages explicit representation of such biases and, as a result, provides for an important additional feature: the ability to *dynamically* adjust system bias. The viability of this approach is illustrated by comparing the performance of GABIL with that of four other more traditional concept learners (AQ14, C4.5, ID5R, and IACL) on a variety of target concepts. We conclude with some observations about the merits of this approach and about possible extensions.

Title: The Evolution of Strategies for Multi-Agent Environments

Author(s): J.J. Grefenstette

E-mail Address: gref@aic.nrl.navy.mil

Citation: Adaptive Behavior, v1, n1, 65-89

Date: Summer 1992

AIC Report No.: AIC-92-002

Abstract

SAMUEL is an experimental learning system that uses genetic algorithms and other learning methods to evolve reactive decision rules from simulations of multi-agent environments. The basic approach is to explore a range of behavior within a simulation model, using feedback to adapt its decision strategies over time. One of the main themes in this research is that the learning system should be able to take advantage of existing knowledge where available. This has led to the adoption of rule representations that ease the expression of existing knowledge. A second theme is that adaptation can be driven by competition among knowledge structures. Competition is applied at two levels in SAMUEL. Within a strategy composed of decision rules, rules compete with one another to influence the behavior of the system. At a higher level granularity, entire strategies compete with one another, driven by a genetic algorithm. This article focuses on recent elaborations of the agent model of SAMUEL that are specifically designed to respond to multiple external agents. Experimental results are presented that illustrate the behavior of SAMUEL on two multi-agent predator-prey tasks.

Title: An Approach to Anytime Learning
Author(s): J.J. Grefenstette and C.L. Ramsey
E-mail Address: gref@aic.nrl.navy.mil, ramsey@aic.nrl.navy.mil
Citation: Proceedings of the Ninth International Machine Learning Workshop,
Aberdeen, Scotland, Morgan Kaufmann, 189-195
Date: July 1992
AIC Report No.: AIC-92-003

Abstract

Anytime learning is a general approach to continuous learning in a changing environment. The agent's learning module continuously tests new strategies against a simulation model of the task environment, and dynamically updates the knowledge base used by the agent on the basis of the results. The execution module controls the agent's interaction with the environment, and includes a monitor that can dynamically modify the simulation model based on its observations of the environment. When the simulation model is modified, the learning process is restarted on the modified model. The learning system is assumed to operate indefinitely, and the execution system uses the results of learning as they become available. An experimental study tests one of the key aspects of this design using a two-agent cat-and-mouse game as the task environment.

Title: Adaptive Testing of Controllers for Autonomous Vehicles
Author(s): A.C. Schultz, J.J. Grefenstette, and K. A. De Jong
E-mail Address: schultz@aic.nrl.navy.mil, gref@aic.nrl.navy.mil,
dejong@aic.nrl.navy.mil
Citation: Proceedings of the Symposium on Autonomous Underwater Vehicles
Technology, Washington DC, 158-164, IEEE
Date: June 2-3, 1992
AIC Report No.: AIC-92-004

Abstract

Autonomous vehicles are likely to require sophisticated software controllers to maintain vehicle performance in the presence of vehicle faults. The test and evaluation of complex software controllers is expected to be a challenging task. The goal of this effort is to apply machine learning techniques from the field of artificial intelligence to the general problem evaluating an intelligent controller for an autonomous vehicle. The approach involves subjecting a controller to an adaptively chosen set of fault scenarios within a vehicle simulator, and searching for combinations of faults that produce noteworthy performance by the vehicle controller. The search employs a genetic algorithm. We illustrate the approach by evaluating the performance of a subsumption-based controller for an autonomous vehicle. The preliminary evidence suggests that this approach is an effective alternative to manual testing sophisticated software controllers.

Title: A Formal Analysis of the Role of Multi-Point Crossover in Genetic Algorithms
Author(s): Kenneth A. De Jong and William M. Spears
E-mail Address: dejong@aic.nrl.navy.mil, spears@aic.nrl.navy.mil
Citation: Annals of Mathematics and Artificial Intelligence 5 (1), 1-26, J.C. Baltzer
AG Scientific Publishing Company
Date: 1992
AIC Report No.: AIC-92-005

Abstract

On the basis of early theoretical and empirical studies, genetic algorithms have typically used 1 and 2-point crossover operators as the standard mechanisms for

implementing recombination. However, there have been a number of recent studies, primarily empirical in nature, which have shown the benefits of crossover operators involving a higher number of crossover points. From a traditional theoretical point of view, the most surprising of these new results relate to uniform crossover, which involves on the average $L/2$ crossover points for strings of length L . In this paper we extend the existing theoretical results in an attempt to provide a broader explanatory and predictive theory of the role of multi-point crossover in genetic algorithms. In particular, we extend the traditional disruption analysis to include two general forms of multi-point crossover: *n-point* crossover and uniform crossover. We also analyze two other aspects of multi-point crossover operators, namely, their recombination potential and exploratory power. The results of this analysis provide a much clearer view of the role of multi-point crossover in genetic algorithms. The implications of these results on implementation issues and performance are discussed, and several directions for further research are suggested.

Title: The Role of Program Structure in Software Maintenance

Author(s): Deborah A. Boehm-Davis, Robert W. Holt, and Alan C. Schultz

E-mail Address: schultz@aic.nrl.navy.mil

Citation: International Journal of Man-Machine Studies, (36), 21-63

Date: 1992

AIC Report No.: AIC-92-006

Abstract

A number of claims have been made by the developers of program design methodologies, including the claim that the code produced by following the methodologies will be more understandable and more easily maintained than code produced in other ways. However, there has been little empirical research to test these claims. In this study, student and professional programmers were asked to make either simple or complex modifications to programs that had been generated using each of three different program structures. Data on the programmers' modification performance, cognitive representations formed of the programs and subjective reactions to the programs suggested that problem structure (as created by the different methodologies), problem content, complexity of modification, and programmer experience all play a crucial role in determining performance and the representation formed.

Title: Crossover or Mutation?

Author(s): William M. Spears

E-mail Address: spears@aic.nrl.navy.mil

Citation: Foundations of Genetic Algorithms 2, D. Whitley (editor), Morgan Kaufmann

Date: July 1992

AIC Report No.: AIC-92-007

Abstract

Genetic algorithms rely on two genetic operators - crossover and mutation. Although there exists a large body of conventional wisdom concerning the roles of crossover and mutation, these roles have not been captured in a theoretical fashion. For example, it has never been theoretically shown that mutation is in some sense "less powerful" than crossover or vice versa. This paper provides some answers to these questions by theoretically demonstrating that there are some important characteristics of each operator that can not be captured by the other.

Title: Is Consistency Harmful?

Author(s): William M. Spears and Diana F. Gordon

E-mail Address: spears@aic.nrl.navy.mil, gordon@aic.nrl.navy.mil

Citation: Proceedings of the Biases in Inductive Learning Workshop for the Machine Learning Conference, Aberdeen Scotland.

Date: July 1992

AIC Report No.: AIC-92-008

Abstract

One of the major goals of most early concept learners was to find hypotheses that were perfectly consistent with the training data. It was believed that this goal would indirectly achieve a high degree of predictive accuracy on a set of test data. Later research has partially disproved this belief. However, the issue of consistency has not yet been resolved completely.

We examine the issue of consistency from a new perspective. To avoid overfitting the training data, a considerable number of current systems have sacrificed the goal of learning hypotheses that are perfectly consistent with the training instances by setting a new goal of hypothesis simplicity (Occam's razor). Instead of using simplicity as a goal, we have developed a novel approach that addresses consistency directly. In other words, our concept learner has the explicit goal of selecting the most appropriate degree of consistency with the training data.

We begin this paper by exploring concept learning with less than perfect consistency. Next, we describe a system that can adapt its degree of consistency in response to feedback about predictive accuracy on test data. Finally, we present the results of initial experiments that begin to address the question of how tightly hypotheses should fit the training data for different problems.

Title: Using a Genetic Algorithm to Learn Behaviors for Autonomous Vehicles

Author(s): Alan C. Schultz and John J. Grefenstette

E-mail Address: schultz@aic.nrl.navy.mil, gref@aic.nrl.navy.mil

Citation: Proceedings of the American Institute of Aeronautics and Astronautics Guidance, Navigation and Control Conference (AIAA), 739-749

Date: August 10-12, 1992

AIC Report No.: AIC-92-009

Abstract

Truly autonomous vehicles will require both projective planning and reactive components in order to perform robustly. Projective components are needed for long-term planning and replanning where explicit reasoning about future states is required. Reactive components allow the system to always have some action available in real-time, and themselves can exhibit robust behavior, but lack the ability to explicitly reason about future state over a long time period. This work addresses the problem of creating reactive components for autonomous vehicles. Creating reactive behaviors (stimulus-response rules) is generally difficult, requiring the acquisition of much knowledge from domain experts, a problem referred to as the knowledge acquisition bottleneck. SAMUEL is a system that learns these behaviors under simulation, automating the process of creating stimulus-response rules and therefore reducing the bottleneck. The learning algorithm was designed to learn useful behaviors from simulations of limited fidelity. Current work is investigating how well behaviors learned under simulation environments work in real world environments. In this paper, we describe SAMUEL, and describe behaviors that have been learned for simulated autonomous aircraft, autonomous underwater vehicles, and robots. These behaviors include dog fighting, missile evasion, tracking, navigation, and obstacle avoidance.

Title: Learning Decision Strategies with Genetic Algorithms
Author(s): John J. Grefenstette
E-mail Address: gref@aic.nrl.navy.mil
Citation: Analogical and Inductive Inference, K.P. Jantke (editor), v 642,
Springer-Verlag, 35-50
Date: 4-9, October 1992
AIC Report No.: AIC-92-010

Abstract

Machine learning offers the possibility of designing intelligent systems that refine and improve their initial knowledge through their own experience. This article focuses on the problem of learning sequential decision rules for multi-agent environments. We describe the SAMUEL learning system that uses genetic algorithms and other competition based techniques to learn decision strategies for autonomous agents. One of the main themes in this research is that the learning system should be able to take advantage of existing knowledge where available. This article describes some of the mechanisms for expressing existing knowledge in SAMUEL, and explores some of the issues in selecting constraints for the learning system.

Title: Genetic Algorithms for Changing Environments
Author(s): John J. Grefenstette
E-mail Address: gref@aic.nrl.navy.mil
Citation: Parallel Problem Solving from Nature -2, R. Manner & B. Manderick (editors),
North-Holland, 137-144
Date: 28-30, September 1992
AIC Report No.: AIC-92-011

Abstract

Genetic algorithms perform an adaptive search by maintaining a population of candidate solutions that are allocated dynamically to promising regions of the search space. The distributed nature of the genetic search provides a natural source of power for searching in changing environments. As long as sufficient diversity remains in the population the genetic algorithm can respond to a changing response surface by reallocating future trials. However, the tendency of genetic algorithms to converge rapidly reduces their ability to identify regions of the search space that might suddenly become more attractive as the environment changes. This paper presents a modification of the standard generational genetic algorithm that is designed to maintain the diversity required to track a changing response surface. An experimental study shows some promise for the new technique.

Title: Inductive Biases in a Reinforcement Learner
Author(s): Helen G. Cobb
E-mail Address: cobb@aic.nrl.navy.mil
Citation: Machine Learning '92, Biases in Inductive Learning Workshop, Morgan
Kaufmann
Date: 1-4, July 1992
AIC Report No.: AIC-92-013

Abstract

Reinforcement Learning Methods (RLMs) typically select candidate solutions stochastically based on a credibility space of hypotheses which the RLM maintains, whether implicitly or explicitly. RLMs typically have both inductive and deductive aspects: they inductively improve their credibility space on a stage-by stage basis; they

deductively select an appropriate response to incoming stimuli using their credibility space. In this sense, RLMs share some learning attributes in common with active, incremental concept learners. Unlike some concept learners that employ deterministic procedures for selecting hypotheses, however, the evaluations of hypotheses provided RLMs are often uncertain, either due to noisy environments, or due to summary evaluations which occur after a sequence of learner-environment interactions. This paper examines issues of inductive learning biases in the context of a simple RLM called Collective Learning Automation (CLA). The CLA learns the shortest path through a small network. The research points out some of the difficulties for finding performance measures that indicate the strongest, correct biases for the automation.

Title: Deception Considered Harmful

Author(s): John J. Grefenstette

E-mail Address: gref@aic.nrl.navy.mil

Citation: Foundations of Genetic Algorithms 2, D. Whitley (editor), Morgan Kaufmann

Date: 1992

AIC Report No.: AIC-92-014

Abstract

A central problem in the theory of genetic algorithms is the characterization of problems that are difficult for GAs to optimize. Many attempts to characterize such problems focus on the notion of "deception", defined in terms of the static average fitness of competing schemas. This note argues this popular approach appears unlikely to yield a predictive theory for genetic algorithms. Instead, the characterization of hard problems must take into account the basic features of genetic algorithms, especially their dynamic, biased sampling strategy.

Title: Queries for Bias Testing

Author(s): Diana F. Gordon

E-mail Address: gordon@aic.nrl.navy.mil

Citation: Proceedings of the Workshop on Change of Representation and Problem Reformulation

Date: April 28 - May 1 1992

AIC Report No.: AIC-92-015

Abstract

Selecting a good bias prior to concept learning can be difficult. Therefore, dynamic bias adjustment is becoming increasingly popular. Current dynamic bias adjustment systems, however, are limited in their ability to identify erroneous assumptions about the relationship between bias and the target concept. Without proper diagnosis, it is difficult to identify and then remedy faulty assumptions. We have developed an approach that makes these assumptions explicit, actively tests them with queries to an oracle, and adjusts the bias based on the test results.

Title: Competition-Based Learning
Author(s): John J. Grefenstette, Kenneth A. De Jong, and William M. Spears
E-mail Address: gref@aic.nrl.navy.mil, dejong@aic.nrl.navy.mil, spears@aic.nrl.navy.mil
Citation: Foundations of Knowledge Acquisition: Machine Learning, A. Meyrowitz (editor), Kluwer Academic Publishers
Date: January 1993
AIC Report No.: AIC-92-018

Abstract

This paper summarizes recent research on competition-based learning procedures performed by the Navy Center for Applied Research in Artificial Intelligence at the Naval Research Laboratory. We have focused on a particularly interesting class of competition-based techniques called *genetic algorithms*. Genetic algorithms are adaptive search algorithms based on principles derived from the mechanisms of biological evolution. Recent results on the analysis of the implicit parallelism of alternative selection algorithms are summarized, along with an analysis of alternative crossover operators. Applications of these results in practical learning systems for sequential decision problems and for concept classifications are also presented.

Title: Minimal Bias Weakening Via Queries
Author(s): Diana F. Gordon
E-mail Address: gordon@aic.nrl.navy.mil
Citation: submitted to Computational Intelligence
Date: 1992
AIC Report No.: AIC-92-019

Abstract

Selecting a good bias prior to concept learning can be difficult. Therefore, dynamic bias adjustment is becoming increasingly popular. Current dynamic bias adjustment systems, however, are limited in their ability to identify erroneous assumptions about the relationship between the bias and the target concept. Without proper diagnosis, it is difficult to identify and then remedy faulty assumptions. We have developed an approach that makes these assumptions explicit, actively tests them with queries to an oracle, and adjusts the bias based on the test results. These queries are influenced by data structures called value trees. Here, we describe experiments that vary aspects of the value trees to reveal the strengths and weaknesses of our approach.

Title: Is the Genetic Algorithm a Cooperative Learner?
Author(s): Helen G. Cobb
E-mail Address: cobb@aic.nrl.navy.mil
Citation: Foundations of Genetic Algorithms 2, D. Whitley (editor), Morgan Kaufmann
Date: 1992
AIC Report No.: AIC-92-020

Abstract

This paper begins to explore an analogy between the usual competitive learning metaphor presented in the genetic algorithm (GA) literature and the cooperative learning metaphor discussed by Clearwater, Huberman, and Hogg. In a blackboard cooperative learning paradigm, agents share partial results with one another through a common blackboard. By occasionally accessing the blackboard for a partial solution, an agent can

dramatically increase its speed in finding the overall solution to a problem. The study of Clearwater, et al., shows that the resulting speed distribution among agents is lognormal. The GA can also be described in terms of an analogous cooperative learning paradigm. Unlike the blackboard learner, the GA shares information by copying and recombining the solutions of the agents. This method of communication slows down the propagation of useful information to agents. The slower propagation of information is necessary because the GA cannot directly evaluate parts of a solution or "partial solutions." The extent to which the GA is cooperative also depends on the choice of heuristics used to modify the canonical GA. The few test cases presented in this paper suggest that the GA may at times yield an approximately lognormal distribution or a mixture of lognormal distributions. While the results look promising, more analysis of the algorithm's overall process is required.

Title: Adapting Crossover in a Genetic Algorithm

Author(s): William M. Spears

E-mail Address: spears@aic.nrl.navy.mil

Citation: Internal report

Date: 1992

AIC Report No.: AIC-92-025

Abstract

Traditionally, genetic algorithms have relied upon 1 and 2-point crossover operators. Many recent empirical studies, however, have shown the benefits of higher numbers of crossover points. Some of the most intriguing recent work has focused on uniform crossover, which involves on the average $L/2$ crossover points for strings of length L . Despite theoretical analysis, however, it appears difficult to predict when a particular crossover form will be optimal for a given problem. This paper describes an adaptive genetic algorithm that decides, as it runs, which form is optimal.

Title: Probabilistic Satisfiability

Author(s): William M. Spears

E-mail Address: spears@aic.nrl.navy.mil

Citation: Internal report

Date: 1992

AIC Report No.: AIC-92-026

Abstract

Given an arbitrary boolean expression, satisfiability refers to the task of finding a truth assignment to the boolean variables that makes the expression true. Since satisfiability is NP-hard it is often necessary to terminate a satisfiability algorithm before a satisfying solution is found, or before it is proven that none exists. Under such circumstances it can often be useful to make probabilistic claims. For example, given that a certain amount of time has elapsed for some given algorithm, can we estimate the probability that a problem is unsatisfiability? Similarly, can we estimate the probability that a problem is satisfiability, without actually finding a solution?

We will examine these issues for two satisfiability algorithms. The first algorithm, the Davis Putnam algorithm, is sound and complete. The second algorithm uses a Hopfield neural network to stochastically search for satisfying assignments. This algorithm is sound, but incomplete. One class of hard satisfiability problems, suggested by recent work (Mitchell, 1992), is investigated. First, we confirm the difficulty of these

problems using the Davis Putnam algorithm. Then we measure the probability that random problems from this class are satisfiable (unsatisfiable). Finally, we investigate the distribution of time for solving satisfiable and unsatisfiable problems (i.e., how many problems can be solved within some time period).

Title: An Overview of Evolutionary Computations

Author(s): William M. Spears

E-mail Address: spears@aic.nrl.navy.mil

Citation: Internal report

Date: 1992

AIC Report No.: AIC-92-030

Abstract

Evolutionary computation uses computational models of evolutionary processes as key elements in the design and implementation of computer-based problem solving systems. In this paper we provide an overview of evolutionary computation, and describe several evolutionary algorithms that are currently of interest. Important similarities and differences are noted which lead to a discussion of important issues that need to be resolved, and items for future research.

INTELLIGENT DECISION AIDS

Title: Application of a Real-Time Control Strategy for Bayesian Belief Networks to Ship Classification Problem Solving

Author(s): S.A. Musman, L.W. Chang, and L.B. Booker

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Citation: to appear in Journal of Artificial Intelligence and Pattern Recognition

Date: 1992

AIC Report No.: AIC-92-021

Abstract

Many classification problems must be performed in a timely or time constrained manner. For this reason, the generation of control schemes which are capable of responding in real-time are fundamental to many applications. For our problem, that of a ship classification, tactical scenarios often dictate the response time required from a system.

In this paper we discuss efficient ways to prioritize and gather evidence within belief networks. We also suggest ways in which we can structure our large problem into a series of small ones. This both pre-defines much of our control strategy into the system structure and also localizes our run-time control issues into much smaller networks. The overall control strategy thus includes the combination of both these methods. By combining them correctly we can reduce the amount of dynamic computation required during run-time, and thus improve the responsiveness of the system.

Title: Study of Interval Belief Combination

Author(s): Rangasami L. Kashyap and Liwu Chang

E-mail Address: liwu@aic.nrl.navy.mil

Citation: to appear in Journal of Intelligent and Robotic Systems

Date: 1992

AIC Report No.: AIC-92-022

Abstract

In this paper, a new mathematical procedure is presented for combining different pieces of evidence which are represented in the interval form to reflect our knowledge about the truth of a hypothesis. Evidences may be correlated to each other (*dependent evidences*) or conflicting in supports (*conflicting evidences*). First, assuming independent evidences, we propose a methodology to construct combination rules which obey a set of essential properties. The method is based on a geometric model. We compare results obtained from Dempster-Shafer's rule, interval Bayes rule and the proposed combination rules with both conflicting and non-conflicting data and show that the values generated by proposed combining rules are in tune with our intuition in both cases. Secondly, in the case that evidences are known to be dependent, we consider extensions of the rules derived for handling conflicting evidence. The performance of proposed rules is shown by different examples. The results show that the proposed rules reasonably make decisions under dependent evidences.

NATURAL LANGUAGE

Title: Eucalyptus: An Integrated Spoken Language/Graphical Interface for Human-Computer Dialog

Author(s): Kenneth Wauchope

E-mail Address: wauchope@aic.nrl.navy.mil

Citation: Proceedings: AVIOS '92 Voice I/O Systems Applications Conference

Date: 22-24, September 1992

AIC Report No.: AIC-92-012

Abstract

As more and more machine intelligence is built into the interactive software tools of the future, the more the human-computer "dialogue" may come to resemble a true human-human dialogue, each party anticipating information needed by the other and avoiding rigid, repetitive or overly detailed exchanges by assuming the existence of a body of shared contextual knowledge. Although to humans dialogue means primarily natural language (NL) communication, friendly and effective human-computer dialogue should be able to take full advantage of an integrated mix of several different interaction modes including keyboard, speech, graphics, and body gestures. Context tracking would allow each input or output transaction to be minimally specific, deriving its full interpretation from background information relevant to the current topic of interchange.

Title: Talking to a Natural Language Interface: Lessons Learned

Author(s): Stephanie S. Everett, Kenneth Wauchope, and Dennis Perzanowski

E-mail Address: severett@aic.nrl.navy.mil, wauchope@aic.nrl.navy.mil,

dennisp@aic.nrl.navy.mil

Citation: Proceedings: AVIOS '92, Voice I/O Systems Applications Conference

Date: 22-24, September 1992

AIC Report No.: AIC-92-016

Abstract

The addition of speech recognition capabilities would seem to be a logical and desirable extension to a keyboard-entry natural language understanding interface, but how does one accommodate the limitations of the current speech recognition technology in a broad and flexible natural language processing system? This paper discusses some of the lessons learned in adapting an existing language interface to accept spoken input.

Title: Talking to InterFIS: Adding Speech Input to a Natural Language Interface

Author(s): Stephanie S. Everett, Kenneth Wauchope, and Dennis Perzanowski

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dennisp@aic.nrl.navy.mil

Citation: Naval Research Laboratory Report, NRL/FR/5510-92-9515

Date: September 11, 1992

AIC Report No.: AIC-92-017

Abstract

This report discusses the addition of speech recognition capabilities to InterFIS, the natural language interface to the Fault Isolation Shell (FIS), an expert system for troubleshooting electronics equipment. Because of the limitations of today's speech

recognition technology, the addition of this capability affects the structure and flexibility of the interface; the consequences and implications of this are discussed in detail in this report. The speech recognition module is described, and a brief evaluation of system performance is presented.

SENSOR-BASED SYSTEMS

Title: Caenorhabditis Elegans: A Proposal to Simulate the Intelligence of a Simple Animal

Author(s): Ralph Hartley

E-mail Address: hartley@aic.nrl.navy.mil

Citation: Artificial Life III

Date: June 15-19, 1992

AIC Report No.: AIC-92-027

Abstract

It is argued that the complete simulation of the functionality of the nervous system of the nematode worm *Caenorhabditis Elegans* is a feasible and desirable goal.

Title: Propulsion and Guidance in a Simulation of the Worm

Author(s): Ralph Hartley

E-mail Address: hartley@aic.nrl.navy.mil

Citation: Animals to Animats, Second International Conference on Simulation of Autonomous Behavior

Date: December 7-11, 1992

AIC Report No.: AIC-92-028

Abstract

A simulation of the mechanics of the Nematode worm *C. Elegans* was constructed and used to study its locomotory behaviors. This simulation sheds light on the mechanisms that must be used by any animal or robot using the same type of propulsion and also on aspects of the behavior of the real worm. The simulation of locomotion is an important step in the understanding of the overall behavior of an animal.

Title: Rapid Recognition of Freeform Objects in Noisy Range Images Using Tripod Operators

Author(s): Frank Pipitone and William Adams

E-mail Address: pipitone@aic.nrl.navy.mil

Citation: submitted to IEEE 1993 Conference on Computer Vision and Pattern Recognition

Date: 1993

AIC Report No.: AIC-92-029

Abstract

The tripod operator is a class of feature extraction operators for computer-represented surfaces, such as range images. It facilitates the recognition and localization of objects by extracting a few sparse point samples in a regimented way, so that N sampled surface points yield only $N-3$ independent scalar features containing ALL the surface shape information in these points and NO other information. They have complete six DOF isometry invariance. A tripod operator consists of three points in 3-space fixed at the vertices of an equilateral triangle and a procedure for making several "depth" measurements in the coordinate frame of the triangle, which is placed on the surface like a surveyor's tripod. Tripod operators can be used in many ways for the recognition and/or pose estimation of arbitrary surface shapes. Here we treat the rapid recognition of

isolated objects in noisy range images using a statistical treatment of a few isolated tripod operators placements. The objects are initially preprocessed with tripod operators. The resulting feature vectors sets are stored. Then new operator placements are made in an image containing an object to be recognized. Experiments show reliable recognition with only a few operator placements, despite significant noise.

NEURAL NETWORKS

Title: Hopfield Model and Optimization Problems

Author(s): Behrooz Kamgar-Parsi and Behzad Kamgar-Parsi

E-mail Address: kamgar@aic.nrl.navy.mil

Citation: Book Chapter, Neural Networks for Perception, Volume 2, Harry Wechsler (editor), Chapter III.4, 94-110

Date: 1992

AIC Report No.: AIC-92-023

Abstract

Hopfield neural networks have found applications in two the broad areas of content addressable memory or information storage and retrieval, and solving hard optimization problems. Here we discuss the latter application, and address the question of how effective Hopfield nets are in solving optimization problems, what type of problems appear to be suited for them, and how well the performance scales with the size of the problem.

Title: Dynamical Stability and Parameter Selection in Neural Optimization

Author(s): Behzad Kamgar-Parsi and Behrooz Kamgar-Parsi

E-mail Address: kamgar@aic.nrl.navy.mil

Citation: Proceedings: International Joint Conference on Neural Networks (IJCNN-92), IV-566-IV-571

Date: June 1992

AIC Report No.: AIC-92-024

Abstract

Finding suitable parameter values in solving optimization problems with the Hopfield net is of crucial importance. In this paper we present a systematic approach, based on analyzing dynamical stability of valid solutions, for finding relationships among parameters which make their selection much easier. Furthermore, this technique can show whether the problem formulation is flawed. As an example we discuss the Hopfield-Tank formulation of the Traveling Salesman Problem and show that it is dynamically unstable, hence obtaining value solutions is difficult. We also discuss the modified formulation by Aiyer, et al. which overcomes the instability problems.

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Title: High Fidelity Communication Network Simulator for SDIO
Author(s): E. L. Althouse, D. N. McGregor, S. G. Batsell, and R. R. Nair
E-mail Address: althouse@itd.nrl.navy.mil
Citation: Proceedings of the Armed Forces Communication and Electronics Association Symposium on Modeling and Simulation in Today's Defense Environment, Annapolis, MD.
Date: October 1992
Report No.: 5521-92-001

Abstract

The Naval Research Laboratory is developing a High Fidelity Network Simulator (HiFiNS) to validate requirements and proposed implementations for the SDI Global Protection Against Limited Strikes (GPALS) and National Missile Defense (NMD) communication systems. This simulator models the detailed communication link and message latency effects throughout the space and terrestrial SDI network. The simulator will run on either a single high speed workstation or a small cluster of these workstations.

Title: A High Fidelity Network Simulator for National Missile Defense
Author(s): E. L. Althouse, D. N. McGregor, S. G. Batsell, and R. R. Nair
E-mail Address: althouse@itd.nrl.navy.mil
Citation: paper presented at the SDIO Sponsored Communications Working Group Meeting, Colorado Springs, CO.
Date: December 1992
Report No.: 5521-92-002

Abstract

A High Fidelity Network Simulator (HiFiNS) is being developed to support the communications analysis and test requirements for various segments of the SDI program with initial emphasis on National Missile Defense needs. The simulator is being developed incrementally into a series of three Builds, each one adding additional capabilities for either modeling or performance improvements. The simulator incorporates a message passing discrete event capability, is driven by a threat and operational message set scenario, includes a graphical user interface for collection of performance statistics, and uses an environmental model for the computation of link degradation effects associated with either noise or nuclear weapons impacts.

Title: The UNT/NRL HF Intratask Force Communication Network Experiment
Authors: D. J. Baker, J. P. Hauser, D. N. McGregor, and J. T. Ramsey
E-mail Address: baker@itd.nrl.navy.mil
Citation: NRL Memorandum Report 6965
Date: June 4, 1992
Report No.: 5521-92-003

Abstract

This report documents results of NRL's HF Intratask Force Network tests, which were performed on September 27, 1990 as part of the Unified Networking Technology (UNT) program. The objective of these tests was to demonstrate an HF communication architecture (Linked Cluster Architecture) that provides robust communication in a multi-hop, multi-frequency network. Detailed analysis of test results showed that the network was restructuring itself properly in response to connectivity changes but was not delivering all of the traffic load. The cause of the problem was traced to a software coding error. To obtain "corrected" test results, the message trace field test data were duplicated in the laboratory simulator by replacing the simulated channels with field-test data showing blocks received and blocks received error free. Having validated the

simulator in this way, the software corrections were made, and the tests were rerun in the laboratory to obtain the corrected field test results. These results were in agreement with simulation results obtained prior to the UNT tests, and show that the Linked Cluster Architecture does indeed provide a robust HF communication network. This architecture is particularly promising for those applications that require the simultaneous handling of both voice and data traffic.

Title: A Neural Network Approach to Solving the Link Activation Problem in Multihop Radio Networks

Author(s): C. M. Barnhart, J. E. Wieselthier, and A. Ephremides

E-mail Address: barnhart@itd.nrl.navy.mil

Citation: submitted to IEEE Transactions on Communications

Date: Revised 1992

Report No.: 5521-92-004

Abstract

We address the problem of "link activation" or "scheduling" in multihop packet radio networks. The objective is to determine a conflict-free schedule of minimum length that satisfies the specified end-to-end communication requirements. It is well known that this problem, in almost all of its forms, is a combinatorial-optimization problem of high complexity. We approach this problem by the use of a Hopfield neural network model in which the method of Lagrange multipliers is used to vary dynamically the values of the coefficients used in the connection weights.

Two forms of the scheduling problem are considered. In the first, communication requirements are specified in terms of the number of packets that must be transmitted over each link in the network. In the second, an additional constraint is incorporated, namely that the sequence of link activations along any multihop path must be preserved. Extensive software simulation results demonstrate the effectiveness of this approach in producing schedules of optimal length.

Title: Marked/Phantom Slot Algorithms for a Class of Scheduling Problems

Author(s): C. G. Cassandras and V. Julka

E-mail Address: wieselthier@itd.nrl.navy.mil

Citation: Proceedings of the 31st IEEE Conference on Decision and Control, 3215-3220, also published as University of Massachusetts at Amherst Technical Report #CCS-92-001 (March 1992)

Date: December 1992

Report No.: 5521-92-005

Abstract

We address the problem of scheduling M customer classes in a single-server system, with customers arriving in one of N arrival streams. In general, $N \neq M$ and a customer from some stream may join one of several classes. We consider a slotted time model where at each scheduling epoch the server is assigned to a particular class and can serve multiple customers simultaneously, one from every arrival stream that can belong to this class. This assignment is based on a *random polling* policy: the current time slot is allocated to the i th class with probability θ_j . Our objective is to determine the optimal probabilities by adjusting them on line so as to optimize some overall performance measure. We present an approach based on perturbation analysis techniques for discrete event dynamic systems, where all customer arrival processes can be arbitrary, and no information about them is required. The basis of this approach is the development of two sensitivity estimators leading to a *Marked Slot* and a *Phantom Slot* algorithm. The

algorithms determine the effect of removing/adding service slots to an existing schedule on the mean customer waiting times by directly observing the system. Numerical results based on a simple optimization algorithm are included.

Title: Mobile-User Networking: The Satellite Alternative

Author(s): A. Ephremides and J. E. Wieselthier

E-mail Address: wieselthier@itd.nrl.navy.mil

Citation: Symposium on Worldwide Advances in Communication Networks, George Mason University, Fairfax, VA

Date: May 1992

Report No.: 5521-92-006

Abstract

In this paper we consider a problem of service integration (i.e., voice and data) in a simple satellite system. We adopt the principle of "boundary" schemes (movable or fixed) as proposed for terrestrial systems, and superpose it on the idea of interleaved-frame reservation-based channel access for satellite usage that was proposed by Wieselthier and Ephremides in 1980. The interleaved-frame protocols are uniquely suited to satellite environments because they take advantage of the latency characteristics of satellite channels. Simple modifications of the basic version of such protocols permit the integration of voice and data by means of the boundary approach.

We describe the operation of the Non-Interleaved-Frame Fixed-Length (NIFFL) protocols, which have been developed for data-only operation. We show how they are easily extended to integrated voice/data operation, and we outline the development of the Markov model for the integrated protocol. Finally, we present performance results that demonstrate that there is an optimal value for the boundary threshold that corresponds to a suboptimally minimum value of the desired performance measure, which is the weighted sum of data packet delay and voice-call blocking probability.

Title: Multi-Access Strategies for Voice/Data Integration in Heterogeneous Mixed-Media Packet Radio Networks

Author(s): E. Geraniotis and M. Soroushnejad

E-mail Address: wieselthier@itd.nrl.navy.mil

Citation: NRL Memorandum Report NRL/MR/5521-92-7107

Date: September 1992

Report No.: 5521-92-007

Abstract

The problem of voice/data integration in a mixed-media packet radio network employing both ground radio links and SATCOM radio links is investigated. Multi-access strategies are devised to take advantage of different characteristics of both radio channels to better serve the requirements of both traffic types. Code-division multiple-access with movable boundary in the code domain is used in the ground subnetwork to serve the voice traffic and the retransmitted data traffic while framed ALOHA with movable boundary is used on the satellite subnetwork for both data and voice.

Based on a Markovian model of the system, a complete analysis of the channel access protocols for both traffic types is given. The performance of the multiple-access schemes used in this mixed-media network is evaluated in terms of voice and data throughput, voice blocking probability, and data delay. It is observed that splitting of retransmission traffic between the satellite and ground subnet may increase the overall data throughput when the voice load is high.

Title: A CDMA/Framed-ALOHA Protocol for Voice/Data Integration in Hybrid Satellite/Terrestrial Networks

Author(s): E. Geraniotis, M. Soroushnejad, and W.-B. Yang

E-mail Address: wieselthier@itd.nrl.navy.mil

Citation: Conference Record of IEEE MILCOM'92, 108-114

Date: October 1992

Report No.: 5521-92-008

Abstract

This paper examines certain protocols for voice/data integration in hybrid satellite/terrestrial packet radio networks. In the ground subnetwork code-division multiple-access with movable boundary in the code domain is used to serve the voice traffic and the retransmitted data traffic; on the satellite subnetwork framed ALOHA with movable boundary is used for both data and voice. Based on a Markovian model of the system, the channel access protocols for both traffic types are analyzed. The performance of the above multiple-access schemes is evaluated in terms of voice and data throughput, voice blocking probability, and data delay. It is shown that splitting of retransmission traffic between the satellite and ground subnets increases the overall data throughput when the voice load is high.

Title: A Multi-Access Scheme for Voice/Data Integration in Hybrid Satellite/Terrestrial Mixed-Media Packet Radio Networks

Author(s): E. Geraniotis, M. Soroushnejad, and W.-B. Yang

E-mail Address: wieselthier@itd.nrl.navy.mil

Citation: Submitted to IEEE Transactions on Communications

Date: 1992

Report No.: 5521-92-009

Abstract

This paper examines protocols for voice/data integration in hybrid packet radio networks consisting of satellite and terrestrial components. The same protocols can be useful in the context of mixed-media packet radio networks employing HF ground radio links and EHF SATCOM radio links. As part of our integration protocol the ground subnetwork employs code-division multiple-access with movable boundary in the code domain to serve both the voice traffic and the retransmitted data traffic; on the satellite subnetwork framed ALOHA with movable boundary is used for both data and voice.

A complete analysis of the channel-access protocols for both traffic types is provided based on a multi-dimensional Markovian model of the integrated voice/data system. The performance of the hybrid network is evaluated in terms of voice and data throughput, voice blocking probability, and data delay. It is observed that appropriate splitting of the retransmission traffic between the satellite and ground subnets may increase the overall data throughput when the voice load is high.

Title: System Design and Development of a Low Data Rate Voice (1200 bps) Rate Converter

Author: J. P. Hauser

E-mail Address: hauser@itd.nrl.navy.mil

Citation: NRL Memorandum Report NRL/MR/5520-92-7136

Date: September 30, 1992

Report No.: 5521-92-010

Abstract

This report presents both a high level and a detailed design for a low data rate voice Rate Converter (RC). On the transmit side, the converter reduces 2400 bps voice

generated by an Advanced Narrowband Digital Voice terminal (ANDVT) to a 1200 bps bit stream. On the receive side it converts the 1200 bps stream back to a 2400 bps stream in ANDVT format. Rate reduction is accomplished with little degradation to the inherent voice quality of the ANDVT.

The primary focus is upon the real-time software design which is implemented using VxWorks, a real-time, multi-tasking operating system and development environment. The high level design defines four tasks, each having its own execution thread and its own "pipe" to facilitate inter-task communication. The Supervisor Task performs initialization and manages input of commands and data to the RC. The Compressor Task reduces a 2400 bps bit stream to 1200 bps while the Decompressor Task converts from 1200 bps back to 2400 bps. The Output Task manages the output of data from the RC. Latter sections of the report describe the software in detail.

Title: Sample Path Techniques for Admission Control in Multiclass Queuing Systems with General Arrival Processes

Author(s): V. Julka, C. G. Cassandras, and W.-B. Gong

E-mail Address: wieselthier@itd.nrl.navy.mil

Citation: Proceedings of the 1992 Conference on Information Sciences and Systems, Princeton University, 227-232, also published as University of Massachusetts at Amherst Technical Report #CCS-92-002 (August 1992)

Date: March 1992

Report No.: 5521-92-0011

Abstract

We address the problem of admission control to a multiclass (K classes) single-server queuing system, where the input is the superposition of K arrival streams, with each stream forming an arbitrary arrival process. Customers are assigned a service time (from a general distribution) upon arrival and the scheduling policy is FIFO. Probabilistic admission control is applied to a (non-empty) subset of M classes as follows: upon arrival, customers from the j th class are admitted into the queue with probability θ_j and rejected with probability $1 - \theta_j$. Our aim is to estimate gradients for general performance measures w.r.t. to $\Theta \equiv \{\theta_j\}_{j=1}^M$. We study a class of unbiased estimators that are based on evaluating the change in the sample performance function when individual customers are selectively removed or "phantomized" from the nominal sample path. We propose the use of simple recursions (Modified Lindley Equations) to efficiently calculate the change in sample performance. Moreover the recursions depend only on quantities directly measurable from the nominal sample path, and thus no distributional knowledge about the arrival or service process is required.

Title: Multireception Probabilities for FH/SSMA Communications

Author(s): T. J. Ketseoglou and E. Geraniotis

E-mail Address: wieselthier@itd.nrl.navy.mil

Citation: IEEE Transactions on Communications, v40, n1, 223-233

Date: January 1992

Report No.: 5521-92-012

Abstract

Exact expressions for the probabilities $P(l, m-lk)$ of l correct packet receptions and $m-l$ erroneous ones, out of total k packets contending in a slot, are presented for the case of frequency-hopped spread-spectrum random-access slotted networks employing random frequency hopping patterns. These expressions are difficult to evaluate numerically for values of $m > 3$. However, our numerical analysis indicates that under

light traffic conditions these probability values are very close to the ones provided by the independent receiver operation assumption, under which the distribution of multireception obeys the binomial law.

Title: Multi-Channel Networking for Naval Tactical Communication

Author(s): D. N. McGregor

E-mail Address: mcgregor@itd.nrl.navy.mil

Citation: Proceedings of the Joint Defense Laboratories Communications Networking Panel, McLean, VA.

Date: August 1992

Report No.: 5521-92-013

Abstract

A Multi-Channel Architecture (MCA) is being developed for Naval tactical communication systems. The MCA networking algorithms require only a single transmitter at each network node but do require several receivers. The network has the ability to adapt to topology changes and jamming effects by adaptively reconfiguring the network and relaying traffic. A distributed control algorithm has been developed for the MCA design. This MCA technology adapts to a wide range of network sizes and connectivities and also provides for the integration of broadcast voice and data services. It also improves system capacity, reduces latency effects, and is applicable to diverse types of networks in all frequency bands.

Title: Network Simulation

Author(s): D. N. McGregor, E. L. Althouse, S. G. Batsell, and R. R. Nair

E-mail Address: mcgregor@itd.nrl.navy.mil

Citation: SDIO Sponsored Communications Working Group Meeting, Los Angeles, CA.

Date: May 1992

Report No.: 5521-92-014

Abstract

An overview of two distinct NRL network simulations is presented to the SDI community. These simulators include the capability to model terrestrial and space communication networks. The first simulator models the Brilliant Pebbles network as well as the space to ground communication links and runs on a large-scale parallel processing machine. The second simulator is under development and models the complete space and terrestrial communication portions for the National Missile Defense system.

Title: High Fidelity Network Simulation (HiFiNS) Status

Author(s): D. N. McGregor, E. L. Althouse, S. G. Batsell, and R. R. Nair

E-mail Address: mcgregor@itd.nrl.navy.mil

Citation: SDIO Sponsored Communications Working Group Meeting, Los Angeles, CA.

Date: May 1992

Report No.: 5521-92-015

Abstract

A high fidelity network simulator is being developed by NRL to provide an assessment of the communications timelines associated with the SDI National Missile Defense system. This simulator is being developed incrementally in a series of three

Builds. Upon completion the simulator will have the capability to model all space and terrestrial SDI communications. This presentation discusses the components of the first Build of HiFiNS and provides a status summary of its evolution.

Title: A Networking Technology Demonstration for Naval Tactical Communications

Author(s): D. N. McGregor, D. J. Baker, and J. P. Hauser

E-mail Address: mcgregor@itd.nrl.navy.mil

Citation: NRL Review: Naval Research Laboratory, Washington, D.C.

Date: May 1992

Report No.: 5521-92-016

Abstract

A distributed, self-organizing, adaptive networking architecture, called the linked cluster architecture (LCA), is being developed by NRL for application to Naval Intra Task Force communication services. This network architecture offers the benefits of improved timeliness and information throughput, the ability to adapt to dynamic stressed situations, enhanced survivability/jam-resistance, and support for virtual circuit setup and maintenance. A seven-node hardware demonstration of this networking architecture (involving a ship, an aircraft, and five land-based nodes) was successfully performed as part of the Unified Networking Technology (UNT) project.

Title: Distributed Protocols for Secure Computation of Binary Functions

Author(s): E. Modiano and A. Ephremides

E-mail Address: modiano@itd.nrl.navy.mil

Citation: Submitted to IEEE Transactions on Information Theory

Date: October 1992

Report No.: 5521-92-017

Abstract

A common task in parallel processing is the distributed computation of a function by a number of processors each of which possesses partial information relevant to the value of that function. In this paper we develop protocols which allow for such computation to take place while maintaining the value of the function secret to an eavesdropper. Of interest is the communication complexity of such protocols. We begin by considering two processors and two channels, one secret and one public, and present a protocol which minimizes the number of bits exchanged over the secret channel, while maintaining ϵ -uncertainty about the value of the function for the eavesdropper. We show that all binary functions can be kept ϵ -secret using a constant number of bits independent of the size of their domain. We then generalize our results to N processors communicating over a network of arbitrary topology.

Title: Multi-Access Strategies for an Integrated Voice/Data CDMA Packet Radio Network

Author(s): M. Soroushnejad and E. Geraniotis

E-mail Address: wieselthier@itd.nrl.navy.mil

Citation: Submitted to IEEE Transactions on Communications

Date: revised 1992

Report No.: 5521-92-018

Abstract

Multiple-access schemes are introduced and analyzed for the integration of voice and data traffic in packet radio networks using code-division multiple-access (CDMA).

The multiple-access capability of the CDMA channel is used to accommodate several voice calls simultaneously, while the data users follow the ALOHA protocol with retransmission control and contend for the remaining (if any) multiple-access capability of that channel. The retransmission probabilities of the backlogged data users are updated based on estimates of data backlog and number of established voice calls, which are obtained from the side information (feedback) about the state of channel activities; retransmission schemes based on different feedback information are considered in this context.

A two-dimensional Markovian model is developed for the voice and data traffic, with the data backlog and number of established voice calls representing the state of the system. Based on this model, the voice-call blocking probability, the throughput of both traffic types, and the delay of the data packets are evaluated and the tradeoffs between the parameters of different traffic types are quantified. The voice/data integration schemes introduced achieve efficient movable-boundary channel access in the code (CDMA) domain.

Title: Optimal Admission Control In Circuit-Switched Multihop Radio Networks

Author(s): J. E. Wieselthier, C. M. Barnhart, and A. Ephremides

E-mail Address: wieselthier@itd.nrl.navy.mil

Citation: Proceedings of the 31st IEEE Conference on Decision and Control, 1011-1013

Date: December 1992

Report No.: 5521-92-019

Abstract

In this paper we address admission control in circuit-switched multihop radio networks. Our problem formulation is based on the multiple service, multiple resource (MSMR) model developed by Jordan and Varaiya. They have shown that, under a reasonable set of assumptions, coupled with the requirement of a coordinate convex state space, a product-form stationary distribution is obtained for the system state. In such systems, the control policy is implemented by restricting the admissible state space to the coordinate convex subspace that results in the optimum value of the desired performance index.

We address the computational evaluation of the performance measures of interest, and we discuss a descent-search procedure for the determination of a good control policy. Computational results demonstrate that little performance improvement is achieved by means of admission-control schemes unless the performance measure associates different weights with different types of calls.

Title: Fixed- And Movable-Boundary Channel-Access Schemes For Integrated Voice/Data Wireless Networks

Author(s): J. E. Wieselthier and A. Ephremides

E-mail Address: wieselthier@itd.nrl.navy.mil

Citation: submitted to IEEE Transactions on Communications

Date: Revised October 1992

Report No.: 5521-92-020

Abstract

In this paper we address the major issues associated with channel access in integrated wireless networks, and we propose and analyze the "Wireless Integrated Multiple Access" (WIMA) protocol. This scheme is based on a mixture of boundary ideas for integration and of previously introduced protocols for wireless access, and is well suited to either satellite or to terrestrial networks. A two-dimensional first-order Markov chain model for this scheme is presented, and techniques that exploit the structural properties of this chain to simplify the evaluation of the equilibrium state,

without sacrificing accuracy, are described. Analytical models for the evaluation of data-packet delay for both fixed- and movable-boundary versions of this protocol and for voice-call blocking probability are presented. Performance results illustrate the dependence of performance on system parameters, and demonstrate the improved performance that can be achieved through the use of the movable-boundary version.

Title: Uncoded and Coded Performance of MFSK and DPSK in Nakagami Fading Channels

Author(s): Paul J. Crepeau

E-mail Address:

Citation: IEEE Log Number 9106356

Date: March 1992

Report No.: 5523-92-001

Abstract

There are many communication systems employing noncoherent MFSK or DPSK that are required to operate in channels with a fairly wide range of fading and scintillation conditions. To model these disturbances there are available two generalizations of the Rayleigh fading channel: the Rician channel and the Nakagami-m channel. Thus far, the majority of analytical studies have utilized the Rician channel in preference to the Nakagami-m channel, and surprisingly, some basic results for the Nakagami channel have been overlooked. In this paper, we present uncoded and coded performance results for noncoherent MFSK and DPSK in a slow nonselective Nakagami-m fading channel. We give simple expressions for the asymptotic slopes of probability of bit error for large signal-to-noise ratio, and show that the effective order of diversity compared to an uncoded Rayleigh channel is the product of two parameters, one of the channel and one for the code. Finally, we present a comparison of the uncoded Nakagami-m results to those of the Rician channel in order to show performance differences between these two generalized fading channel models.

Title: WR-10 Band Noise Measurement

Author(s): J. A. Molnar, T. V. Mai, J. J. O'Neill

E-mail Address:

Citation: NRL Memorandum Report No. 9399, Naval Research Laboratory, Washington DC

Date: August 21, 1992

Report No.: 5524-92-001

Abstract

A WR-10 band (75 GHz - 110 GHz) noise measurement system was developed to evaluate a solid state noise source in this band. The noise measurement system was characterized with a gas discharge tube that provided a stable output Excess Noise Ratio (ENR) of 14.2 dB + 0.5 dB throughout the band. To ensure the accuracy of the system characterization, the results were correlated with the results of noise temperature measurements, obtained from a load maintained at ambient and liquid nitrogen temperatures. The principles of noise measurement, method and limitations of each technique, and results of receiver characterization are discussed. The results of the receiver characterization are applied to the evaluation of solid state noise sources. The resulting Double Side Band (DSB) ENR of the noise sources are presented and discussed. The accuracy of this DSB evaluation was compared to a Single Side Band (SSB) measurement using the "Three Point Measurement" method.

Two WR-10 band noise sources were evaluated with the noise measurement system developed at NRL. The device performance was specified as: an ENR of 15 dB \pm

1 dB and full waveguide coverage. The actual performance results indicate that ENR values in excess of 15 dB are available, but the devices lacked a flat output over the band.

The objective of this study is to develop a WR-10 band general purpose field test system, and to assess the accuracy and stability of WR-10 band solid state noise sources that would be implemented.

Title: Development of a Fault Isolation System Database Manager

Author(s): C. B. Barclay, J.A. Molnar

E-mail Address:

Citation: NRL Memorandum Report NRL/MR/5524-92-6944, Naval Research Laboratory, Washington DC

Date: February 10, 1992

Report No.: 5524-92-002

Abstract

The Fault Isolation System Database Manager (FISDM) is an interactive database interface developed to enhance data and configuration management of causal models. A causal model of a Unit Under Test (UUT) describes the interrelationship of the electronic components composing the UUT. The interface, written in C, was integrated with the Empress data management software package to access data manipulation routines. Standard data manipulation features are incorporated to enhance the creation and management of the knowledge database. Output features allow delivery of the data in multiple formats. The format required for the Fault Isolation System (FIS) knowledge database is produced directly as an output option. Additionally, a comma delimited format compatible with other database and spreadsheet software provides portability and flexibility for configuration management. Data management is achieved through maintenance of a standard format which can be translated to working version in other formats. FISDM permits central management of expert systems that require occasional modifications from multiple sources. This is a situation which often occurs over the fielded lifetime of military electronic systems.

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5521-92-002 A High Fidelity Network Simulator for National Missile Defense, *E. L. Althouse, D. N. McGregor, S. G. Batsell, and R. R. Nair*

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5521-92-004 A Neural Network Approach to Solving the Link Activation Problem in Multihop Radio Networks, *C. M. Barnhart, J. E. Wieselthier, and A. Ephremides*

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5521-92-007 Multi-Access Strategies for Voice/Data Integration in Heterogeneous Mixed-Media Packet Radio Networks, *E. Geraniotis and M. Soroushnejad*

5521-92-008 A CDMA/Framed-ALOHA Protocol for Voice/Data Integration in Hybrid Satellite/Terrestrial Networks, *E. Geraniotis, M. Soroushnejad, and W.-B. Yang*

5521-92-009 A Multi-Access Scheme for Voice/Data Integration in Hybrid Satellite/Terrestrial Packet Radio Networks, *E. Geraniotis, M. Soroushnejad, and W.-B. Yang*

5521-92-010 System Design and Development of a Low Data Rate Voice (1200 bps) Rate Converter, *J. P. Hauser*

- [] 5521-92-011 Sample Path Techniques for Admission Control in Multiclass Queuing Systems with General Arrival Processes, *V. Julka, C. G. Cassandras, and W.-B. Gong*
- [] 5521-92-012 Multireception Probabilities for FH/SSMA Communications, *T. Ketseoglou and E. Geraniotis*
- [] 5521-92-013 Multi-Channel Networking for Naval Tactical Communication, *D. N. McGregor*
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- [] 5521-92-020 Fixed- and Movable-Boundary Channel-Access Schemes for Integrated Voice/Data Wireless Networks, *J. E. Wieselthier and A. Ephremides*
- [] 5523-92-001 Uncoded and Coded Performance of MFSK and DPSK in Nakagami Fading Channels, *Paul J. Crepeau*
- [] 5524-92-001 WR-10 Band Noise Measurement, *J. A. Molnar, T. V. Mai, and J. J. O'Neill*
- [] 5524-92-002 Development of a Fault Isolation System Database Manager, *C. B. Barclay and J. A. Molnar*

IV. Human-Computer Interaction Code 5530

NRL's Human-Computer Interaction Lab performs interdisciplinary research on communication between people and computer systems. Human-Computer Interaction (HCI) can be viewed as the bi-directional communication of information between two powerful information processors: people and computers. Information can be in the form of data, symbolic knowledge, or control specifics. The goal of HCI research is to define the methods and management of this communication so that it is maximally effective in multiple contexts; a basic premise of work within the Lab is Human-In-the-Loop systems rather than autonomous ones. NRL's HCI Lab focuses on research leading to the development of software principles and methods to achieve this goal.

The HCI Laboratory is organized around four research areas which jointly contribute to the development of software principles and methods. These areas are voice systems, experimental testing, advanced interfaces, interface design and integration.

Title: Canned Speech in Tactical Voice Message Systems
Author(s): G.S. Kang, and D. Heide
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Citation: Tactical Communication Conference, Fort Wayne, IN
Date: April 28-30, 1992
Report No.: HCI-92-033

Abstract

Since the invention of the telephone, *interactive two-way* conversation has been a widely-used mode of telecommunication. For the past forty years, various secure telephones (i.e., vocoders) were developed to provide Government interactive voice communication capabilities. Another mode of voice communication which has not drawn as much attention is *noninteractive one-way* voice message transfer. One-way tactical messages include: surveillance reports, tactical coordination information, warnings, and reminders. These messages usually do not require immediate verbal response from the listener. Examples of noninteractive one-way tactical messages are: "No enemy sighted," "Permission granted to leave net," "Initiate sync." etc. In some of the tactical message systems such as LINK-11 of the Naval Tactical Data System, each sentence of the message is coded into a three-letter symbol (somewhat analogous to jargon used by Citizen's Band operators). Whether messages are spoken in plain English or jargon, military messages are normally delivered without much pitch inflections. Furthermore, the vocabulary size is rather limited (several hundred to several thousand, dependent on the nature of mission). Canned speech is for this type of tactical messages.

We examined various aspects of canned speech generation. In this approach, brief tactical messages are generated by concatenating the speech waveforms corresponding to the individual words. According to our tests, listeners unanimously preferred canned speech over synthetic speech generated by a text-to-speech converter. They selected *canned speech* not only for its higher intelligibility, but they also felt that canned speech was more natural. Some listeners thought that canned speech was originally recorded as sentences rather than individual words strung together.

The data rate required to transmit canned speech is very low (well below 100 b/s). Such a low-data-rate voice encoding technique is essential when the network is congested. Future voice communication should be designed in such manner that no voice messages are preempted because any voice call might be delivering vital tactical information.

There are other merits of canned speech. In extremely noisy environments (helicopters, tanks, etc.), live speech cannot be vocoded and transmitted because the resultant speech intelligibility is very poor. In this case, canned speech entered by a nonverbal means (e.g., keyboard) achieves a reliable message transfer. Furthermore, canned speech can readily be translated into other languages. With the availability of low-cost, high-density memory devices, canned speech generation is practical in many applications.

Title: 800-B/S Voice Encoding Algorithm
Author(s): G.S. Kang, and L. F. Fransen
E-mail Address: kang@itd.nrl.navy.mil or fransen@itd.nrl.navy.mil
Citation: Tactical Communication Conference, Fort Wayne, IN
Date: April 28-30, 1992
Report No.: HCI-92-034

Abstract

The 2400-b/s linear predictive coder (LPC) is currently being widely deployed to support tactical voice communication over narrowband channels. However, there is a

need for lower-data-rate voice encoders for special applications: improved performance in high bit-error conditions, low-probability-of-intercept (LPI) voice communication, and narrowband integrated voice/data systems.

We present an 800-b/s voice encoding algorithm which is an extension of the 2400-b/s LPC. In essence, the 800-b/s voice algorithm is a 2400-b/s LPC with modified parameter quantifiers with the following characteristics:

- Speech parameters are generated by the 2400-b/s LPC at a frame of 50 Hz (rather than 44.444 Hz).
- Speech parameters over two frames are jointly quantified by look-up tables. Three sets of parameters (amplitude parameter, pitch period, and filter coefficients) are transmitted once every two frames.
- *Amplitude parameters* over two adjoining frames are vectorially encoded into 9 bits. The amplitude resolution is as good as that of the 2400-b/s LPC (i.e., 5 bits each over two frames).
- *Pitch period* is scalarly encoded into 5 bits. Pitch resolution is 12 steps per octave from the fundamental pitch frequency of 66.667 Hz to 400 Hz. Since the pitch contour does not change as radically, pitch period is transmitted once every other frame.
- *Filter coefficients* (line-spectrum pairs derived from reflection coefficients) over two consecutive frames are jointly encoded into 17 bits. Coefficient templates are so arranged that only 2048 templates are searched in two frames. At the conference, we will elaborate the details of this tree arrangement which is a most critical element in the 800-b/s voice encoding algorithm.
- *Voicing decision* is implicitly specified by filter coefficients.

To construct look-up tables, we used speech samples of 420 speakers uttering 8 sentences each, excerpted from the Texas Instrument-Massachusetts Institute of Technology (TIMIT) Acoustic-Phonetic Speech Data Base.

Speech intelligibility of the 800-b/s voice encoding algorithm measured by the diagnostic rhyme test (DRT) is 91.5 for three male speakers. This score compares favorably with the 2400-b/s LPC of a few years.

Title: Formatted Messages in Tactical Communication

Author(s): T. M. Moran

E-mail Address: moran@itd.nrl.navy.mil

Citation: Tactical Communication Conference, Fort Wayne, IN

Date: April 28-30, 1992

Report No.: HCI-92-035

Abstract

In many tactical voice communications information is exchanged in a formatted, or predetermined way over radio channels. Often the type and extent of the data to be communicated is well defined and is rote in nature, as in aircraft status reports. To preserve radio resources, and for other reasons, it is desirable to reduce the data rate for these communications.

Through the use of formatted messages it is possible to provide communications at data rates as low as 20 bits per second. In such a system a collection of incomplete

message forms are stored at both the transmitter and receiver. The message forms are displayed on a computer screen and can be written in several different formats. No matter how the forms are displayed they comprise a message structure which requires some minimal additional information to complete the message. The computer guides the user in the selection of the proper choices to fill in this specific information. The user's choices in selecting and filling in a message correspond to indices which are the only data sent to the receiver. Since only the essential information is transmitted, the data rate is kept extremely low.

The methods of implementing a formatted message system are myriad, with the method of input being the most variable aspect of the system. Some input methods include: keyboards using pictures or icons, regular keyboards, touch screen displays, mouse-driven displays, and speech recognition. The highly structured input and limited vocabulary size are ideally suited to speech recognizers as they can be made to perform much better than an unconstrained system. It is also possible to use a combination of input methods. An example that has been demonstrated uses a speech recognition computer with a mouse-driven, virtual button display.

Output of this system is also flexible. Both text and speech are stored at the receiver. The indices that are received from the transmitter are used to look up the corresponding message and the additional information used in filling in the form. The entire message can be displayed as text, or played out as narrative speech compiled from separate, pre-recorded speech files.

A formatted message system, in certain situations, provides a practical method of communicating with some real advantages over more conventional methods. The input method not only insures that there is no omission of information but also prevents the leakage of sensitive information. The low data rate would allow this system to have very good anti-jam characteristics. For the same reason, it would have good low-probability-of-intercept characteristics. Since the data being transmitted is simply indices, the output could be in any language; providing multilingual capability. For these reasons and more, this simple concept can have some powerful applications.

Title: Dual-Task Performance as a Function of Presentation Mode and Individual Differences in Verbal and Spatial Ability

Author(s): L. B. Achille, A. Schmidt-Nielsen, and L. E. Sibert

E-mail Address: achille@itd.nrl.navy.mil, schmidt-nielsen@itd.nrl.navy.mil, or sibert@itd.nrl.navy.mil

Citation: NRL-9372

Date: January 1992

Report No.: HCI-92-036

Abstract

The effectiveness of alternative display formats as a function of individual differences in verbal and spatial abilities was evaluated in a dual-task paradigm. Tasks consisted of two-dimensional tracking and a classification task in which items were presented as text, speech, or icons. Spatial ability was correlated with performance on the tracking task both for single task and for dual task in combination with the various presentation modes of the classification task. Verbal ability was not consistently correlated with performance on any of the tasks. Significant individual differences in dual task performance were found, and individuals were highly consistent with themselves across different presentation modes. Classification task performance is compared for the three presentation modes singly and in combination with the tracking task. Dual task classification was slower than single task classification for the visual modes, but there

was no increase in reaction time between single and dual task performance for speech. In the dual task conditions, the largest tracking performance decrements were found for the text condition, with smaller decrements for speech and smallest decrements for iconic presentations.

Title: Intelligibility and Acceptability Testing for Speech Technology

Author(s): A. Schmidt-Nielsen

E-mail Address: schmidt-nielsen@itd.nrl.navy.mil

Citation: NRL Report 9379

Date: 1992

Report No.: HCI-92-037

Abstract

The evaluation of speech intelligibility and acceptability is an important aspect of the use, development, and selection of voice communication devices -- telephone systems, digital voice systems, speech synthesis by rule, speech in noise and the effects of noise stripping. Standard test procedures can provide highly reliable measures of speech intelligibility, and subjective acceptability tests can be used to evaluate voice quality. These tests are often highly correlated with other measures of communication performance and can be used to predict performance. If the speech signal is severely degraded or highly processed, a more complete evaluation of speech quality is needed, one that takes into account the many different sources of information that all contribute to how we understand speech.

Title: Direct Manipulation and Intermittent Automation in Advanced Cockpits

Author(s) J. Ballas, C. L. Heitmeyer, and M. A. Perez

E-mail Address: ballas@itd.nrl.navy.mil, heitmeyer@itd.nrl.navy.mil, or perez@itd.nrl.navy.mil

Citation: NRL 9375

Date: 1992

Report No.: HCI-92-038

Abstract

Increasing use of automation in computer systems, such as advanced cockpits, presents special challenges in the design of user interfaces. The challenge is particularly difficult when automation is intermittent because the interface must support smooth transitions from automated to manual mode. A theory of direct manipulation predicts that this interface style will smooth the transition. Interfaces were designed to test the prediction and to evaluate two aspects of direct manipulation, semantic distance and engagement. Empirical results supported the theoretical prediction and also showed that direct engagement can have some adverse effects on another concurrent manual task. Generalizations of our results to other complex systems are presented.

Title: An Agenda for Human-Computer Interaction Research: Input/Output Devices and Interaction Styles

Author(s): R.J.K. Jacob, J. Leggett, B. Meyers, and R. Pausch

E-mail Address: jacob@itd.nrl.navy.mil, leggett@cs.tamv.edu, bam@a.gp.cs.cmu.edu, or pausch@cs.virginia.edu

Citation:

Date: (In Press)

Report No.: HCI-92-039

Abstract

The bottleneck in improving the usefulness of interactive systems increasingly lies not in performing the processing task itself but in communicating requests and results between the system and its user. The best leverage for progress in this area therefore now lies at the user interface, rather than the system internals. Faster, more natural, and more convenient means for users and computers to exchange information are needed. On the user's side, interactive system technology is constrained by the nature of human communication organs and abilities; on the computer side, it is constrained only by input/output devices and methods that we can invent. The challenge before us is to design new devices and types of dialogues that better fit and exploit the communication-relevant characteristics of humans.

Title: Human-Computer Interaction in Encyclopedia of Artificial Intelligence

Author(s): R.J.K. Jacob

E-mail Address: jacob@itd.nrl.navy.mil

Citation: Encyclopedia of Artificial Intelligence, Second Edition, S.C. Shapiro (editor), 618-625, John Wiley and Sons, Inc.

Date: February 1992

Report No.: HCI-92-040

Abstract

The history of advances in the study and techniques of human-computer interaction has been intertwined with that of AI; each has contributed to the other. At times research in AI has developed techniques to improve user-computer communication, and at other times, the unique demands placed on the users and programmers of AI systems have led them to be the first to apply innovative techniques for human-computer communication. Because AI systems are often designed to perform complicated and poorly-understood tasks, they need to interact with their users more intimately than other systems and in more complex, less stereotyped ways. AI programs are also among the most complicated programs written, least amenable to being specified clearly in advance, and most unpredictable. Hence their programmers have been the first to need such advances as powerful interactive debuggers, editors, programming tools, and environments, and they have developed many of them.

Title: Software Requirements for the A-7E Aircraft
Author(s): T. A. Alspaugh, S. R. Faulk, K. H. Britton, R.A. Parker, D.L. Parnas, and J.E. Shore
E-mail Address: alspaugh@itd.nrl.navy.mil, faulk@itd.nrl.navy.mil, and britton@itd.nrl.navy.mil
Citation:
Date: February 1992
Report No.: HCI-92-041

Abstract

The Software Cost Reduction (SCR) research project introduced a new approach to specifying requirements for real-time embedded systems. The principles were applied in the development of the Software Requirements of the A-7E Aircraft, as an example of the use of the approach.

The system software requirements specification document comprises the first product in a series of products which the SCR methodology produces. The methodology is intended to be adaptable for various types of systems.

Specification properties which it supports include: (1) conciseness, (2) preciseness, (3) aids to completeness, (4) avoidance of redundancy, (5) descriptions of all externally visible behavior, (6) ease of change, (7) good reference tool, (8) record of fundamental assumptions which might otherwise be only implicit, (9) record of responses to error conditions, (10) specification of constraints on the system, and (11) separation of concerns; that is, a division of the information into distinct, independent parts.

Title: Engineering Case Tools to Support Formal Methods for Real-Time Software Development
Author(s): C. L. Heitmeyer, P. C. Clements, B. G. Labaw, and A. Mok
E-mail Address: heitmeyer@itd.nrl.navy.mil, clements@itd.nrl.navy.mil, labaw@itd.nrl.navy.mil, or mok@cs.utexas.edu
Citation: NRL-202
Date: February 1992
Report No.: HCI-92-042

Abstract

A prototype toolset is described whose goal is to provide comprehensive support for constructing verifiably correct real-time systems. The toolset supports the development of specifications in the graphical Modechart language and several methods for improving the correctness of the specifications, including formal verification, simulation, and consistency and completeness checking. An engineering approach for developing the toolset is presented that integrates software engineering principles, prototyping, and early and continued focus on user interface design. Contributions that the toolset effort makes to CASE support for formal methods are summarized.

Title: Interpreting the Language of Informational Sound
Author(s): J. Ballas
E-mail Address: ballas@itd.nrl.navy.mil
Citation: Journal of the Washington Academy of Sciences
Date: 1992
Report No.: HCI-92-043

Abstract

Sound offers advantages for information delivery of alerts, duration information, to encode rapid incoming information, for reaction time enhancement, for background

monitoring, and information intended to represent position in 3-D space around the person. To assist in utilizing these advantages, background information on auditory capabilities and design guidelines are available. This paper discusses ways of conveying information using non-speech audition, including the limitations of present applications of auditory signals, the basis of these limitations, recent developments in the field, including encoding of urgency, presenting 3-D audio and using sounds of real events in computer systems. In order to conceptualize the use of informational sound, analogies to language are presented and described. While these analogies have clear limitations, they provide a useful framework. Specifically, sounds are used analogously as exclamations, for deistic reference both to place and to entities, as simile and metaphor, and for symbolic reference. The incorporation of everyday sounds as symbols for computer processes is examined in detail. Issues in this application include the integration of the sound with a concurrent visual stimulus, and the identifiability of the sound. Recent research on causal ambiguity of everyday sounds is presented.

Title: The Perceptual Structure of Multidimensional Input Device Selection

Author(s): R.J.K. Jacob and L. E. Sibert

E-mail Address: sibert@itd.nrl.navy.mil or jacob@itd.nrl.navy.mil

Citation: Human Factors in Computing Systems Conference, CHI'92, ACM Press

Date: May 1992

Report No.: HCI-92-044

Abstract

Concepts such as the logical device, taxonomies, and other descriptive frameworks have improved understanding of input devices but ignored or else treated informally their pragmatic qualities, which are fundamental to selection of input devices for tasks. We seek the greater leverage of a predictive theoretical framework by basing our investigation of three-dimensional vs. two-dimensional input devices on Garner's theory of perception of structure in multidimensional space. We hypothesize that perceptual structure provides a key to understanding performance of multidimensional input devices on multidimensional tasks. Two three-dimensional tasks may seem equivalent, but if they involve different types of perceptual spaces, they should be assigned correspondingly different input devices. Our experiment supports this hypothesis and thus both indicates when to use three-dimensional input devices and adds credence to our theoretical basis for this indication.

Title: Evaluating Two Aspects of Direct Manipulation in Advanced Cockpits

Author(s): J. A. Ballas, C. L. Heitmeyer, and M. A. Perez

E-mail Address: ballas@itd.nrl.navy.mil or heitmeyer@itd.nrl.navy.mil

perez@itd.nrl.navy.mil

Citation: Human Factors in Computing Systems Conference, CHI'92, ACM Press

Date: May 1992

Report No.: HCI-92-045

Abstract

Increasing use of automation in computer systems, such as advanced cockpits, presents special challenges in the design of user interfaces. The challenge is particularly difficult when automation is intermittent because the interface must support smooth transitions from automated to manual mode. A theory of direct manipulation predicts that this interface style will smooth the transition. Interfaces were designed to test the

prediction and to evaluate two aspects of direct manipulation, semantic distance and engagement. Empirical results supported the theoretical prediction and also showed that direct engagement can have some adverse effects on another concurrent manual task. Generalizations of our results to other complex systems are presented.

Title: Eye Movement-Based Human Computer Interaction Techniques: Toward Non-Command Interfaces

Author(s): R.J.K. Jacob

E-mail Address: jacob@itd.nrl.navy.mil

Citation: *Advances in Human-Computer Interaction*, v4, H.P. Hartson and D. Hix (editors), Ablex Publishing Co.:Norwood, N.J.

Date: June 1992

Report No.: HCI-92-046

Abstract

User-computer dialogues are typically one-sided, with the bandwidth from computer to user far greater than that from user to computer. The movement of a user's eyes can provide a convenient, natural, and high-bandwidth source of additional user input, to help redress this imbalance. We therefore investigate the introduction of eye movements as a computer input medium. Our emphasis is on the study of interaction techniques that incorporate eye movements into the user-computer dialogue in a convenient and natural way. This chapter describes research at NRL on developing such interaction techniques and the broader issues raised by non-command-based interaction styles. It discusses some of the human factors and technical considerations that arise in trying to use eye movements as an input medium, describes our approach and the first eye movement-based interaction techniques that we have devised and implemented in our laboratory, reports our experiences and observations on them, and considers eye movement-based interaction as an exemplar of a new, more general class of non-command-based user-computer interaction.

Title: Evaluation Criteria for Real-Time Specification Languages

Author(s): P.C. Clements, C.B. Gasarch, and R. Jeffords

E-mail Address: clements@itd.nrl.navy.mil, gasarch@itd.nrl.navy.mil, or jefford@itd.nrl.navy.mil

Citation: NRL-6935

Date: February 1992

Report No.: HCI-92-047

Abstract

We develop a set of general evaluation criteria for (formal or informal) real-time specification languages. These criteria cover important properties of a specification (applicability to real-time systems, completeness, etc.) as well as techniques for analyzing those properties (verification, traceability, etc.). These general criteria are intended as a guide to development of more specific criteria during actual evaluations of languages.

Title: A Graphical User Interface for Shipboard Damage Control
Author(s): D. L. Tate
E-mail Address: tate@itd.nrl.navy.mil
Citation: 1992 NRL Review
Date: May 1992
Report No.: HCI-92-048

Abstract

The combat effectiveness and survivability of Navy ships are directly affected by the ability of the vessel to detect, analyze, report, and control the effects of damage from either accident or hostile action. To respond quickly to various kinds of damage, it is important that information from the damage control sensors be presented in a way that helps damage control personnel make a quick and accurate assessment of the nature and extent of the damage. The Human Computer Interaction Laboratory has developed a method of displaying information from shipboard damage control sensors graphically and using the graphical display for operator control of selected equipment and system functions.

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or phone 202-767-2518, FAX 202-404-8441, or email: marbury@itd.nrl.navy.mil. Please limit requests to one copy per report. Thank you.

- HCI-92-033** Canned Speech in Tactical Voice Message Systems, *G. S. Kang and D. Heide*
- HCI-92-034** 800-B/S Voice Encoding Algorithm, *G. S. Kang, and L. F. Fransen*
- HCI-92-035** Formatted Messages in Tactical Communication, *T. M. Moran*
- HCI-92-036** Dual-Task Performance as a Function of Presentation Mode and Individual Differences in Verbal and Spatial Ability, *L. B. Achille, A. Schmidt-Nielsen, and L. E. Sibert*
- HCI-92-037** Intelligibility and Acceptability Testing for Speech Technology , *A. Schmidt-Nielsen*
- HCI-92-038** Direct Manipulation and Intermittent Automation in Advanced Cockpits, *J. Ballas, C. L. Heitmeyer, and M. A. Perez*
- HCI-92-039** An Agenda for Human-Computer Interaction Research: Input/Output Devices and Interaction Styles, *R.J.K. Jacob, J. Leggett, B. Meyers, and R. Pausch*
- HCI-92-040** Human-Computer Interaction in Encyclopedia of Artificial Intelligence, *R.J.K. Jacob*
- HCI-92-041** Software Requirements for the A-7E Aircraft , *T. A. Alspaugh, S. R. Faulk, K. H. Britton, R.A. Parker, D.L. Parnas, and J.E. Shore*
- HCI-92-042** Engineering Case Tools to Support Formal Methods for Real-Time Software Development, *C. L. Heitmeyer, P. C. Clements, B. G. Labaw, and A. Mok*
- HCI-92-043** Interpreting the Language of Informational Sound, *J. Ballas*

- [] **HCI-92-044** The Perceptual Structure of Multidimensional Input Device Selection, *R.J.K. Jacob and L. E. Sibert*
- [] **HCI-92-045** Evaluating Two Aspects of Direct Manipulation in Advanced Cockpits, *J. A. Ballas, C. L. Heitmeyer, and M. A. Perez*
- [] **HCI-92-046** Eye Movement-Based Human Computer Interaction Techniques: Toward Non-Command Interfaces, *R.J.K. Jacob*
- [] **HCI-92-047** Evaluation Criteria for Real-Time Specification Languages, *P.C. Clements, C.B. Gasarch, and R. Jeffords*
- [] **HCI-92-048** A Graphical User Interface for Shipboard Damage Control, *D. L. Tate*

**V. Center for Computer High Assurance Systems
Code 5540**

The Center for Computer High Assurance Systems performs research and develops technology in areas supporting military requirements for communication security (COMSEC) and computer security (COMPUSEC). Emphasis is given to the development of concepts, architectures, analysis techniques and methodology that exploit appropriately the opportunities available through systematic consideration of the total security problem and its impact on communication and computer systems. The Center provides leadership and is the Navy's lead laboratory for research and development of COMPUSEC technology and evaluation techniques. Areas of activity include development of information security devices, subsystems and system technology through the conceptual, analysis and experimentation, and proof-of-concept phases. The Center works closely with Navy system developers and with the National Security Agency.

Title: A Single-Level Scheduler for the Replicated Architecture for Multilevel-Secure Databases
Author(s): John P. McDermott
E-mail Address: mcdermott@itd.nrl.navy.mil
Citation: Proceedings of 7th Annual Computer Security Applications Conference, 2-11, San Antonio, TX
Date: December 1992
Report No.: 5540-92-001

Abstract

The replicated architecture for multilevel secure database systems provides security by replicating data into separate untrusted single-level backends. To be successful, a system using the replicated architecture should have a database concurrency control algorithm that works correctly for replicated data and also does not introduce any covert channels. Jajodia and Kogan have developed one such algorithm that uses update sets. This paper describes an alternative algorithm that has different structural properties. The algorithm described here uses replicated transactions and conservative timestamp ordering. A new definition of correctness is required for this approach, so we present one and show how it can be used to demonstrate that our algorithm is correct. The possibility of extending the algorithm to use scheduling techniques other than conservative timestamp ordering is discussed.

Title: Using Traces of Procedure Calls to Reason About Composability
Author(s): Catherine A. Meadows
E-mail Address: meadows@itd.nrl.navy.mil
Citation: Proceedings of the 1992 IEEE Symposium on Security & Privacy, 177-188, IEEE Computer Society Press
Date: May 1992
Report No.: 5540-92-002

Abstract

Information flow models are usually conceived in terms of requirements on traces of a system, while verification that a system satisfies information flow requirements is usually done in terms of a state machine specification. The necessary translation from one model to another may result in a loss of understandability and expressiveness. Recently McLean has pointed to a solution to this problem by showing how a trace specification language, in which the traces used are traces of procedure calls on modules, may be used to reason about security, and how one may prove that a program satisfies the requirements of a specification written in that language. The language that he uses, however, does not easily lend itself to specification of composition of communicating processes. In this paper we modify the language so that it is possible to specify the composition of systems. We also define an information flow property, a generalization of noninterference to nondeterministic systems, and show that it is composable. The fact that the generalization is intuitively obvious suggests that our extension is one that will prove useful in the specification of secure systems.

Title: The Influence Of Delay Upon An Idealized Channel's Bandwidth
Author(s): Ira S. Moskowitz and Allen R. Miller
E-mail Address: moskowit@itd.nrl.navy.mil or miller@itd.nrl.navy.mil
Citation: Proceedings of the 1992 IEEE Symposium on Security & Privacy, 62-67,
IEEE Computer Society Press
Date: May 1992
Report No.: 5540-92-003

Abstract

We look at an optimization problem in calculating the bandwidth of a covert timing channel. Special function techniques and numerical analysis are used to analyze the bandwidth. This paper generalizes previous work by the authors and was motivated by an example of J. Millen.

Title: A Logical Approach to Multilevel Security of Probabilistic Systems
Author(s): James W. Gray, III and Paul F. Syverson
E-mail Address: gray@itd.nrl.navy.mil or syverson@itd.nrl.navy.mil
Citation: Proceedings of the 1992 IEEE Symposium on Security & Privacy, 164-176,
IEEE Computer Society Press
Date: May 1992
Report No.: 5540-92-004

Abstract

This paper sets out a second order modal logic for reasoning about multilevel security in probabilistic systems and derives a characterization of security in that logic. We present a possible world semantics and prove that the logic is sound with respect to it. The semantics is novel in treating probability measures themselves as possible worlds. We show that the semantic interpretation of our syntactic definition of security is equivalent to an earlier independently motivated characterization, PNI ([Gra91]). We also look at a syntactic representation of Gray's AFM (a special case of McLean's FM, given in [McL90]), and discuss the relation between these characterizations of security and between their usefulness in security analysis. We give a syntactic description of a round robin server and formally prove its security.

Title: A Multilevel Transaction Problem for Multilevel Secure Database Systems and Its Solution for the Replicated Architecture
Author(s): Oliver L. Costich and John P. McDermott
E-mail Address: costich@itd.nrl.navy.mil or mcdermott@itd.nrl.navy.mil
Citation: Proceedings of the 1992 IEEE Symposium on Security & Privacy, IEEE Computer Society Press, 192-203
Date: May 1992
Report No.: 5540-92-005

Abstract

Most of the transaction management theory for multilevel secure database systems has been developed for transactions that act within a single security class. In this paper, we look at transactions that act across security classes, that is the transaction is a multilevel sequence of database commands, which more closely resemble user expectations. We then give an algorithm for controlling concurrent execution of these transactions on a particular multilevel secure database architecture.

Title: A Practical Transaction Model and Untrusted Transaction Manager for Multilevel-Secure Database Systems

Author(s): Myong Kang, Oliver L. Costich and Judith Froscher

E-mail Address: kang@itd.nrl.navy.mil, costich@itd.nrl.navy.mil or froscher@itd.nrl.navy.mil

Citation: 6th IFIP Working Conference on Database Security, 289-310

Date: August 1992

Report No.: 5540-92-006

Abstract

A new transaction model for multilevel-secure databases which uses replicated architecture is presented. A concurrency control mechanism (scheduler) is given based on this transaction model. There are two components in the scheduler; global and local schedulers. Since the global scheduler has to make scheduling decisions based on transactions (i.e., without any knowledge of actual data or physical layout of data), an accurate analysis technique which can detect conflicts among queries is needed. The data dependence analysis introduced here provides a method to determine precisely whether the portions of relations affected by various database operations overlap without the knowledge of actual data.

Title: Discussion Summary: Fifth IFIP WG 11.3 Working Conference and Meeting

Author(s): Catherine A. Meadows

E-mail Address: meadows@itd.nrl.navy.mil

Citation: Database Security V: Status & Prospects, 387-397

Date: August 1992

Report No.: 5540-92-007

Abstract

The discussions that occurred during the IFIP WG 11.3 Fifth Working Conference and during the IFIP WG 11.3 business meeting held just afterwards are summarized below. The summary follows the chronology of the meetings. The authors of the papers and participants in the discussions have not, in general, had the opportunity to review this account; it is the product of the author's notes and recollections. Because authors have had the opportunity to revise papers (and in some cases retitle them as well) following the Working Conference and prior to their publication in this volume, readers may find some minor discrepancies between the record of discussions and the final, published version of a paper.

Title: A Classical Automata Approach to Noninterference Type Problems

Author(s): Ira S. Moskowitz and Oliver L. Costich

E-mail Address: moskowit@itd.nrl.navy.mil

Citation: Proceedings of the 1992 Computer Security Foundations Workshop, 2-8

Date: June 1992

Report No.: 5540-92-008

Abstract

Using classical automata theory we show how noninterference and restrictiveness can be viewed as the same phenomenon. We also give direction for future work concerning timing and probabilistic security problems using classical automata theory.

Title: Data Dependence Analysis for an Untrusted Transaction Manager in a Multilevel Database System

Author(s): Myong H. Kang, Henry G. Dietz, and Bharat Bhargava

E-mail Address: mkang@itd.nrl.navy.mil

Citation: Proceedings of the ISMM First International Conference on Information and Knowledge Management, 441-448

Date: November 8, 1992

Report No.: 5540-92-009

Abstract

There are two components in the scheduler for multilevel-secure databases which use the replicated architecture: global and local schedulers. Since the global scheduler, which enforces data consistency among replicas, has to make scheduling decisions based on transactions (i.e., without any knowledge of actual data or physical layout of data), an accurate analysis technique which can detect conflicts among queries is needed. The data dependence analysis introduced here provides a method for precisely determining whether the portions of relations affected by various database operations overlap without the knowledge of actual data.

Title: Orange Locking: Channel-Free Database Concurrency Control Via Locking

Author(s): John McDermott and Sushil Jajodia

E-mail Address: mcdermott@itd.nrl.navy.mil

Citation: Proceedings of the 6th IFIP WG 11.3 Working Conference on Database Security, 271-288

Date: August 1992

Report No.: 5540-92-010

Abstract

The concurrency control lock (e.g. file lock, table lock) has long been used as a canonical example of a covert channel in a database system. Locking is a fundamental concurrency control technique used in many kinds of computer systems besides database systems. Locking is generally considered to be interfering and hence unsuitable for multilevel systems. In this paper we show how such locks can be used for concurrency control, without introducing covert channels.

Title: The Handbook for the Computer Security Certification of Trusted Systems

Author(s): Charles Payne and Judith Froscher

E-mail Address: payne@itd.nrl.navy.mil or froscher@itd.nrl.navy.mil

Citation: Proceedings of the MIT.COM Conference '92

Date: October 1992

Report No.: 5540-92-011

Abstract

The Navy has designated the Naval Research Laboratory (NRL) as its Center for Computer Security Research and Evaluation. NRL is actively developing a Navy capability to certify trusted systems. This paper describes the NRL effort to understand assurance, certification, and trusted system certification criteria through the production of the Handbook for the Computer Security Certification of Trusted Systems. Through this effort, NRL hopes to discover new and more efficient ways of satisfying the assurance requirement for high assurance systems.

Title: An Internetwork Authentication Architecture
Author(s): Randall J. Atkinson
E-mail Address: atkinson@itd.nrl.navy.mil
Citation: IEEE Networks or Transactions on Networking (NRL Formal Report in Preparation)
Date: 1992
Report No.: 5540-92-012

Abstract

Current internetworks do not have effective host-to-host authentication mechanisms. The lack of these mechanisms contributes substantially to currently widespread network security problems. Public key authentication is a good approach to providing optional authentication in internetworks. An internetwork authentication architecture using public key authentication technology is proposed as a possible mechanism to substantially improve the security of large internetworks. Limitations of the proposed authentication architecture are also described.

Title: A Comparison of ISDN and LAN Technologies for Shipboard Use
Author(s): Randall Atkinson
E-mail Address: atkinson@itd.nrl.navy.mil
Citation: Proceedings: IEEE Military Communications, 21.2.1 - 21.2.3
Date: 1992
Report No.: 5540-92-013

Abstract

This paper discusses the use of ISDN, B-ISDN and FDDI for use as link protocols aboard ship. Connectionless services and connection-oriented services are compared and their appropriateness for use in a tactical environment is analyzed. Conclusions are drawn on which technology is most appropriate for shipboard use and for use between land-based command centers.

Title: IFIP WG11.3 Database Security: Research Questions of Current Significance
Author(s): Carl E. Landwehr
E-mail Address: landwehr@itd.nrl.navy.mil
Citation: Database Security, V: Status and Prospects, 399 North Holland
Date: August 1992
Report No.: 5540-92-014

Abstract

The Research Question list is intended both to reflect issues of current importance in providing/improving security in database systems and to provide a central focus for the activities of WG 11.3. It is revised periodically, and reports of WG 11.3 address the current questions.

Title: The ECA Critical Requirements Model
Author(s): Charles Payne, David Mihelcic, Andrew Moore and Kenneth Hayman
E-mail Address: payne@itd.nrl.navy.mil or mihelcic@itd.nrl.navy.mil
Citation: NRL Report 9528
Date: December 28, 1992
Report No.: 5542-92-001

Abstract

The ECA is an embedded computing device that processes message traffic for a network that must enforce end-to-end user message confidentiality. The ECA uses a commercial, off-the-shelf cryptographic device to transform sensitive data from the Red Domain of the network so that it can be transmitted over the untrusted communication links of the Black Domain. For transmission purposes, certain parts of a message, namely the message header, must be bypassed around the cryptographic device. The primary critical requirement for the ECA, "Restricted Red-to-Black Flow" (RRTBF), requires that the bypassed portion of each message must satisfy certain format restrictions, and that the rate of bypass must be constrained. In this report, we present an informal model of the ECA's critical requirements together with the assumptions under which the model was constructed. We then formalize this model by using the CSP Trace Model of computation.

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- 5540-92-001 A Single-Level Scheduler for the Replicated Architecture for Multilevel-Secure Databases, *John P. McDermott*
- 5540-92-002 Using Traces of Procedure Calls to Reason About Composability, *Catherine A. Meadows*
- 5540-92-003 The Influence Of Delay Upon An Idealized Channel's Bandwidth, *Ira S. Moskowitz and Allen R. Miller*
- 5540-92-004 A Logical Approach to Multilevel Security of Probabilistic Systems, *James W. Gray, III and Paul F. Syverson*
- 5540-92-005 A Multilevel Transaction Problem for Multilevel Secure Database Systems and Its Solution for the Replicated Architecture, *Oliver L. Costich and John P. McDermott*
- 5540-92-006 A Practical Transaction Model and Untrusted Transaction Manager for Multilevel-Secure Database Systems, *Myong Kang, Oliver L. Costich and Judith Froscher*
- 5540-92-007 Discussion Summary: Fifth IFIP WG 11.3 Working Conference and Meeting, *Catherine A. Meadows*
- 5540-92-008 A Classical Automata Approach to Noninterference Type Problems, *Ira S. Moskowitz and Oliver L. Costich*
- 5540-92-009 Data Dependence Analysis for an Untrusted Transaction Manager in a Multilevel Database System, *Myong H. Kang, Henry G. Dietz, and Bharat Bhargava*
- 5540-92-010 Orange Locking: Channel-Free Database Concurrency Control Via Locking, *John McDermott and Sushil Jajodia*
- 5540-92-011 The Handbook for the Computer Security Certification of Trusted Systems, *Charles Payne and Judith Froscher*

- [] 5540-92-012 An Internetwork Authentication Architecture, *Randall J. Atkinson*
- [] 5540-92-013 A Comparison of ISDN and LAN Technologies for Shipboard Use, *Randall Atkinson*
- [] 5540-92-014 IFIP WG11.3 Database Security: Research questions of Current Significance, *Carl E. Landwehr*
- [] 5542-92-001 The ECA Critical Requirements Model, *Charles Payne, David Mihelcic, Andrew Moore and Kenneth Hayman*

VI. Transmission Technology

Code 5550

The Transmission Technology Branch conducts a research and development program directed toward the improvement of information transmission and reception between surface, air, submerged and space platforms. The Branch mission includes understanding and developing approaches to satisfy the need for affordable, efficient and robust dissemination of combat management information. In support of this goal, the Branch investigates all aspects of the process of information transfer including the development of state-of-the-art transmission equipment as well as research into antennas and channel propagation phenomena. Emphasis is placed on those aspects of transmission technology that permit adaptation to inhospitable natural or man-made environments. In addition, the Branch conducts research and development in support of signal intercept and related intelligence system projects. Areas of activity include; (1) Wideband HF architecture and RF system engineering, (2) Communication channel characterization including Arctic communication issues, (3) Intercept system analysis, development, and prototype evaluation, (4) Satellite and space communication technology and (5) Research into wideband and compact antenna systems.

Title: Proceedings of the Workshop on Integrated Cryogenic Satellite Design: Current Practice and Future Possibilities
Author(s): Junho Choi, Editor
E-mail Address: jchoi@itd.nrl.navy.mil
Citation: NRL Memorandum Report 6946, Naval Research Laboratory, Washington, DC
Date: October 21-22, 1991 (c1992)
Report No: TT-92-001

Abstract

This workshop emphasized the many roles that cryogenic technology plays in the development, integration, implementation, and utilization of cryogenic spacecraft sensors. Current spacecraft design evolution has been driven by room-temperature electronics devices. The purpose of this workshop was to investigate satellite design evolutions that may be driven by cryogenic electronics or systems. Two main objectives are to determine the impact of cryogenic systems on the operational capability of satellite systems and to assess potential methods of cooling spacecraft.

Title: Radial Ground Screen Design for a Vertical Monopole
Author: Michael A. Rupar
E-mail Address: rupar@itd.nrl.navy.mil
Citation: RF Design, v15, n1, 29-33
Date: January 1992
Report No: TT-92-002

Abstract

The characteristics of vertical monopole antennas are generally well defined. However, one factor that is not easily understood is the influence of the ground constants (the conductivity, σ , and relative dielectric constant, ϵ_r) on the input impedance of a vertical monopole. Considering that the input impedance of a monopole less than a quarter-wave-length in height may have a resistive part less than one ohm, the change in the antenna's input impedance caused by an imperfect ground can be significant.

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TT-92-001 Proceedings of the Workshop on Integrated Cryogenic Satellite Design: Current Practice and Future Possibilities, *J. Choi*

TT-92-002 Radial Ground Screen Design for a Vertical Monopole, *M.A. Rupar*

VII. Advanced Information Technology Code 5580

The Advanced Information Technology Branch of the Information Technology Division develops and implements cutting edge hardware and software solutions for Navy problems in a number of application areas. Current research and development thrusts include:

- parallel and distributed hardware, software and display technologies;
- novel signal processing techniques directed primarily toward the exploitation of massively parallel systems;
- development of hardware independent systems for developing and porting code for parallel processing systems;
- design and implementation of reactive and interactive control systems;
- development of technologies for decision support systems and prototyping of all varieties of decision systems including tactical decision aids and mission planning;
- exploration and demonstration of new methods for data management including data fusion, design and navigation of database systems, and correlation and tracking of current and historical information; and display technologies for visual management of all of the above applications.

The technical programs in the Branch include some basic research (6.1), a substantial exploratory development program (6.2) and a continuing effort to field technology through a succession of advanced technology demonstrations (6.3a). The Branch draws on expertise in computer science, mathematics, operations research, electrical engineering and physics.

Title: Simulations of Acoustic Fields on a Massively Parallel Computer
Author (s): S.K. Numrich, R.A. Krutar, D.B. Creamer, and J.B. Cole
E-mail Address: numrich@itd.nrl.navy.mil
Citation: Conference
Date: 1992
AIT Report No: AIT-92-001

Abstract

Through use of finite difference computations cast in a cellular automation architecture, we have developed an efficient and flexible solution to the wave equation in two and three dimensions. The solution has been implemented on a Connection Machine, a massively parallel SIMD computer. The model permits the use of multiple sources, a variety of boundaries and the ability to change the speed of sound in the fluid medium. Results have been tested against known physical field behavior and numerical solutions in several cases where exact analytical solutions are available. The output can be displayed as the field develops in time and the resultant animated video gives additional insight into the physical processes that give rise to the field behavior. Among the illustrations shown are visualizations of diffraction in near and far field, evanescent waves, source interference phenomena and the ideal wedge benchmark suggested by the Acoustical Society of America.

Title: Computation of Acoustic Fields on a Massively Parallel Processor Using Lattice GA Methods
Author(s): S.K. Numrich, R.A. Krutar, and R. Squier
E-Mail Address: numrich@itd.nrl.navy.mil
Citation: Computational Acoustics, v1, 81
Date: 1992
AIT Report No: AIT-92-002

Abstract

We have begun to explore lattice GA methods in the computation of acoustic field behavior. The model being implemented was developed by Hudong Chen, Shiyi Chen, Gary Doolen and Y.C. Lee as a solution to the wave equations and was redesigned for the Connection Machine by an NRL research team. In addition to providing a parallel implementation, we have added the ability to model independently driven point sources, each with its own amplitude, frequency and phases. These sources have been used to test new array configurations as well as replicate familiar beam patterns for shaded and unshaded arrays. The model can handle both rigid and pressure release boundary develop global field behavior through defining only local interactions. Once physical behavior, a pressure release boundary, for example, has been correctly modeled by these local interactions, it can be placed as isolated points or aggregates in any chosen geometry at any position in the field, and replicated as often as desired. As an illustration, we have modeled the interaction of a propagating sound field through a random distribution of pressure release points in imitation of a school of fish. The output of the model shows the two-dimensional evolution of the sound field as it emerges from the source array, encounters the biological clutter and propagates partially through and is scattered by the distribution of modeled swim bladders.

Title: Algorithms for Multiple-Target Tracking
Author(s): Jeffrey K. Uhlmann
E-mail Address: uhlmann@itd.nrl.navy.mil
Citation: American Scientist, v80, n2
Date: 1992
AIT Report No.: AIT-92-003

Abstract

This article describes new theoretical and practical breakthroughs in the area of multiple-target tracking and correlation. These results surmount combinatorial obstacles that have plagued the field for almost 50 years. In addition to historical background detailing the problem, the first-ever sketch of its complete solution is provided. Empirical results demonstrate the revolutionary progress that has been achieved and the prospect for applying the results to tracking problems considered thoroughly intractable just a few years ago.

Title: A MOD LOC Vulnerability Assessment Tool
Author(s): Jeffrey K. Uhlmann
E-mail Address: uhlmann@itd.nrl.navy.mil
Citation: Proceedings of the Conference on Command and Control Decision Aids
Date: 1992
AIT Report No.: AIT-92-004

Abstract

Simply identifying the single best, or even the k best, avenues of approach for an enemy target is not enough. An ASW commander needs to know generally how vulnerable the carrier is and whether available resources are sufficient to eliminate all of the significant holes in the current sensor coverage. This report describes a decision aid display paradigm that simultaneously presents information about all optimal avenues of approach from all possible sub positions. Implementation issues for real-time performance are described.

Title: Classification of Underwater Targets using Bayesian Networks
Author(s): Ranjeev Mittu
E-mail Address: mittu@itd.nrl.navy.mil
Citation: CISC '92 Conference Proceedings
Date: 1992
AIT Report No.: AIT-92-005

Abstract

The Battle Management Technology (BMT) Branch of the Naval Research Laboratory (NRL) has been involved in building ASW decision support systems for the purpose of assisting the ASWC for a number of years. Recently the BMT branch began development of systems designed to detect, track and classify underwater targets based on information received from passive sonar. The program was named the Integrated Acoustic Decision Support System, or IADSS, and the classification scheme involved the use of Bayesian belief networks. This paper will explore the design of the Bayesian network classifier.

Title: Implementing Metric Trees to Satisfy General Proximity/Similarity Queries

Author(s): Jeffrey K. Uhlmann

E-mail Address: uhlmann@itd.nrl.navy.mil

Citation: NRL memo report

Date: 1992

AIT Report No.: AIT-92-006

Abstract

Efficient metric tree construction and search routines are developed and ANSI C source code with test results are provided. The routines will permit the satisfaction of proximity/similarity queries in arbitrary metric spaces. An efficient, dynamic classification technique is also described.

Title: Construction of a Likelihood Function for Information from Active Sonar Systems in a Nonlinear Filter

Author(s): Becky Mahal

E-mail Address: mahal@itd.nrl.navy.mil

Citation: DAWG '92, Book of Proceedings

Date: 1992

AIT Report No.: AIT-92-007

Abstract

Likelihood functions are an essential part of the nonlinear filter used in the CALOW TABS decision support system. In this paper we will guide you through the construction and design of the active detection likelihood function used for measurement data from active sonobouys.

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- AIT-92-007** Construction of a Likelihood Function for Information from Active Sonar Systems in a Nonlinear Filter, *Becky Mahal*