Faculty of
Engineering

RESEARCH PROJECTS

Winning Strategies for Colouring Games

- ✎ CAI Leizhen
- ❑ 1 October 1998
- ❖ CUHK Research Committee Funding

The *edge colouring game* is a two-player game played on a graph *G*. Two players Alice and Bob use a pre-determined set of colours to colour the edges of the graph alternately. Alice moves first. In each move, a player chooses an edge *e* and assigns to it a colour that has not already been assigned to edges adjacent to *e*. The game stops when a player cannot make a legal move. Alice wins when all edges of *G* are coloured; otherwise Bob wins. The smallest number of colours for which Alice has a winning strategy is called the *game chromatic index* of *G*. This colouring game is motivated by applications where parties with conflicting interests are involved in resource allocation.

The aim of this project is to design winning strategies for Alice and establish lower and upper bounds for game chromatic indices when the game is played on graphs of various types. (EE98009)

An intelligent system for medical data mining and visualization

- ✎ HENG Pheng Ann ● FU Wai Chee Ada ● LEUNG Kwong Sak ● CHENG Chun Yiu Jack (Orthopaedics & Traumatology)
- ❑ 1 November 1998
- ❖ Research Grants Council

The revolutionary use of imaging modalities in medicine such as computed tomography, magnetic resonance, ultrasound, nuclear medicine and other forms of computer-assisted diagnostic radiology, have not only provided many powerful diagnostic tools to the physicians, but also turned hospitals into medical data warehouses. In this project, we propose to develop an intelligent system for interactive medical data mining and visualization in order to explore and analyze these large medical databases. Such a data mining system will enable physicians or researchers or researchers to extract more clinically useful information from multiple datasets in order to achieve more accurate diagnosis or help make a better surgical decision together with interactive medical visualization tools for visual comparison and surgical simulation. The system would be an ideal tool for training and research in diagnostic imaging. Medical image sets that are representative of certain pathologies can be extracted and compiled from different databases for training, and diagnostic utility of various imaging modalities can be compared and evaluated over a broad set of extracted cases. We will also focus on automatic knowledge acquisition and knowledge discovery in mining medical databases for diagnosing patients based on genetic techniques applied on suitable imaging modalities. (CU98306)

Virtual Reality, Visualization and Imaging Research Centre

- ✎ HENG Pheng Ann ● LEUNG Kwong Sak ● SUN Hanqiu ● TSUI Hung Tat (Electronic Engineering) ● WONG Chak Kuen ● XU Yangsheng (Mechanical and Automation Engineerin) ● ZHANG Yuanting (Electronic Engineering) ● HJELM Nils Magnus (Chemical Pathology) ● CHAM Wai Kuen (Electronic Engineering) ● FU Wai Chee Ada ● HUI Kin Chuen (Mechanical and Automation Engineerin) ● KING Kuo Chin Irwin ● LEE Tong (Electronic Engineering) ● LI Wen Jung (Mechanical and Automation Engineerin) ● LIAO Wei Hsin (Mechanical and Automation Engineerin) ● WONG Kin Hong ● XU Jianbin (Electronic Engineering)
- ❑ 15 March 1999
- ❖ Co-operative Research Centres Scheme

We propose to establish a "Virtual Reality, Visualization and Imaging Research Centre", with strong emphasis on developing the state of the art technologies to facilitate research advancement and technology transfer of interdisciplinary applications that involved powerful visualization, advanced imaging, and innovative virtual reality techniques.

Central to our vision are the following two core system concepts:

(1) *Medical and Surgical Virtual Environment*

By incorporating advanced technologies from biomedical visualization, medical imaging, haptical interface, image-guided surgery, image-guided robotics, tele-robotics, machine intelligent, and distributed networking, we propose to develop a virtual environment that is applicable to surgical training, surgery simulation, tele-consultation, tele-diagnosis, computer-assisted surgical planning, and computer-assisted surgical execution. The end result is a customizable computer integrated surgery system that can enhance surgeons' operating skills and overcome many traditional surgery limitations. We hope to improve medical training and surgical practice through such an intelligent virtual environment that consists of many new advances in computing and engineering technologies.

(2) *Engineering and Prototyping Virtual Environment*

By incorporating enabling technologies from virtual reality, visualization, and imaging, we propose to develop a virtual environment that is applicable to rapid prototyping, concurrent engineering and

massive information/data visualization. The result is a customizable integrated digital product development environment that can reduce production time and improve product quality. We also aim to provide other advanced technologies such as 3D metrology, collaborative scene visualization, delicate virtual sculpting, intelligent data analysis and mining, as well as accurate models for design analysis. (EE98037)

Image Data Mining and Visualization for Cardiac MR

- ? HENG Pheng Ann ● YANG Guang Zhong* ● FU Wai Chee Ada ● TSUI Hung Tat (Electronic Engineering) ● ZHANG Yuanting (Electronic Engineering)
- ❑ 1 April 1999
- ❖ UK/Hong Kong Joint Research Scheme, the British Council

Recent advances in fast cardiac magnetic resonance imaging have enabled the acquistion of detailed anatomical and functional information within a short period of time. Being non-invasive and versatile, MR imaging is ideal for detecting abnormal cardiovascular function, and monitoring the progression and effectiveness of intervention procedures, either for preventative or therapeutic measures. These advances require rapid retrieval and effective management of large quantity of image data. To this end, cardiac image data mining, which involves sieving through large volumes of image data to locate salient spatio-temporal features, is needed.
In addition to image data mining, new interactive computerized visualization techniques will provide a multi-dimensional and easily interpretable representation of anatomical and functional imaging data. This combined approach with the incorporation of data residing in the Hospital Information System (HIS) will provide clinicians with an effective cardiovascular diagnostic tool.
The purpose of this project is to develop new image data mining, interactive visualization and intelligent data representation techniques for cardiovascular magnetic resonance images and their integration into hospital information system.
(EE98042)

A Pilot Scheme on "Q-Mark" Software for Hong Kong Quality Education

- ✍ KAN Wing Kay
- ❑ 1 August 1998
- ❖ Quality Education Fund

The objectives of the proposed "Q-mark" Software Scheme for HK quality education are achieved in the mechanism similar to the product review performed by the HK Consumer Councils. The reviews involve software selection, user evaluation and expert recommendation. In order to evaluate the effectiveness of the pilot, recommended software will be installed and evaluated in the participated schools for trial and comment. Teachers and students will feedback their needs and requirement for using software in their teaching and learning. Based on the evaluation and feedback, focal study and research will then be performed to make the appropriated recommendations to all parties involved in the development of education software for local curriculum.
(1) To collect the information and available titles of software packages for education purpose form local and overseas markets through different channels, such as publishers and software developers, libraries and Internet, and suggestions from teachers and experts.
(2) To evaluate the selected software for analysis and recommendation.
(3) To publish and disseminate the evaluation results.
(4) To promote the use of quality education to schools, teachers and students.
(EE98051)

Electronic Commerce Front End for Hong Kong Apparel Industry Community

- ? KING Kuo Chin Irwin ● FU Wai Chee Ada ● CHAN Lai Wan ● XU Lei
- ❑ 1 September 1998
- ❖ Industrial Support Fund, Industry & Technology Development Council

The objective of this project is to enhance the global competitiveness of the Hong Kong apparel industry through wide spread use of a cost effective electronic commerce front end. The World Wide Web (WWW) is currently the most popular Internet navigation tool for finding and getting information in a multimedia format with colour graphics, audio and video. Although only a recent development, it is already being used extensively for electronic commerce. The proposed project will develop a web site which offers a simple and fundamentally sound industrial standard for the Hong Kong textile and clothing industrialists to build their own web sites. This will minimize the cost to advertise their product/service on the web in textile and clothing industry. The web site will also provide a search engine by category using parameters for fabric, trims, merchandising and enabling technologies so that users can source as well as to compare products and services. Furthermore, the projects will assist small and medium size enterprises to actively participate in the Quick Response Centre and to adapt new technology.
(EE98045)

Using Stochastic Methods to Guide Search in Constraint Programming

- ✍ LEE Ho Man Jimmy ● LEUNG Ho Fung ● STUCKEY P. J.*
- ❏ 1 November 1998
- ❖ Research Grants Council

Constraint satisfaction problems (CSP's), NP-hard in general, occur in all walks of industrial applications, such as scheduling, binpacking, resource allocation, among others. A general algorithm designed to solve any CSP will necessarily require exponential time in problem size in the worst case. Traditional search-based constraint-solving, typically used in constraint programming (CP), allows systematic enumeration of the search space. While stochastic methods can be considerably more efficient than their search-based counterparts, users do not have control on how the answer is generated. The aim of this project is to investigate a general integration framework for CP and stochastic solvers so as to speed up the solution search process. We propose to use the stochastic solver, instead of being the principal solver of a CP system, to augment the existing solver of the CP system. The developed technique will be useful in tackling large-scale and very difficult CSP's. The need for the proposed system is urgent since the ability to handle larger CSP's implies more robust and efficient products and services, and higher profit margin for the industrial sectors.
(CU98302)

Adaptive Transform Domain Video Indexing

- ✍ LEE Moon Chuen ● ADJEROH Donald#
- ❏ 1 December 1998
- ❖ CUHK Research Committee Funding

The performance of video indexing algorithms can be improved if techniques could be developed, which can adaptively determine the indexing parameters on the basis of the specific characteristics of the scene being indexed. The proposed project aims to develop such a scene-adaptive mechanism for transform domain video indexing, which can lead to enormous gains in both robustness and efficiency. Researchers characterise the video scene in terms of its complexity based on the motion and activity in the scene. Then, using the characterization, we plan to make the video indexing process adaptive, by relating the error parameters with the particular characteristic of the video scene, and the video quality. This project will serve as a pilot study for a forthcoming full-scale project which aims at applying the adaptive techniques to the general problem of video sequence analysis, for operations on video encoded by using different compression techniques, and for the dynamic selection of abstractions for digital video.

Moreover, the results of the research will be of great importance in general application areas that require access to large-scale video repositories, such as digital libraries, and Internet search engines.
(EE98010)

Architectures and Implementations of Constraint Systems on FPGA Hardware

- ✍ LEONG Philip Heng Wai
- ❏ 1 December 1998
- ❖ CUHK Research Committee Funding

Constraint satisfaction problems (CSPs) are an important class of problems in the field of artificial intelligence which find application in such areas as computer vision, planning, resource allocation, temporal reasoning etc. CSPs are usually NP complete and require large amounts of computing power to find solutions, even if efficient algorithms are used. Constraint solving systems have traditionally been implemented on general purpose computers or supercomputers. In this project searchers propose to develop new computing architectures and field programmable gate array (FPGA) implementations to solve constraint problems in real-time. Specialised VLSI hardware has the disadvantage of being expensive and requiring long fabrication times. In contrast, FPGAs can be reused, minimising the cost, and has fabrication times of milliseconds. This technology thus allows more aggressive and problem specific designs to be made which can ultimately result in a faster overall system. The resulting system will have several orders of magnitude improvement in performance over other approaches and enable us to solve CSPs in real-time and/or problems previously intractable using other approaches.
(EE98011)

Soft Constraint-Based Scheduling in Intelligent Multiagent Systems

- ✍ LEUNG Ho Fung ● LEE Ho Man Jimmy ● CLARK K. L.*
- ❏ 15 October 1998
- ❖ Research Grants Council

The Investigation of Constraint Satisfaction Problems (CSP) is a very active branch in the research in Artificial Intelligence (Al). Informally, a CSP can be described as a system that consists of a finite set of variables, each ranging over a finite domain, as well as a finite set of constraints that restrict the (combination of) values the variables can take. Many real-life problems, such as scheduling and resources allocation, can be naturally modelled as CSP's. An assignment to the variables that satisfies "all" constraints is said to be a *solution* to the CSP. A *soft*

CSP is a CSP in which the constraints are not strict and need not be fully satisfied.

Multiagent Systems is another area that is attracting much attention from many researchers in AI. A multiagent system is a software system that consists of agents, `software robots' that are *autonomous* (they have control over their actions and internal states), *sociable* (they communicate with one another and possibly humans), *reactive* (they perceive the environment and respond to the changes), and *pro-active* (they take initiatives).

It is an interesting and important topic to investigate the problem of multiagent co-operative (soft) constraint satisfaction. Intuitively, each of the agents in such a setting has its private set of (soft) constraints over a common set of variables. These agents need to communicate, negotiate and (possibly) compromise to achieve a globally acceptable solution. This project aims at investigating such a problem, devising new techniques and efficient communication protocols for this problem.
(CU98304)

Using Evolutionary Computation on Large Scale Information Fusion

- ✐ LEUNG Kwong Sak
- ❑ 1 October 1998
- ❖ CUHK Research Committee Funding

The investigation in the research proposal is to establish a suitable aggregation model in large scale information fusion where the data are allowed to be continuous. After discretizing the data, by using evolutionary computation, researchers learn a Bayesian network to detect the correlation among attributes qualitatively. Then a dependency analysis is made to reduce the number of attributes and, therefore, the complexity of the problem. Returning to use continuous data, researchers introduce a new nonlinear multiregression as an aggregation tool for information fusion. This nonlinear multiregression model is based on nonadditive set functions (fuzzy measures) and relevant nonlinear integrals, such as Choquet integrals, pan-integrals, and another new type of nonlinear integral defined by the investigator, that can describe the inherent interaction among attributes. Regarding the values of the employed set function as the unknown parameters (regression coefficients), a special evolutionary algorithm is developed to determine them. Researchers will also develop a non-linear integral based network that can used for representing relationship amongst data of continuous and discrete types. Their overall system will be evaluated through two real database obtained from the Department of Orthopedics and Traumatology in Prince of Wales Hospital. Thus, the proposed project will contribute significantly in basic and applied research in heterogeneous data mining

and help the business and industry to exploit the possible applications.
(ED98004)

Design and Implementation of a Multi-users Virtual Exploration System

- ✐ LUI Chi Shing John
- ❑ 1 December 1998
- ❖ CUHK Research Committee Funding

With the advances in multimedia systems, parallel/distributed database systems and high speed networking technologies, it is now possible to build a system which allows many users to virtually explore a 3D environment (e.g., a new city, a new office building, a natural science museum,...etc) under the same session and at the same time, users under the same virtual environment session should be able to interact with each other and an action taken by any user should also be *visible* by other users. This way, users can communicate with each other and they should also have the capability to extract any relevant information about the virtual environment that they are exploring. In this research proposal, researchers propose to investigate, design as well as implement such kind of virtual exploration and information retrieval system. They plan to extend and utilize the technical experience they have accumulated in the VINCENT (Virtual INformation and Concurrent Exploration NeTworking System) research project [1]. The major limitation of the VINCENT system is that it only allows a single user to explore the 3D environment, which is a large scale, high resolution graphical environment composes of many high-resolution 3D sub-objects. Although the VINCENT system allows multiple users to explore the virtual environment in *different sessions*, but this restriction also limits the interaction among users who are exploring the same virtual environment. Researchers propose to address the following technical issues:

(1) Capability of allowing multiple users to explore the same 3D environment concurrently and at the same time, users can interact with each other in the same virtual 3D environment.

(2) Design, analyze, and implement various communication protocols in their system so that they can overcome the problem of network bandwidth limitation (either in LAN or WAN environments) and network latency.

(3) Design, analyze and implement various object (or avatar) communication protocols so that users in the same 3D environment will have a consistent view of the virtual environment.

(4) Design and implement a parallel database inference engine so that users will be able to retrieve relevant information about the 3D environment.

(EE98013)

Structure-Based Software Reliability Modeling Techniques

- ✍ LYU Rung Tsong Michael
- ❑ 1 October 1998
- ❖ CUHK Research Committee Funding

The subject of reliability modeling and analysis for software systems has been mostly approached by black-box schemes without looking into the structure of the systems. In this project, researchers propose to investigate architecture-based, white-box methods for a series of generic software reliability problems, including reliability allocation, testing, integration, and analysis. Researchers plan to derive reliability allocation methods, conduct structure-based testing schemes, apply software reliability models, and construct simulation techniques for software reliability analysis. Their approach is to express the reliability measure of an integrated system by examining system architectures and module dependencies. Researchers will develop and evaluate methods to estimate the reliability of a product, given the reliability of its components and its architecture. The software component development and product integration process will be refined using feedback control concepts. Researchers plan to design and implement a systematic tool to encapsulate the techniques we formulate in this project and encourage its distribution to industry and academia. This research is important to the software industry for the development, testing and quality assurance of modern complex software systems. It is also critical to the software acquisition and integration effort of other major industry in Hong Kong, including transportation industry, finance industry and information industry, which heavily rely on dependable software-intensive systems for daily operations. The recent turmoil in the opening of the new Hong Kong International Airport contributed to software system errors reinforce the urgency of this software reliability engineering work. (EE98003)

Architecture-Based Techniques and Tools for Software Reliability Engineering

- ✍ LYU Rung Tsong Michael ● KANOUN Karama*
- ❑ 31 March 1999
- ❖ France/Hong Kong Joint Research Scheme

In this project, the researchers investigate architecture-based, white-box methods for a series of generic software reliability problems, including reliability allocation, testing, integration, and analysis. This objective is achieved by exploiting the internal structure of a software system's code and its module interactions, and by incorporating this information into the reliability analysis effort. The significance of this research is its attempt to solve the urgent and difficult problem of making reliability predictions for different software configurations and environments. It also provides an early engagement of reliability engineering efforts in the front-end of the software engineering life cycle. These efforts include component reliability allocation and acquisition, software testing strategies, resource planning and project scheduling, and feedback control for optimal software design architectures. This research is important to the software industry for the development, testing and quality assurance of modern complex software systems. It is also critical to the software acquisition and integration effort of other major industry in Hong Kong and France, including avionics industry, transportation industry, finance industry and information industry, which heavily rely on dependable software-intensive systems for daily operations. (EE98039)

High-level Synthesis for Dynamically Reconfigurable FPGAs

- ✍ NG Kam Wing
- ❑ 1 December 1998
- ❖ CUHK Research Committee Funding

Whilst there are well-established techniques for the high-level synthesis of ASICs with fixed or static programmable architectures, DR FPGAs pose a difficult challenge for the development of high-level automated design tools due to the need for dynamic hardware allocation. The major difficulty is a lack of understanding of the effect of dynamic reconfiguration, and guidance on how to develop reconfigurable designs. There have been very few studies on modeling and high-level synthesis methods for dynamic reconfiguration, on identifying automatically reconfigurable regions from behavior description and on automatic synthesis of reconfiguration controller. The objectives of researchers' work are to enhance the effective use of reconfiguration technology by addressing these issues. In this project, researchers propose to investigate a modeling technique that describes a design in a mixed schema that combines the advantages of both graph-based and algebra-based approaches, such that reconfigurability can be abstracted, analyzed and synthesized. This model can be used to solve efficiently the dynamic reconfigurability for a series of generic DR FPGAs high-level synthesis problem, including the automatic identification of reconfigurable regions, data-path and control-path synthesis. Researchers plan to develop a dynamically scheduling system that combines data-flow and control-flow techniques and contains a reconfiguration control-partitioning algorithm for

design space exploration and reconfiguration controller synthesis.
(EE98014)

Design Framework and Tools for Reconfigurable Computing

- ✍ NG Kam Wing ● LUK Wayne*
- ❑ 1 June 1999
- ❖ UK/Hong Kong Joint Research Scheme, the British Council

Reconfigurable computing involves computations implemented in advanced field-programmable gate array (FPGA) technology, which combines the flexibility of general-purpose computers with a speed approaching that of application-specific integrated circuits. Design frameworks and tools for reconfigurable computing are still at a primitive stage, and this project aims to improve the state-of-the-art in this area. The research will involve comparing and combining complementary techniques and tools currently under development at Imperial College and the Chinese University of Hong Kong. Such techniques include graph-based design models and optimization methods based on genetic algorithms and linear programming. Various case studies, from video processing and other fields, will be used to evaluate our approach.
(EE98043)

Pose-based Virtual Hand Input in VR Applications

- ✍ SUN Hanqiu
- ❑ 1 December 1998
- ❖ CUHK Research Committee Funding

As the hands are the primary connection of human beings to the physical world, mechanical manipulation such as assembly has been performed by robot hands/arms that are fully programmed for the task. It is usually costly and complex to program a robot hand/arm for performing a specific task. The construction of virtual environments allows human operators to conduct off-line robot programming in computer-synthesized worlds through human-computer interaction. DataGlove interfaces play an important role in transferring the dexterity and naturalness that characterize human hands into mechanical manipulation tasks themselves.

The main goal of this research is to investigate recognition algorithms that are capable of dealing with imprecise device-sensing data; to develop efficient recognition process that minimizes the CPU time in VR applications; to develop flexible recognition system that can work with any set of postures without any modification of the system architecture. The output of the research will feature

better human-computer interactions, reduce the limitations of 2D windowing environments by incorporating pose-based hand input and dexterous hand manipulation directly in the immersive virtual environment, and improve the efficiency developing the robot hands/arms programming systems and applications. It will benefit the VR community of Hong Kong in automated assembly operations, architectural modeling, manufacturing design, and robotics and tele-operation simulation.
(EE98015)

Constrained Global Search and Its Application to Subband Image Coding

- ✍ WAH Wan Sang Benjamin
- ❑ 1 October 1998
- ❖ CUHK Research Committee Funding

Digital imaging is very important in many industrial and real-life applications, especially in multimedia computing. Recently, subband or wavelet image coding has become a cutting-edge technology for image compression. In this research, the researchers have formulated subband image coding as a nonlinear constrained optimization problem and study methods to solve it efficiently. Their research has led to the following results.

They have formulated subband image coding as a constrained optimization problem. Such a formulation involves multiple objectives and constraints, derived from domains of signal processing, coding theory, and wavelet theory. Since the overall problem is a highly nonlinear mixed-integer optimization problem, involving both continuous and discrete variables, we have studied two subproblems involving the search of subband/wavelet transforms and the quantization and bit allocation of subimages.

They have studied efficient sequential search methods for solving these optimization problems. This research is challenging, as nonlinear constraints may be hard to satisfy, and nonlinear objectives may have many local minima, making good solutions very difficult to find. Based on their previous work on global search, they have developed a global-search framework that combines global-search algorithms with local-search algorithms. To handle constraints in both global and local search, they have extended their discrete Lagrangian theory to solve discrete as well as mixed integer problems.
(EE98004)

On Algorithmic Fundamentals of Computer-Assisted Medical Diagnosis

- ✍ WONG Chak Kuen
- ❑ 1 September 1998
- ❖ Research Grants Council

The application of neural networks to image-based medical diagnosis has been intensely discussed in recent literature. The research is mainly focusing on computer-assisted radiology, i.e., the neural networks are trained with digital images (typically, fragments of a 1024 X 1024 matrix of up to 1024 shades of grey) and then used as a decision support system in routine diagnostics.

Instead of standard neural networks, we plan to investigate an approach specifically designed for X-ray diagnosis. This approach is based on the relatively new framework of *probably approximately correct learning* (PAC learning), which provides a predictable level of confidence about the outcome. The theory of PAC learnability has been developed over the past decade in close relation to problems which are formulated in terms of Boolean functions. Since a digital X-ray image represents an ordered set of Boolean matrices, the learnability problem of X-ray features can be expressed in a natural way within the class of Boolean vector functions. Consequently, more efficient and reliable classification results can be expected from the PAC learning approach.

We plan to develop appropriate models (formulations) of PAC learnability for X-ray related digital images and to find efficient algorithms for the corresponding learning problems. For a certain X-ray feature such as binary polygonal structures with a certain range of fractal dimensions, a learning algorithm has to compute from positive and negative examples of the feature a representation H, for instance, disjunctive normal forms, which with a provably high degree of confidence classifies arbitrary inputs correctly. To find efficient algorithms for these PAC learning problems, we plan to utilize the stochastic method of inhomogeneous Markov chains. The resulting algorithms will be implemented and their run-time performance analyzed.
(CU98010)

Parallel and Distributed Computing for Job Shop Scheduling

- ✍ WONG Chak Kuen ● ALBRECHT Andreas Alexander
- ❑ 16 April 1999
- ❖ Germany/Hong Kong Joint Research Scheme

Design and analysis of stochastic local search algorithms for solving job shop scheduling problems. The algorithms will be implemented in a distributed computing environment. The main goal is to expand the range of applicability of stochastic local search methods to large scale, real world problems by using parallelized versions and distributed computing facilities.
(EE98049)

Indexing Methods for Sequence Data Searching

- ✍ WONG Man Hon ● FU Wai Chee Ada
- ❑ 1 October 1998
- ❖ CUHK Research Committee Funding

In real life, data collected day by day often appear in the form of sequences and this form of data is called sequence data. The technique of searching similar patterns among sequence data is very important in many applications. The objective of this research is to derive new indexing methods to store sequence data so that researchers can improve the performance of finding a similar subsequence in a sequence database. The result will benefit the design of the next generation database systems to support scientific and business applications.
(EE98016)

Tree-Structure Based Synthesis for Psendo-Exhaustive VLSI Testing

- ✍ WU Yu Liang
- ❑ 1 December 1998
- ❖ CUHK Research Committee Funding

To verify the correctness of a circuit, both logic function and timing behavior must be considered. As the chip size and performance requirements (e.g. high clock frequency) of current VLSI circuits continue to grow rapidly, the delay fault that can affect the operating speed of the system has become a more important and challenging testing problem. Although the conventional path delay fault model can handle part of the weakness of the gate delay fault model, it also has inherent deficiencies. Since the number of paths in a logic circuit is tremendous, exhaustively testing each signal propagation path is prohibitive. To deal with the weakness of this traditional delay test technique, a new delay test approach including a new delay test output observation method and an adaptive path selection method is proposed. The basic idea of the approach is to measure the signal transition time for each delay test, and more paths are selected for a second stage test (if necessary) to ensure the timing behavior of the circuit under test. Initial results obtained by computer simulation demonstrate that a more thorough test is really needed if many late signal transitions are observed and our proposing methodology should be able to reduce the test effort and enhance the test quality significantly in most practical cases. Researchers believe that further refinement of our initial work on this problem will yield very practical results making a significant contribution in this field.
(EE98017)

Adaptive Learning for Temporal Radial Basis Function Network and Financial Investment Analysis Environment on Microsoft Window

✍ XU Lei

❑ 1 December 1998

❖ Research Grants Council

RBF net is one most popular supervised learning model that have been studied intensively with a lot of applications for function approximation, statistical regression, classification and decision. Though many achievements made in the last decade, there still remain three major problems for learning on RBF net. First, for various existing learning algorithms, the learning of the parameters on the input layer and the output layer is made in two separated stages heuristically and usually results in a sub-optimal solution. Second, the radii of basis functions are obtained by some clustering algorithm or heuristics, which is not suitable for complicated data distributions. Third, there still lack a concrete practical criterion for appropriately selecting the number of basis functions. All these problems will affect the performance of the learned RBF net considerably. This project aims to tackle these problems and develop an adaptive RBF net learning algorithm on an appropriate temporal RBF net structure, such that all the parameters in both the input layer and the output layer of a RBF net can be learned systematically under the maximum likelihood principle and the number of basis functions can be appropriately and effectively selected under a selection criterion during the adaptive learning. Then, the results are used as a core to develop a user-friendly software environment on Microsoft Window platform. The software environment can be used by various financial institutions and individuals, and also by various users involving time series modeling, prediction and analysis.
(CU98297)

Please refer to previous issues of this publication for more details of the following ongoing research at the department:

Edition   Title/Investigators

1995-96   Uniformly Polynomial-time Algorithms for Parameterized Families of Graphs (CU95510)
     ✍ CAI Leizhen

1996-97   A Theoretical Study on Two New Types of Reliable Networks (CU96537)
     ✍ CAI Leizhen

1996-97   Improving Generalization of Recurrent Networks in Time Series Prediction (CU96529)
     ✍ CHAN Lai Wan ● MOODY John*

1997-98   A State Space Approach to Recurrent Neural Network (CU97560)

✍ CHAN Lai Wan ● KING Kuo Chin Irwin

1995-96   Performance Analysis and Theoretical Studies for Replicated Databases (CU95531)
     ✍ FU Wai Chee Ada ● WONG Man Hon ● CHEUNG David W. L.*

1996-97   Abstraction, Association and Clustering in Data Mining (CS96004)
     ✍ FU Wai Chee Ada ● WONG Man Hon

1996-97   A Virtual Environment for Real-time Exploratory Scientific Visualization (CS96005)
     ✍ HENG Pheng Ann

1997-98   An Intelligent Virtual Environment for Bronchoscopy Simulation (CU97555)
     ✍ HENG Pheng Ann ● LEUNG Kwong Sak ● TSUI Hung Tat (Electronic Engineering) ● YIM Ping Chuen Anthony (Surgery) ● ABDULLAH Victor (Surgery)#

1997-98   Image Based Rendering with Controllable Illumination (CS97005)
     ✍ HENG Pheng Ann ● WU En Hua*

1995-96   FACE: A Face Analysis and Computing Environment (CU95513)
     ✍ KING Kuo Chin Irwin ● XU Lei ● CHAN Lai Wan

1996-97   Min/Max Entropy Principles for Unsupervised Visual Processing via Constrained Sigmoidal Neural Networks (CS96007)
     ✍ KING Kuo Chin Irwin

1997-98   Working Model for Intranet Commerce in Fabric Sourcing and Trading (CS97003)
     ✍ KING Kuo Chin Irwin ● XU Lei ● FU Wai Chee Ada ● CHAN Lai Wan

1997-98   Content-Based Image Retrieval of Classical Chinese Paintings and Calligraphy (CU97569)
     ✍ KING Kuo Chin Irwin ● FU Wai Chee Ada ● CHAN Lai Wan

1996-97   Multiparadigm Programming Language Implementation and Applications (CS96008)
     ✍ LEE Ho Man Jimmy ● LEUNG Ho Fung

1997-98 CUVIR: Comprehensive and Uniform Access to Visual Information Repositories (CU97557)
  ✍ LEE Moon Chuen

1996-97 Real-time Separation of Multineuron Recordings (EE96014)
  ✍ LEONG Philip Heng Wai

1995-96 Real-time Logic Programming for Intelligent Control (CS95020)
  ✍ LEUNG Ho Fung ● LEE Ho Man Jimmy

1995-96 Binary Fuzzy Constraint Satisfaction Problems: Properties and Solutions (CS95025)
  ✍ LEUNG Ho Fung ● LEE Ho Man Jimmy

1996-97 Object-oriented Real-time Rule-based Programming for Intelligent Control (CS96006)
  ✍ LEUNG Ho Fung ● LEE Ho Man Jimmy

1997-98 Co-operative Constraint Satisfaction Among Intelligent Agents (CS96003)
  ✍ LEUNG Ho Fung ● LEE Ho Man Jimmy ● CLARK K. L.*

1995-96 Automatic Knowledge Acquisition in an Inexact Environment Based on Genetic Techniques (CU95514)
  ✍ LEUNG Kwong Sak ● WONG Man Leung#

1996-97 Optimal Mappings Between Problem Models and Parallel Genetic Algorithms (CU96535)
  ✍ LEUNG Kwong Sak ● WONG Chak Kuen ● LEUNG Yee (Geography)

1997-98 An Automatic Learning System Based on a Novel Generic Evolutionary Programming Framework (CU97554)
  ✍ LEUNG Kwong Sak ● WONG Man Leung*

1995-96 Resource Management and Performance Analysis for Cost-effective Multi-media Storage Server (CU95509)
  ✍ LUI Chi Shing John

1996-97 Operating System and Network Support for Distributed Multimedia Services (CS96016)
  ✍ LUI Chi Shing John

1997-98 Providing Multi-Resolutions, VCR Functionalities, Load Balancing and Fault-Tolerance Features in a Video-On-Demand Storage Server via Subband Coding Techniques (CU97564)
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1997-98 A Phase-Based Approach for Software Reliability Engineering (CS97015)
  ✍ LYU Rung Tsong Michael

1996-97 3D Motion Specification in the Virtual Space (CS96021)
  ✍ SUN Hanqiu

1997-98 Physics-based Picking Functions of Virtual Hand Models (CS97004)
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1994-95 Research on a New Class of Optimization Problems Related to the Handling of Elastic 3-D Objects by Robots and Its Application in Industry (CS95008)
  ✍ WONG Chak Kuen ● LEUNG Kwong Sak ● HUI Kin Chuen (Mechanical and Automation Engineerin) ● LEUNG Yee (Geography) ● ALBRECHT Andreas*

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1997-98 A New FPGA Architecture and Design Automation Methodology for High Chip Performance and Fast Circuit Mapping (CU97556)
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1996-97 From Mixture Model to Ying-Yang Machine: New Methods for Nonlinear Time Series Modeling and Its Application to Financial and Trading Data Analyses (CU96515)
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RESEARCH PROJECTS

Optical Recognition of Cursive Hand-written Chinese Characters by Relational Graph Matching

- ✍ CHAM Wai Kuen
- ❑ 1 November 1998
- ❖ CUHK Research Committee Funding

The most natural approach to the input of Chinese characters into computers is to write characters on pieces of paper and let computers to recognize them. Although this research field has been studied for more than twenty years, practicable recognition systems are not available now because of the inherent difficulties of the problem. Therefore, methods that can recognize handwritten Chinese characters as quickly as possible with an acceptable accuracy are in urgent need.

Researchers propose to develop an optical Chinese character recognition system based on an on-line graph matching algorithm which was developed by us in a recently completed RGC Earmarked Grant project. The recognition rate of the on-line algorithm is 97% when characters with 9 to 11 strokes are written as ones having 6 to 8 strokes, and it is 91% when these characters are written as having 3 to 4 strokes. The goal of this project is to develop a system on a personal computer that can achieve optical recognition of Chinese characters at about one character per second for about 5000 frequently used Chinese characters and achieve a recognition rate better than that of the on-line algorithm.
(EE98018)

A High Speed CMOS Asynchronous Memory

- ✍ CHAN Cheong Fat ● CHOY Chiu Sing Oliver
- ❑ 1 January 1999
- ❖ CUHK Research Committee Funding

A jump in IC performance can be delivered by the ever decreasing device dimensions. This can no longer be relied upon however as the optical photolithography limit has almost been reached. Instead, one must turn to better design techniques. Synchronous design cannot meet this challenge because of its clock skew problem and its inherent speed dependence on the slowest part of the circuit.

Asynchronous systems do away with the clock, and their components are allowed to run independently at the maximum speed. As a result, the overall system performance depends on the average speed of the components. In addition, an asynchronous system will consume less power as each component operates only when required. One of the key components in high speed digital systems is memory. Conventional static and dynamic memories cannot be used with an asynchronous system, because it does not have the special handshaking signals required for an asynchronous system. The goal of this project is to design and build a general purpose asynchronous memory system. This memory system is specially targeted for the internal cache of a very high speed asynchronous digital system. The key features of this new asynchronous memory system are high speed, low power, simple handshaking signals and easy integration.
(EE98019)

Course Development for DECT Receiver Design

- ✍ CHAN Kam Tai
- ❑ 1 September 1998
- ❖ Hong Kong Productivity Council

Development of teaching material for a Hong Kong Productivity Council's course on DECT Receiver Design. The design will focus on Low Noise Amplifier, Mixer, and Frequency Synthesizer.
(EE98001)

High Repetition Rate Fiber Laser Source with Ultrashort Pulse Duration for Very Large Capacity Optical Communication

- ✍ CHAN Kam Tai ● LI Shenping# ● LOU Caiyun*
- ❑ 1 November 1998
- ❖ Research Grants Council

An optical source with high repetition rates and short pulse widths constitutes a key component for realizing future large capacity and ultrahigh speed optical communications. Mode-locked fiber lasers may be the preferred choice because they can easily produce transform limited pulses at tens of GHz. We propose here a novel technique for generating high quality and high repetition rate pulses, namely rational harmonic mode-looking in a hybrid passively and actively mode-locked fiber laser. The hybrid passively and actively mode-locking technique can result in "stable ultrashort" transform limited optical pulses whereas the rational harmonic mode-locking method allows us to generate such pulses at "high repetition rates" without being severely limited by the speed of the optical modulator used in the active mode-locking part of the laser. We will first configure a figure-eight fiber laser, using the nonlinear amplifier loop mirror to provide passive mode-locking, and an intensity modulator to perform active rational harmonic mode-locking in the main loop of the laser. Next we will use various stabilization techniques, such as active cavity length control, to force the laser to operate at the optimum condition over a long period of time. Then an optical filter such as the fiber Bragg grating will be inserted

into the laser to achieve wavelength selecting and tuning. Lastly, based on a similar laser configuration, we will demonstrate a high-repetition rate all-optical clock recovery system using optically-injected pulses. (CU98311)

Advanced MMIC Design Based Upon GaAs Technology

- ✍ CHENG Kwok Keung Michael
- ❑ 1 December 1998
- ❖ CUHK Research Committee Funding

Frequency-and phase-locked devices are essential components for many microwave communication systems like phase-locked loops, frequency synthesizers and adaptive phase array antenna. These devices include injection-locked oscillators and frequency dividers. However, designing better injection-locked oscillators requires a more complete understanding of how the nonlinear aspects of the oscillator affects its operation. Recently, researchers have developed a novel approach for the unified analysis of injection-locked oscillators. This new formulation makes use of current probe and Volterra series theory to determine the locking characteristics of injection-locked oscillators operating either in the fundamental-, harmonic-, or subharmonic-mode. In this project, researchers aim at developing new circuit topologies that enable low cost, high performance injection-locked oscillators and regenerative frequency dividers to be constructed. Furthermore, They will focus on circuit implementation based upon GaAs devices. (EE98020)

Wavelet Packet Division Multiplexing

- ✍ CHING Pak Chung ● WONG Kon Max
- ❑ 1 August 1998
- ❖ Research Grants Council

The objective of this research programme is to investigate how orthogonal wavelet packet can be applied to multi-user communication systems. Orthogonal Wavelet decomposition enables signal components to be localized in sub-bands. As well, the sub-band constituent components can be recombined to perfectly reconstruct the original signals. The proposed system makes use of this reconstruction-decomposition scheme to form the transmission-reception parts of a multiplexing system known as the Wavelet Packet Division Multiplexing (WPDM) system. Here, we propose that each of the orthogonal sub-band constituent signals can be used as a carrier for the communication data from various users. Such a system does not require guard bands or guard time for the individual user signals and therefore increases the capacity of the channel. The

performance of the WPDM system under impulsive noise interference and fading channel conditions will be studied. This system also adds the possibility of wavelet hopping which opens up the concept of wavelet packet spread spectrum techniques resulting in better immunity to fading and better communication security. All these advantages will be exploited and applied to multi-user communication systems, especially to the case of mobile communications. (CU98105)

To Investigate and Design New Asynchronous Basic Cells and Fast Handshaking Scheme for Next Generation of Asynchronous Designs

- ✍ CHOY Chiu Sing Oliver ● CHAN Cheong Fat
- ❑ 1 January 1999
- ❖ CUHK Research Committee Funding

Asynchronous design techniques are believed to solve some of the problems of asynchronous design, mainly those connected to the general clock signal distribution. This is why this field gained significant popularity worldwide nowadays. Combining knowledge gained from previous research undertaken by the laboratory and that of other researchers, some preliminary investigations were made pointing the direction for further work.

Researchers found most asynchronous logic cells to be based on a single core circuit. They propose to investigate existing logic variations further with outcome of selecting the best of them or creation of new enhanced circuit. In parallel, there is the possibility of designing a new core using more balanced P&NMOS transistors designed with even better performance.

In addition to designing new cells, researchers propose to spend some time investigating into communication between cells. Communication or handshaking is an essential part of asynchronous systems since it secures correct function and timing. They have already found that less strict handshake protocol (i.e. smaller circuitry requirement) can still secure right functionality with further increase in speed.

In both proposed areas, researchers intend to focus on parallelism, concurrency and correctness of data as well as control signal flows. The best cells and handshake circuits will be used in the design of a functional system that would be fabricated, tested and compared with other current designs worldwide. (EE98021)

A study of metalorganic chemical vapor deposition (MOCVD) using nitrogen as the carrier gas

- ✍ HSU Chung Chi ● XU Jianbin
- ❑ 1 August 1998

❖ Research Grants Council

In this project, we plan to study the use of nitrogen as the carrier gas for MOCVD. We will investigate the gas flow dynamics of the MOCVD growth in nitrogen in order to optimize the growth efficiency and uniformity. We will also study the surface growth kinetics in MOCVD using nitrogen as the cannier gas. Finally, certain device structures such as GalnP/GaAs heterojunction bipolar transistors, GalnArN/GaAs photodetectors will be made to characterize the material quality.
(CU98346)

An Active Array Smart Antenna for 3rd Generation Mobile Phone Base Station

? LAI Kin Yue Albert
❑ 1 December 1998
❖ CUHK Research Committee Funding

Mobile communication is growing at an astonishing rate throughout the world. Hong Kong alone has 4 mobile phone companies and 6 personal communication system (PCS) companies. In the quest for the best coverage in terms of ubiquitous reach and channels availability, service providers are reducing cell size and using "intelligent" techniques such as smart antennas with multiple beams for spatial frequency reuse, etc. Most of these upcoming "smart antennas" contain an antenna array of many elements. Instead of using the expensive phase shifters and the notoriously inefficient distribution network, designers are looking more and more to active array with independent phase control accomplished by digital beam forming. This project will develop a smart antenna array for advanced 3rd generation mobile phone base station. It consists of an active antenna array front-end, wide band sampling IF and digital down-converter, an all-digital base band modulation/demodulation unit and formatter. The theoretical model for an active array antenna will also be developed. It involves the simultaneous simulation of active circuit and near field/far field radiation. This project will lay the foundation for smart antenna global simulation, where global simulation refers to simulation from physical layer up to system level. This is necessary for smart antenna because it is not just a hardware, but also a complete system.
(EE98022)

3D Shape Reconstruction from an Image Sequence Captured by a Hand-Held Camera

? TSUI Hung Tat ● ZHANG Zhongying#
❑ 1 November 1998
❖ Research Grants Council

Estimating the 3D shape of an object using a single moving video camera is a central problem in computer vision with many applications. Since our camera is hand-held (without knowledge of the camera location and pose for each image), the conventional stereo vision technique will not work. Using one of the un-calibrated camera techniques [5,13,27], we can recover a 3D structure up to a 3D projective ambiguity. If the intrinsic parameters of our camera are constant and are determined by self-calibration[27] or prior calibration, an Euclidean shape of an object can be obtained up to a global scale. However, the existing algorithms for the above are numerically complex and not very robust. We shall develop better alternative algorithms. To keep the target object in focus, we need to change the focal length of the camera. A new non-restrictive method of self-calibration will be developed which allows us to determine the ratio of focal lengths (with respect to the first camera position) at each camera position[17]. In cases where the image sequence is acquired by an unknown camera, a scheme with human interaction will be developed for camera self-calibration. Significantly, we shall also produce an interactive package of 3D model reconstruction for the industrial and commercial communities who may want higher accuracy and flexibility. Practical applications of the package include 3D object inspection, interior design and product visualization.
(CU98310)

Probing the Interface of Diamond Like Carbon/Magnetic Layers by Conducting Atomic Force Microscopy

? WILSON Ian Howard ● XU Jianbin ● YAN Xiao*
❑ 1 October 1998
❖ Research Grants Council

In magnetic recording technology, a thin insulating diamond like carbon (DLC) layer is frequently used to cover the both sides of the magnetic medium and read/write heads. The DLC layer protects the magnetic layer from wear. The rapid technological progress demands an ultra thin DLC film with solid bonding and a perfect interface to the magnetic layers. In order to control the quality of the magnetic devices, a reliable and convenient diagnostic technique, which is able to observe defects and roughness at the interface of DLC/ magnetic layers, is very much to be desired. The main aim of this project is to develop a new methodology to enable the imaging of nanometer sized interface defects from above the insulating DLC layer and to quantitatively measure the interface roughness of DLC/magnetic layers. We anticipate that this project will enable us to develop a reliable, convenient diagnostic technique with which interface defects ad roughness of DLC/magnetic layers can be directly observed and measured on

nano-meter scale. The advantages of our technique include; simple sample preparation, the non-destructive nature and adaptability to industrial applications. It will be very helpful for quality control and failure analysis of magnetic recording devices.
(CU98175)

Pilot Symbol Sequence Design for TDMA Fading-Channel Wireless Communications

- ✍ WONG Kainam Thomas
- ❑ 1 November 1998
- ❖ CUHK Research Committee Funding

The transmission of information bearing signals in mobile wireless communications may be degraded by Raleigh or Rician fading (resulting in time-variant multiplicative noise), frequency distortions (leading to inter-symbol interference), unknown Doppler (producing frequency mis-synchronization), carrier phase mis-synchronization (causing random unknown phase), symbol mis-synchronization, and burst noise. Such fading channel's degradation of the information signal may be estimated (and thus subsequently corrected) by embedding in the transmitted symbol sequence pilot symbols of values and time-slot positions known to the receiver. For example, the IS-136 time-division multiple access (TDMA) signaling standard provides 14 pilot symbols in each "frame" of 162 transmitted symbols.

This project proposes, develops, and evaluates new pilot symbol sequences with various (1) pilot symbol values and (2) pilot symbol positions within each frame. The aim is to optimize TDMA system performance in terms of (a) the estimation of the fading channel parameters and (b) the temporal localization of the desired signal's output at the spatio-temporal RAKE receiver's match-filter correlators -- all these in various time-varying frequency-selective Raleigh/Rician channel fading environments.
(EE98005)

Novel Algorithms for Self-Calibration of Diversely Polarized Antenna Arrays

- ✍ WONG Kainam Thomas ● NEHORAI, Ayre*
- ❑ 1 June 1999
- ❖ CUHK Mainline Research Scheme

An antenna array offers angular diversity and spatial diversity to estimate (1) the information carried by a propagating electromagnetic wavefront, (2) the transmitting sources' angular locations, and (3) the transmitting sources' dynamic movements. With sophisticated signal processing capability, an antenna array (called "smart antennas") increases the cellular system's channel capacity, expands geographic coverage, improves signal reception quality, and reduces hardware costs. The above advantages, however, are predicated on proper deployment and maintenance of the antenna array hardware. Antenna miscalibration -- deviation in the antennas' locations and in the magnitudes and phases of the antennas' responses from their prescribed nominal values -- degrades the effectiveness of an antenna array. An antenna array may self-calibrate (i.e., estimate the transmitter's instantaneous location and dynamic spatial movements, as well as the antennas' gain, phase and spatial characteristics) using the measured data of unknown incident sources while also estimating the information-bearing signal. Self-calibration contrasts with aided-calibration wherein the calibration process is performed using additional electromagnetic hardware and human labor while shutting down the antenna array's normal operation. Numerous sophisticated self-calibration algorithms have been proposed in the research literature [6-14], but none of these explicitly confronts and exploits the diversely polarized character of antenna array systems. Antennas, as electromagnetic devices, are characterized not only by their magnitude and phase characteristics but have diverse polarization dependent on their shapes, construction and orientation. Similarly, impinging electromagnetic wavefronts are by definition polarized physical entities. Overlooking this essential aspect (i.e. polarization) of the information-carrying medium (i.e., the electromagnetic wavefield) and the information-detecting device (i.e., the antenna array) leads to preventable degradation in calibration performance. This proposed research aims to directly confront the polarized nature of electromagnetic communication systems and radar systems to devise self-calibration algorithms for diversely polarized "smart antennas".
(EE98048)

Magnetic-filtered Pulsed Metal Vapor Vacuum Arc Deposition of Magnetic Thin Films and Magnetic Multilayers

- ✍ WONG Sai Peng Joseph ● TSANG Hon Ki
- ❑ 16 September 1998
- ❖ Research Grants Council

This project aims at applying a new method, namely, magnetic filtered pulsed metal vapor vacuum arc deposition method, to synthesize magnetic thin films and multilayers, and to study their magnetic properties and microstructures. A few granular magnetic thin film systems, including CoAg and FeAg granular films will be studied first. Other new material systems of interest for magnetic storage and device applications will also be explored later.
(CU98152)

Investigation of low-dimensional silicon based materials by scanning probe microscopy

- ✍ XU Jianbin ● CHEN Kun Ji* ● WONG Sai Peng Joseph ● WILSON Ian Howard ● HARK Sui Kong (Physics)
- ❑ 1 November 1998
- ❖ Research Grants Council

Low dimensional quantum structures of silicon-based materials have been long attracted the attention of researchers in solid state electronics, and of technological importance for optically active components. Scanning probe microscopies, derived from the scanning tunneling microscope (STM), are uniquely suited to this type of miniaturized exploration. In particular, conducting scanning force microscope (c-SFM) and near-field scanning optical microscopy (NSOM) allow us to perform high resolution scans of samples while simultaneously collecting locally either electrical or optical information about the sample surface or interface. This is also highly desirable to nanofabricate low dimensional quantum structures and nano-devices.

In this project we propose to study the electrical and optical properties of low dimensional quantum structures of group IV materials. The specific aims include:
(1) Fabrication of low dimensional quantum structures on Si by PECVD.
(2) Local characterization of electrical and optical properties of the structures by conducting AFM and NSOM.
(CU98172)

Measurement and Analysis of Knee Vibroarthrography for Non Invasive Diagnosis of Joint Cartilage Pathology

- ✍ ZHANG Yuanting ● CHAN Kai Ming (Orthopaedics & Traumatology) ● QIN Ling (Orthopaedics & Traumatology)
- ❑ 1 December 1998
- ❖ CUHK Research Committee Funding

Arthritic degeneration of the knee is a common condition caused by external injuries and system diseases. Diagnosis of knee joint cartilage disorders is complicated due to the high density of surrounding bones, which make analysis of X-ray and other types of image difficult. Arthroscopy has been commonly used in clinics. However, arthroscopy is not a practical gold-standard for all patients because it is invasive and does carry some risk with it. Alternatively, as noninvasive procedure, many researchers have tried to investigate vibration signals generated from knee joint as they pass over each other.

The specific objectives of this project are:

(1) to refine our advanced vibroarthrosraphic (VAG) signal analysis techniques developed early for the interference removal and for the modeling and feature extraction of VAG signals; and
(2) to validate our techniques with clinical data for achieving a clinically acceptable classification rate of arthroscopically-confirmed chondromalacia.

The successful completion this proposed research would result in the better understanding of knee pathology and in the development of a noninvasive device for the diagnosis of joint cartilage pathology which is still lacking presently in clinical environments.
(EE98033)

Please refer to previous issues of this publication for more details of the following ongoing research at the department:

Edition	Title/Investigators
1997-98	Injection Locked Digital Controlled Oscillator (EE97002) ✍ CHAN Cheong Fat ● CHOY Chiu Sing Oliver
1995-96	Theoretical Modelling and Experimental Study of Multisection Distributed Feedback Lasers for Advanced Lightwave Communications (EE94007) ✍ CHAN Kam Tai ● LIEW CHAN So Kuen# ● WANG Wei* ● WANG Qi Ming* ● EVANS Gary A.* ● BUTLER Jerome*
1996-97	Numerical Modelling and Experimental Studies of the Fiber Ring Laser for the Generation of Ultrashort Optical Pulses for Soliton Communication (EE96006) ✍ CHAN Kam Tai
1997-98	Selective Multi-wavelength Fiber Ring Lasers for Wavelength Division Multiplexed and Photoic Switching Applications (CU97566) ✍ CHAN Kam Tai ● LI Shenping#
1996-97	Study of Intermodulation Distortion in MMIC Active Filters (EE96004) ✍ CHENG Kwok Keung Michael
1997-98	Characterization and Modeling of CPW Discontinuities in Monolithic Microwave Integrated Circuits (EE97003) ✍ CHENG Kwok Keung Michael
1997-98	Transition Metal Silicides Synthesis and Devices Application by High Beam Current Ion Implantation (EE97004)

☎ CHEUNG Wing Yiu ● WONG Sai Peng Joseph

1996-97 Blind Signal Estimation Using High Order Cumulants (EE96016)
☎ CHING Pak Chung

1996-97 Development of an Automatic Recognition System for Continuous Cantonese Speech (CU96509)
☎ CHING Pak Chung

1997-98 Development of a Large Vocabulary Speech Database for Cantonese (EE97001)
☎ CHING Pak Chung

1997-98 Advanced Signal Processing Techniques for Communications (CU97502)
☎ CHING Pak Chung ● WONG Kon Max

1995-96 An Adaptive Circuit Design Technique to Suppress Power Noise in a High Speed Output Driver (CU95526)
☎ CHOY Chiu Sing Oliver ● CHAN Cheong Fat

1997-98 Automatic Synthesis of Fault-Tolerant Asynchronous Circuits (CU97565)
☎ CHOY Chiu Sing Oliver ● CHAN Cheong Fat

1997-98 Microcode Automation Targeted at Asynchronous DSP Processors Design (EE97019)
☎ CHOY Chiu Sing Oliver ● CHAN Cheong Fat

1996-97 Strained-layers Growth for Semiconductor Laser Applications (CU96551)
☎ HSU Chung Chi ● XU Jianbin ● HARK Sui Kong (Physics)

1995-96 A Novel Meandering Inverted F Antenna (MIFA) for Mobile Communications (CU95506)
☎ LAI Kin Yue Albert

1996-97 Mobile Radio Propagation Characterization and Prediction: A Neural Network Approach (EE96008)
☎ LAI Kin Yue Albert

1997-98 A Wideband Antenna for Ubiquitous Communication (CU97506)
☎ LAI Kin Yue Albert ● CHENG Kwok Keung Michael

1995-96 III-V Based Ultrafast Meta-semiconductor-metal Photodetectors (CU95528)
☎ SHU Ching Tat C. ● HSU Chung Chi ● CHAN Kam Tai

1995-96 A Novel Scheme of Wavelength-Multiplexing Using Self-Injection Locked Lasers (EE95005)
☎ SHU Ching Tat C. ● TSANG Hon Ki ● ZHAO Yang*

1997-98 Spectral Dynamics in Gain-Switched Distributed-Feedback Laser Diode under the Influence of Weak External Feedback (CU97517)
☎ SHU Ching Tat C. ● TSANG Hon Ki

1995-96 Optoelectronic Waveguide Components for the Next Generation of Communication Systems (CU94511)
☎ TSANG Hon Ki ● CHAN Kam Tai

1995-96 Fabrication and Characterisation of Magnetic Thin Films on III-V Semiconductors (EE95006)
☎ TSANG Hon Ki ● SCHWARZACHER Walther*

1997-98 New Methods for Characterizing and Generating Ultrashort Optical Pulses (CU97515)
☎ TSANG Hon Ki ● SHU Ching Tat C.

1995-96 3-D Object Recognition by Active Vision Systems Using Belief Networks for Information Fusion (CU95518)
☎ TSUI Hung Tat

1997-98 Inferring 3D Shape Using Physics Based Techniques (CU97509)
☎ TSUI Hung Tat

1997-98 Scanning Probe Microscopy of the Impact of Energetic Beams on the Surface of Electronic Materials (EE97005)
☎ WILSON Ian Howard

1995-96 Ion Beam Synthesis and Modification of SiC/Si Heterostructures for Electronic Device Applications (CU95535)
☎ WONG Sai Peng Joseph ● WILSON Ian Howard

1996-97 Formation and Properties of Granular Structures by MEVVA Implantation (CU96534)

? WONG Sai Peng Joseph ● WILSON Ian Howard ● WONG Hong Kuen (Physics)

1997-98 Photoelasticity Study of Stress Distribution in Semiconductors (CU97548)
? WONG Sai Peng Joseph

1995-96 Investigations of Inorganic Ferroelectric Films by Scanning Probe Microscopy (CU95504)
? XU Jianbin ● WONG Hong Kuen (Physics) ● WILSON Ian Howard

1996-97 Development of Scanning Near Field Optical Microscopy and its Applications in Electronic Engineering (CU96512)
? XU Jianbin ● WONG Sai Peng Joseph ● WILSON Ian Howard

1997-98 Nano-Characterization and -Fabrication of Dielectrics and MIS Junctions on Silicon (CU97530)
? XU Jianbin ● WONG Sai Peng Joseph ● CHEUNG Wing Yiu ● WILSON Ian Howard ● KWOK Wai Man Raymund (Chemistry)

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see also <AG98002>, <P983138>, <P990990>, <P991493>

RESEARCH PROJECTS

Bandwidth Management Device for All-Optical Links and Networks

- ✍ CHEN Lian Kuan ● TONG Fuk Kay Franklin
- ❑ 15 September 1998
- ❖ Research Grants Council

Future information superhighway will be built upon all-optical networks, that may have bandwidth of multi - Tbps. It is important to have a bandwidth management device in the network to regulate the bandwidth, such that proper tariff can be collected. In this project, we will investigate and implement a tunable bandwidth throttling device based on optical sampling principle.
(CU98153)

The Development of Mobile Computing and Connectivity Technologies

- ✍ CHEUNG Kwok Wai ● FONG Chi Bun (Centre for Innovation and Technology) ● CHEUNG Lawrence* ● PANG Stephen*
- ❑ 1 June 1999
- ❖ Industrial Support Fund, Industry & Technology Development Council

Just as mobile phones expand our communicable environment from office and home to anywhere on the move, connected mobile or handheld devices will be the keys in expanding the computable environment from office and home to professionals on the move. This is setting up to be the next major phase of development in IT and electronics since the advent of Personal Computer.

This project is concerned with technology prototyping and dissemination efforts such that local manufacturers interested in taking part in the next IT and Electronics revolution in Mobile Computing can gain this generic technology. This is achieved through the "Development of Mobile Computing and Connectivity Technologies" that aims to capture and develop the key technologies involved with the following two main focuses: Mobile Computing Application Systems and Connectivity Peripherals.

For the former, the proposed project will develop complete turnkey mobile application systems in four sectors: automobile, education, e-Commerce and the last one to be determined with the sponsors. For the latter, the proposed project will concentrate its effort on the development of wired and wireless communication peripherals for mobile computing applications. The duration of this project is 24 months. Hong Kong Productivity Council will be the overall project manager of the project and will carry out the product development while the Chinese University of Hong Kong will be the technology provider and will develop, adapt and provide some of the core technologies developed in the ISF Funded Integrated Communications Laboratory (ICL) Project (AF/41/98).
(EE98052)

Combined Source-Channel Coding Using Multicarrier Modulation

- ✍ HO Keang Po Ricky
- ❑ 1 October 1998
- ❖ CUHK Research Committee Funding

This proposal investigates a simple yet powerful combined source-channel coding scheme using multicarrier modulation. Source coding (signal compression, quantization, and digitization) is the conversion of analog source to digital data. Channel coding (line code, modulation, and error correction code) is the physical scheme to transmit digital signal from transmitter to receiver. Conventionally, source and channel coding are designed separately and then cascaded together. The source and channel coding are optimized together in combined source-channel coding to minimize the overall distortion from the analog source at the transmitter input to the reconstruction at the receiver output.

While high complexity schemes have been proposed for combined source-channel coding, multicarrier modulation can provide unequal error protection in a natural way without increase the complexity of both transmitter and receiver. The power, modulation, and channel coding of each subchannel can be adjusted to provide unequal error protection according to the importance of the compressed data.

The project will apply combined source-channel coding with multicarrier modulation for selected signal compression standards. Compressed data are classified quantitatively and separated into more and less significant sub-streams with different importance. Subchannel resources of multicarrier modulation, including bandwidth and power, are allocated for optimal performance.
(EE98025)

An Interactive Multimedia Exchange with Open Software Interface for Media Industry and Digital Library

- ✍ HUI Yu Ngai ● YEN Jerome (Systems Engineering & Engin. Managem) ● LYU Rung Tsong Michael (Computer Science and Engineering)
- ❑ 1 July 1998
- ❖ Industrial Support Fund, Industry & Technology Development Council

The purpose of Interactive Multimedia Archive and Exchange is to build a common user interface

mounted onto a broadband internet exchange. The user interface will integrate functionalities such as searching, indexing, retrievals and content creation. We will employ open and locally developed components including the Chinese search engine, the mage search engine, and various video retrieval engines. We will also integrate emerging 3-dimensional high resolution technologies for panoramic and high resolution mage retrieval on the Internet. These high bandwidth applications will be delivered over a broadband internet exchange. Means of high capacity delivery to the end users using ADSL or cable modems will also be demonstrated.
(EE98046C)

Traffic Control Strategies for Quality-of-Service Guarantees in Cross-Path ATM Packet Switches

- ✍ LEE Tong Tony ● TO Pak Tung Philip#
- ❑ 1 August 1998
- ❖ Research Grants Council

In order to successfully deploy a broadband Asynchronous Transfer Mode (ATM) network, the network providers must guarantee that the Quality-of-Service (QoS) (for instance, the upper bound on cell delay) delivered to each network connection satisfies the requirements negotiated in the contract in the call setup phase. Unfortunately, at present, end-to-end QoS guarantees is hardly achievable due to the fact that a connection usually goes through a number of intermediate switching nodes in which there is currently no effective way to maintain the QoS of the connection. In fact, most existing switch architectures inherently prohibit any implementation of QoS control. Recently, a promising ATM switch architecture known as Cross-path Switch has been proposed by the PI. The switch architecture allows traffic control schemes to be incorporated within the switch fabric. In this project, we propose to develop a complete set of traffic control strategies for the Cross-path Switch in the path level, the call level and the cell level. It is envisioned that with these traffic control schemes, true end-to-end QoS guarantee can be achieved. In this context, we will develop a mathematical model for the Cross-path switch so that the switch can be used as a "black box" network component. This will greatly simplify network design and allow systematic deployment of large-scale broadband ATM networks.
(CU98349)

Joint Design of Signal Format and Interference Suppression Scheme for CDMA Systems

- ✍ LOK Tat Ming
- ❑ 1 December 1998
- ❖ CUHK Research Committee Funding

Code division multiple access (CDMA) communication systems have been gaining popularity in recent years. CDMA technology allows multiple users to transmit simultaneously in the same frequency spectrum. However, as the number of users increases, multiple access interference (MAI) becomes the major problem that limits the capacity. Approaches to reduce MAI include improved signal design and the application of MAI suppression techniques. Prior works often treat these approaches separately. In signal design, simple matched filtering is often assumed without MAI suppression while in MAI suppression schemes, the standard binary direct sequence spread spectrum (DS/SS) system is often assumed. However, the two approaches should obviously complement each other and be considered together. Researchers recent work on chip waveform design with interference suppression clearly demonstrates the advantages of joint design. The interference suppression scheme makes use of information about the chip waveform to suppress MAI while the chip waveform is chosen so that MAI suppression can be optimized. In this project, research in this direction will be continued and expanded. Signal design, including the design of signature sequences, chip waveform, and modulation, will be performed under interference suppression schemes while interference suppression schemes will be enhanced through suitably designed signals. Researchers anticipate that through joint design of signal format and interference suppression scheme, the overall performance of CDMA systems can be improved. The results could impact future CDMA standards.
(EE98026)

Intelligent Image Coding for Underwater Optical Survey

- ✍ TANG Xiaoou
- ❑ 1 January 1998
- ❖ CUHK Research Committee Funding

Marine bio-monitoring is essential for understanding biodynamic ocean systems. However, because of the arduous, time consuming, and expensive manual process involved in the data collection and sampling procedure, it has long been a difficult task. Recent advances in video imaging have enabled us to develop the Video Plankton Recorder (VPR), a towed underwater video microscope system, for measuring abundance and behavioural patterns of planktonic taxa. This system acquires images in an electronic format that is suitable for automatic processing. In order to store, transmit, and analyze the overwhelming amount of imagery data, researchers study a image coding approach taking advantage of intelligent information offered by an advance pattern recognition system. By introducing intelligent image recognition into an image coding system, researchers

will be able to adaptively control the coding strategy according to what is present in the current image, thus achieving much higher compression ratio. (EE98006)

A High-Capacity WDMA Local- and Metropolitan-Area Ring/Bus Network

- ✍ TONG Fuk Kay Franklin ● CHEN Lian Kuan ● HO Keang Po Ricky
- ❑ 25 September 1998
- ❖ Research Grants Council

Future information superhighway infrastructure will be based upon multi-wavelength all-optical network, as the multiple wavelength approach is the most viable means to fully exploit the vast bandwidth offered by the optical fibers. The Next Generation Internet initiative in U.S. is particular designed to achieve such purpose, aiming to deliver end-to-end data rate of 100 Mbps to 1 Gbps to 100 sites by year 2002. Inspired by this initiative, we are proposing to experimentally demonstrate a high-capacity local or metropolitan sized (less than 50 km in diameter) multiaccess network with architecture identical to that of the computer ring or bus networks.

While there are many on-going research work on the backbone (wavelength routing network), and on the subscriber networks (broadcast network as cable TV), few focuses on the multiaccess capability, as in the computer environment. We propose to build a packet-switched, multi-wavelength multiaccess all-optical network with three operating nodes, with at least one node completely equipped with wavelength add-drop capability. Our proposed network will address the high capacity and bandwidth-sharing efficiency aspects through a dense wavelength assignment and high-speed time-slot access scheme. (CU98157)

Hong Kong Cyber Campus

- ✍ WONG Po Choi
- ❑ 15 July 1998
- ❖ Quality Education Fund

Hong Kong Cyber Campus is a large scale project to build an Internet Campus linking universities, secondary and primary schools, and kindergartens in Hong Kong. The project will connect 350 secondary and primary schools to the Internet, provide network resources and technical support to schools, strengthen the interactions between schools and universities, and foster the development and sharing of educational content and software.

The highlights of the Hong Kong Cyber Campus project include:

(1) Cyber Campus web-site, Education Content, Discussion and Activities, eTouch Web-Magazine;
(2) Cyber IT Camp -- Cyber Campus CDROM;
(3) Teacher Training;
(4) Information Literacy Programme -- Virtual Campus, Research and Evaluation.
(ED98019)

Network Information Flow Theory

- ✍ YEUNG Wai Ho Raymond
- ❑ 1 September 1998
- ❖ Research Grants Council

The researcher introduces a new class of multiuser source coding problems inspired by computer network applications. Let V be the set of nodes of a point-to-point communication network. Such a network is represented by a directed graph G=(V, E), where E is the set of edges, such that information can be sent noiselessly from node i to node j for all (i, j) $\in$ E. The researcher considers the situation in which a number of user multicast information simultaneously. Let X_1, ..., X_m be mutually independent information sources. The information rate of X_i is denoted by h_i, and let h = [h_1 ......h_m]. Let a:{1, ..., m}$\rightarrow$ V and b:{1, ..., m} $\rightarrow 2^v \setminus \phi$ be arbitrary mappings. The source V_i is generated at node a(i) and it is multicast to node j for all j $\in$ b (i). The goal of this project is to determine the admissible coding rate region. (CU98342)

Multiparty Videoconferencing in Virtual Path Based ATM Networks

- ✍ YUM Peter Tak Shing ● WONG Po Choi
- ❑ 1 September 1998
- ❖ Research Grants Council

Asynchronous transfer mode (ATM) network design and analysis at the call-level may be formulated in the framework of circuit-switched loss networks with effective bandwidth encapsulating cell-level behavior. We propose to develop an analytical framework for a kind of multiparty videoconferencing in the VP based ATM network at the call-level. For this kind of conference, only the video and voice of the current speaker are broadcast to other conferees. We first need to address conference management issues in the VP based ATM network, including the bandwidth allocation strategies, routing rule and call admission policy. Next, we need to formulate a traffic model for the conferences. Since an exact analysis of such a multiparty conference network is mathematically intractable, an approximate analysis for such conferences will be explored. This shall be done first in a fully connected VP network and then be generalized to other specialized topologies. We aim

at developing an analytical tool that can give accurate prediction of the blocking probabilities for new conference calls as well as video freeze probabilities for ongoing conferences. The fixed-point iteration method will be explored. Fine-tuning of the method for multi-point conferencing by use of queuing theory tools will be performed.
(CU98159)

Please refer to previous issues of this publication for more details of the following ongoing research at the department:

Edition	Title/Investigators

1996-97   Fiber-based Components for Ultra-high Speed Optical Networks (CU96525)
     ✍ CHEN Lian Kuan ● CHEUNG Kwok Wai ● JIAN Shuisheng*

1997-98   Surveillance Schemes for Passive Branched Optical Networks with Erbium-Doped Fiber Amplifiers (CU97533)
     ✍ CHEN Lian Kuan ● TONG Fuk Kay Franklin

1997-98   Universal Hong Kong Cantonese Characters Set Font Development Project (CS97002)
     ✍ CHEUNG Kwok Wai ● HUANG Erwin* ● TSE Aaron* ● TSE Ping Kin Ken*

1997-98   Electronic News Media & Publishing Consortium - Second Phase (CS97013)
     ✍ CHEUNG Kwok Wai ● LAM Wing Kwan Ringo (Centre for Innovation and Technology) ● LAU Chun Hung (Centre for Innovation and Technology) ● YEUNG Yim Shan (Centre for Innovation and Technology)

1997-98   High Speed Multimedia Optical Network Prototype (CU97563)
     ✍ CHEUNG Kwok Wai ● CHEN Lian Kuan

1997-98   Integrated Communications Laboratory (EE97020)
     ✍ CHEUNG Kwok Wai ● LEE Kin Hong (Computer Science and Engineering) ● LEUNG Hong Chung (Electronic Engineering)# ● HO Keang Po Ricky ● CHING Pak Chung (Electronic Engineering) ● CHAM Wai Kuen (Electronic Engineering) ● WEI Keh Wei Victor ● FONG Chi Bun (Centre for Innovation and Technology) ● KO

Kin Wa (Centre for Innovation and Technology) ● CHAN Kwong Wing Raymond (Centre for Innovation and Technology)

1997-98   Effects of Crosstalk in Wavelength-Division-Multiplexing (WDM) Systems (EE97006)
     ✍ HO Keang Po Ricky

1995-96   High Capacity Network Infrastructures for Internet Service Providers and Multimedia Applications (CS95027)
     ✍ HUI Yu Ngai ● CHEUNG Kwok Wai ● CHENG Che Hoo

1997-98   Dynamic Routing and Traffic Management for ATM Networks (CU97536)
     ✍ HUI Yu Ngai

1996-97   Path Switching - A Quasi-Static Routing Scheme for Large-Scale ATM Packet Switches (CU96523)
     ✍ LEE Tong Tony

1997-98   The Principle of Multi-dimensional Switching and Its Applications in High-speed ATM Packet Switches (CU97570)
     ✍ LEE Tong Tony

1997-98   Efficient Multimedia Striping for Disk Arrays (CS97007)
     ✍ LEE Yiu Bun

1995-96   Video Aggregation: Integration of Video Data Compression and Multiplexing for Transport in Broadband Communication Networks (CU95502)
     ✍ LIEW Soung Chang

1996-97   Control-Theoretic Approach to Adaptation of VBR Compressed Video for Transport over a CBR Communications Channel (CU96506)
     ✍ LIEW Soung Chang

1997-98   Lossless Transmission of Multiple Video Streams (CU97532)
     ✍ LIEW Soung Chang

1996-97   Design and Analysis of Multicarrier CDMA Systems for Wireless Communications (EE96017)
     ✍ LOK Tat Ming

1997-98   Signal Processing Techniques in Spread Spectrum Systems with Adaptive Antenna Arrays (EE97007)
     ✍ LOK Tat Ming

1997-98	Preliminary Study of Image Compression by Automatic Recognition (CS97014) ✍ TANG Xiaoou	1996-97	Integrating Data Services on DECT Systems (EE96001) ✍ WONG Wing Shing ● CHAN Kam Tai (Electronic Engineering) ● YUM Peter Tak Shing
1997-98	Component Surveillance and Error Detection in Multi-Wavelength Networks (EE97015) ✍ TONG Fuk Kay Franklin ● MARZ Reinhard*	1996-97	New Approaches to Mobility Management and Multiple Access Protocol for Cellular Systems (CU96524) ✍ WONG Wing Shing
1996-97	Information Security in Communication and Computing Networks (CU96526) ✍ WEI Keh Wei Victor	1997-98	Wireless ATM: Issues in Multi-Rate Multiple Access (CU97538) ✍ WONG Wing Shing ● HUI Yu Ngai
1997-98	Theoretical Study of Partitioning Techniques for Iterative Methods in Circuit Simulation (CU97540) ✍ WING Omar ● LUK Wai Shing (Computer Science and Engineering)#	1996-97	Multilevel Diversity Coding (CU96501) ✍ YEUNG Wai Ho Raymond ● ZHANG Zhen*

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see also <P984738>

RESEARCH PROJECTS

Homography-based Stereo Vision for Polyhedral Reconstruction

- ✍ CHUNG Chi Kit Ronald
- ❑ 1 January 1999
- ❖ Research Grants Council

Stereo vision is the vision cue of reconstructing three-dimensional information of a scene from two images taken at widely separated positions. The key problem to solve in stereo vision is the correspondence problem, which is to decide which feature-pairs in the two images are projected by the same entities in space. The classical approach of solving the correspondence problem is rooted at the assumption that the scene is smooth. However, occlusions in the scene, which are commonplace, cause violations to the assumption and thus present great difficulty to the approach.

This project studies how the smoothness assumption can be avoided for polyhedral scenes by capturing the image-to-image mappings induced by the scene surfaces. The mappings are known as homographies. The goals of the project are to reconstruct polyhedral structures in the scene accurately, to identify occlusion boundaries explicitly and without them smoothed out, and to derive a surface level segmentation of the polyhedral structures.
(CU98169)

An Approximation Method for the L2 Gain Attenuation Problem in Discrete-time Nonlinear Systems

- ✍ HUANG Jie
- ❑ 1 September 1998
- ❖ Research Grants Council

The L2 gain attenuation problem, also known as H-infinity control problem, aims to design a control law to stabilize a given control system, and attenuate the L2 gain of the closed-loop system by a prescribed level. This problem has been well understood for the class of linear systems. However, for the class of nonlinear systems, many key issues remain unaddressed. One of these issues is the solvability of what is called discrete-time Hamilton-Jacobi-Isaacs (DHJI) equation arising in synthesizing the H-infinity control law for a discrete-time nonlinear system. DHJI equation consists of a set of algebraic and partial differential equations. Due to the nonlinear nature, it is rarely possible to obtain the closed form solution for DHJI equation. Thus it is imperative to devise approximation methods for solving the DHJI equation in order to make the discrete nonlinear H-infinity control theory practically useful. This proposal intends to develop an approximation

approach to solving DHJI equation in terms of the Taylor series. Such an approach should lead to an iterative algorithm featuring efficiency, simplicity, and compatibility with the routine computer languages and software packages. Success of this research may make the discrete nonlinear H-infinity control a feasible practical design tool that can find wide range applications in complex uncertain nonlinear control systems.
(CU98168)

Volume Modeling of Deformable Objects

- ✍ HUI Kin Chuen
- ❑ 1 February 1999
- ❖ CUHK Research Committee Funding

Existing geometric and solid modeling techniques used in contemporary CAD/CAM systems usually assume that the objects being modeled are rigid. Special operations for deforming geometric models are only provided as a tool for editing the shape of the object, and may not be related to the physical behavior of the object. In general, analyzing the behavior of an elastic object requires converting the object representation to a mesh of cells (e.g. cubes, or tetrahedrons) which are then used for evaluating the deformation of the object with finite differences or finite element techniques. Modifying the shape of an elastic object thus cannot be performed interactively. Recent works in physical modeling try to integrate physical properties to the geometric model of an object. However, this techniques can only be applied to objects with specific representation (superquadric) which may not be useful for general design purposes. This research aims at developing an object representation based on volume modeling techniques to allow numerical analysis to be applied directly while shape editing can be performed without conversion of representations. This provides a basis for developing solid modeling systems that can be used for the modeling of soft objects which may have potential applications in the design of soft products (e.g. infant utensil or toys) as well as the modeling of soft tissues in biomedical engineering applications.
(EE98027)

Integrated Micro Six-Dimensional Force Sensor

- ✍ LI Wen Jung
- ❑ 1 November 1998
- ❖ CUHK Research Committee Funding

The lack of suitable force sensors for microrobots has been the impetus for researchers to develop miniature/micro multi-dimensional force sensors in recent years. Currently, the world's smallest six-dimensional force sensor is $4.5 \times 4.5 \times 1.5 mm^3$ in size (Jin and Mote 1998, see attached proposal), which

was fabricated by using MEMS technology. However, the existing force sensors are still inadequate in their usefulness in mesorobotic and microrobotic applications due to

(1) excessive total volume and

(2) robustness to applied forces.

Researchers propose to create an integrated MEMS six-dimensional force sensor with total dimension of $2.5\times2.5\times1.5mm^3$, which can be used for meso and micro scale robotic applications. Researchers will bulk-etch CMOS integrated piezoresistors and sensing circuitry chips to create the main sensing element which will minimize the overall sensor size and maximize the spatial resolution. They will also bulk-etch a silicon backstop substrate to enhance the robustness of the sensor. If successful, the sensor will be the world's smallest six-dimensional force detection element with resolution good enough for many meso scale robots. The integrated sensor has potential applications in active catheters, tactile sensing for virtual reality and robots, and micro satellite service systems. Please see the attached proposal for detailed research methodology.
(EE98028)

Inchworm Motor Systems for Ultraprecision Positioning

- ✍ LIAO Wei Hsin
- ❑ 1 October 1998
- ❖ CUHK Research Committee Funding

The inchworm motor is a useful device utilizing the intrinsic qualities of piezoelectric materials. Motion can be created through sequential activation of three piezoelectric elements. The outer two elements act as clamps. The central element expands and contracts along the motor shaft when voltage is applied. When a voltage is applied to one outer element, it clamps the shaft. Then a staircase voltage is applied to central element, causing it to change length on nanometer level. The staircase takes numerous steps from its upper to lower limit and may be stopped and reversed at any point on the ramp. At the end of the ramp, a voltage is applied to the other outer element, causing it to grip the shaft. Voltage is removed from original outer element, releasing it from the shaft. The staircase starts downward until it reaches its lower limit, at which point one element is reactivated, the other element is released and the staircase begins again. The cycles may be repeated to move along the shaft over a long distance. It is a linear motor with extremely fine resolution. The inchworm motor also has very unique features such as zero backlash, zero heat generated to hold position, non-magnetic construction and operation. The goal of this research is to develop inchworm motor systems capable of simultaneously providing nanometer resolution, high stiffness, large output force, long travel range, and compactness for ultraprecision positioning of

machine tools. Their characteristics and potential applications in microsurgery will also be studied and explored.
(EE98029)

A Haptic Tactile Display Design System Integration and Applications

- ✍ LIU Yunhui
- ❑ 1 December 1998
- ❖ Research Grants Council

Tactile feeling is crucial to the success of teleoperated manipulation tasks as well as to the improvement of reality and quality of virtual reality. To enable humans to feel interactions with remote or virtual environments, the concept of tactile display has been proposed for rendering the surfaces of objects touched. However, no tactile display system has widely been accepted nor is available on market despite tremendous research efforts in recent years. In this project, we will develop a new tactile display system with high spatial resolutions using conventional actuators by a modular approach. The modular approach is based on the proposal of a one-dimensional (1D) tactile display board that demonstrates tactile information on a straight line. By packaging the 1D display boards into multiple layers or other structures, we obtain two-dimensional (2D) flat or curved tactile displays. The display board offers flexibility in re-configuring and re-shaping tactile displays. High spatial resolutions will be achieved by properly structuring the display boards. We will develop a prototype system of 10×10 display pins spaced at a distance of $1.5\,mm$. The prototype tactile display will be integrated into a five-fingered hand and a virtual environment at the Chinese University of Hong Kong. We will evaluate the performance of the tactile display and demonstrate its validity through dynamic simulations in the virtual environment and teleoperation of the robot hand.
(CU98166)

Multilayer Recurrent Neural Networks for Real-time Optimization and Their Applications to Optimal Control of Kinematically Redundant Manipulators

- ✍ WANG Jun ● XU Yangsheng
- ❑ 1 December 1998
- ❖ Research Grants Council

The ability to solve optimization problems with time-varying parameters is essential in many real-time control applications. While existing neural network approach to convex optimization has demonstrated its promise, the use of neural networks for optimizing dynamic systems in real time still needs in-depth

investigations in terms of asymptotic stability of the entire systems and solution optimality of the results. In this proposed project, multilayer recurrent neural networks are to be developed for the optimization and control of dynamic systems (e.g., robots). By extending the previous results obtained by the principal investigator on the recurrent neural networks for convex programming based on primal problem formulations, the proposed research will involve the analysis and design of multilayer recurrent neural networks based on primal *and* dual formulations. By explicitly minimizing the duality gap between the primal and dual problem formulations, the proposed recurrent neural networks are conceived to solve time-dependent optimization problems autonomously in real time. The proposed recurrent neural networks will be applied for optimization and control of kinematically redundant manipulators for generating joint velocity/acceleration commands which results in the optimal motion in terms of various criteria and constraints. The proposed neural network approach is conceived to be suitable for optimal kinematics control of redundant manipulators in uncertain environments.
(CU98165)

Human Control Strategy Learning and Transfer

✍ XU Yangsheng

❑ 1 July 1998

❖ Research Grants Council

We propose to develop methodologies for modeling and transferring human control strategies (HCS) in response to real-time inputs. The research provides a framework for abstracting human skills so as to facilitate analysis of human control, to allow machines to learn from human partners in human-machine cooperation, and to transfer skill from human to human through learning human machine interfaces. We will address the following issues:
(1) how to efficiently model human control strategy,
(2) how to validate the resulting models' performance,
(3) how to evaluate the quality of the models, and
(4) how to effectively transfer human control strategy.
We utilize the efficient cascade neural network architecture, where network parameters are updated through extended Kalman filtering in a flexible functional form of variable hidden units and variable activation functions. The resulting models will be independently verified through a novel similarity-based stochastic model validation procedure, based on Hidden Markov Model (HMM) observation probabilities. Next, we propose to evaluate the skill exhibited in human control strategy and corresponding models through several defined performance criteria. Finally, we propose to use HCS

models as virtual teachers in transferring skill from a human expert to a novice operator. This research has application in areas important to Hong Kong. Better understanding and modeling of human control strategies can lead to automatic safety devices for cars and other human-operated machines. Video and virtual-reality games can learn to adapt to individual users through player monitoring, and generate game scenarios that maintain player excitement independent of individual skill levels.
(CU98164)

Service Robotics

✍ XU Yangsheng ● LIU Yunhui ● TSO S. K.* ● LANG Y. T. Sherman* ● SO T. P. Albert*

❑ 1 April 1999

❖ RGC-Central Allocation Scheme - Group Research

We propose to develop robotic technologies that enhance the quality of service in Hong Kong. Service robots are usually more intelligent than conventional industrial robots, with capabilities and functions made specific to the service tasks. We will develop robotic technologies that are specifically useful in service applications, and examine these technologies with the following service robot systems:
(1) hospital transporting/laboratory robot,
(2) high-rise building wall cleaning robot,
(3) building service maintenance robot, and
(4) petrol filling robot.
Though applications of the service robots vary, they share the common set of following fundamental research issues that are interwoven and must be addressed in a systematic way:
(1) motion planning and localization,
(2) human skill learning and transfer,
(3) human-robot coordination and interface, and
(4) robot-facility interface.
MAE team of the Chinese University of Hong Kong and CIDAM team of the City University of Hong Kong have both built up a concentration of robotics and automation resources and expertise. There is a conscious effort in both teams to support the productivity drive of the various service sectors through increasing usage of suitable technology. We believe the group research proposed will bring the first class scientists together working on the emerging, and the most promising area that will significantly impact the industry competitiveness and the quality of life in Hong Kong. The major resources to be built up over three years (1) establishment of a consolidated service robotics manpower base in Hong Kong, (2) working prototypes of service robots, and (3) "open laboratories" to facilitate industrial collaboration and technology transfer.
(EE98038)

A Geometric Approach for Fuzzy Interpolation

? YAM Yeung

❑ 1 December 1998

❖ CUHK Research Committee Funding

In order to resolve the dimensionality problem for fuzzy approximation, some researchers have proposed the use of sparse rule base together with an interpolation method to extract the conclusion for in-between observation. Numerous works have been pursued along this line but so far, they have all focused on manipulating the membership functions directly in order to get to an interpolated conclusion. This proposal adopts a new perspective in tackling the interpolation problem. By representing each membership function as a point in an inner product space, a fuzzy rule base becomes a set of mappings between the antecedent and consequent spaces. The ensuing interpolation (or extrapolation) problem can thus be pursued by constructing a continuous transformation between the two. The pay-off and significance of the present proposal include a set of rigorous procedures for fuzzy interpolation, and a new formulation under which fuzzy system theory and analysis can be tackled using transformation theory.
(EE98030)

Please refer to previous issues of this publication for more details of the following ongoing research at the department:

Edition   Title/Investigators

1995-96   Using 2-D Invariants for 3-D Object Recognition (CU94506)
    ? CHUNG Chi Kit Ronald

1996-97   Three-Dimensional Reconstruction from Stereo-Motion (CS96009)
    ? CHUNG Chi Kit Ronald

1997-98   Stereo Vision and Motion Analysis in Complement Using SVD (CU97507)
    ? CHUNG Chi Kit Ronald

1996-97   Robust Control of Nonminimum Phase Nonlinear Systems (CU96518)
    ? HUANG Jie

1997-98   An Efficient Iterative Approach to Computing Nonlinear H^∞ Control Laws (CU97508)
    ? HUANG Jie

1997-98   Interacting with a Virtually Deformable Object with an Instrumented Glove (CU97542)
    ? HUI Kin Chuen

1997-98   Real Intelligence Map: Theoretical Study and Hardware Implementation (CU97545)
    ? KWONG Chung Ping

1997-98   Intelligent Mechanical Structures (EE97010)
    ? LI Wen Jung

1997-98   Smart Dampers for Train Suspension Systems (EE97009)
    ? LIAO Wei Hsin ● XU Yangsheng

1997-98   Optimization of Active-Passive Hybrid Structural Control (PS97026)
    ? LIAO Wei Hsin

1996-97   Decentralized Adaptive Control for Multiple Manipulators in Cooperation (EE96012)
    ? LIU Yunhui

1997-98   Mapping Human Hand Motion to Robotic Hands: Learning and Optimizing (CU97544)
    ? LIU Yunhui

1996-97   Recurrent Neural Networks for Solving Combinatorial Optimization Problems with Time-Varying Parameters and Their Applications for En-Route Vehicle Guidance in Intelligent Transportation Systems (CU96521)
    ? WANG Jun

1997-98   Multilayer Recurrent Neural Networks for Rear-time Synthesizing and Optimizing Robust Linear and Nonlinear Control Systems (CU97543)
    ? WANG Jun ● HUANG Jie

1997-98   A Human-Machine Interface that Learns (CS97008)
    ? XU Yangsheng ● NECHYBA Michael Christian#

1997-98   Satellite Servicing Robot (EE97018)
    ? XU Yangsheng ● ZHANG Jiong*

1993-94   A Next-Generation Intelligent Robot with Creativity (EE94001)
    ? YAM Yeung ● SHI Xiaolun# ● HUI Kin Chuen ● CHUNG Chi Kit Ronald ● KWONG Chung Ping

1995-96   Manipulator Control for Soft Contact Applications Using Neuro-fuzzy Techniques and Non-parametric Models (CU95539)
    ? YAM Yeung ● KWONG Chung Ping

1996-97 Identification of Fuzzy System via
Singular Value-based Methods (EE96011)
  ✍ YAM Yeung

1997-98 Singular Value-Based Fuzzy
Identification (CU97531)

  ✍ YAM Yeung

1997-98 A Reduction Procedure for Neural
Networks (EE97011)
  ✍ YAM Yeung

RESEARCH OUTPUTS AND PUBLICATIONS

<P975002> **Chung, Ronald.** "Non-Epipolar Rigidity Constraint Over Image-to-Image Correspondences Under Paraperspective Projection". *Proceedings of the SPIE Conference: Vision Geometry VI (SD'97)* pp.218-229. San Diego, USA, 1997.07.

<P980918> **Xia, Youshen and Jun Wang.** "Recurrent Neural Networks for Shortest-Path Routing". *Proceedings of the International Conference on Information Fusion* pp.237-244. Las Vegas, USA, 1998.07.

<P980922> **Song, Jingyan and Yeung Yam.** "Complex Recurrent Neural Network for Computing the Inverse and Pseudo-Inverse of the Complex Matrix". *Applied Mathematics & Computation* vol.93, pp.195-205. USA, 1998.07.

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<P983612> **Baranyi, Peter; Attila Martinovics; Domonkos Tikk; Yeung Yam and Koczy T. Laszlo.** "Fuzzy Rule Base Reduction for Arbitrary Inference Algorithm Using Singular Value Decomposition". *Proceedings of the 5th International Conference on Soft Computing and Information/Intelligent Systems* pp.487-490. Iizuka, Japan: World Scientific, 1998.10.16.

<P983614> **Baranyi, Peter; Attila Martinovics; Szilveszter Kovacs; Domonkos Tikk and Yeung Yam.** "A General Extension of Fuzzy SVD Rule Base Reduction Using Arbitrary Inference Algorithm". *Proceedings of the 1998 IEEE Conference on Systems, Man and Cybernetics* pp.2785-2890. San Diego, CA, USA: IEEE, 1998.10.11.

<P983615> **Yam, Yeung and Ji-Feng Zhang.** "Exponentially Stabilizing Adaptive Control for Linear Slowly Time-Varying Systems". *Proceedings of the IFAC Workshop on Adaptive Control and Signal Processing* pp.165-170. Glasgow, UK: IFAC, 1998.08.26.

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see also <P975001>, <P982149>

RESEARCH PROJECTS

Solving the U-line Balancing Problem

- ✍ CHENG Chun Hung
- ❑ 1 November 1998
- ❖ CUHK Research Committee Funding

Just-In-Time (JIT) manufacturing was first implemented by Toyota Motor Company to eliminate wastes of material, labor, and space in their manufacturing systems. Because of the Toyota's success, many manufacturing firms have explored JIT possibility. As a consequence of JIT implementation, these firms are organizing U-shaped production lines to replace their traditional straight production lines. The experience with U-lines in the JIT environment was documented in *Toyota Production System* written by Y. Monden, *Zero Inventories* by R. Hall, and *Just In Time for America* by K.A. Wantuck. In this research, researchers investigate the problem of designing U-shaped production lines. Unlike designing traditional straight lines, very little research has been done on the U-line balancing problem. The purpose of this research is to develop new models and algorithms for designing and operating U-lines.
(EE98031)

Knowledge Engineering for Crime Analysis and Management

- ✍ LAM Kai Pui ● BRAHAN J. W.* ● CHAN Hilton*
- ❑ 1 January 1999
- ❖ Research Grants Council

A collaborative development project on crime analysis and management called AICAMS (Artificial Intelligence Crime Analysis and Management System) has been recently initiated, with the objective of completing a first prototype to demonstrate the potential of knowledge based systems for police operations. As the project proceeds with active users' participation and feedback, it is observed that there are urgent needs for academic research in three major areas, namely, effective matching algorithms for facial memory recall in forensic applications, exploratory crime analysis by collating relevant map patterns, and machine learning techniques to develop a knowledge base for crime investigation. Through our previous efforts, some useful tools including a facial Identi-kit, a map-based user interface, a decision matrix for vehicle crimes, have been developed to support further work. The present proposal aims at opening new ground in the applied research of the focused areas, based on our current development basis in the collaboration. As some of the proposed research areas are largely unexplored,

we are confident in obtaining original contributions which have significant impact in the practical law enforcement of Hong Kong.
(CU98185)

Polyhedral Combinatorial Methods for Planning Problems with Interaction Costs

- ✍ LEUNG May Yee Janny
- ❑ 1 March 1999
- ❖ CUHK Research Committee Funding

Many planning problems are combinatorial in nature. Moreover, many decisions are interlinked and their interaction effects must be considered. In order to adequately represent the interaction costs, quadratic or higher-order cost-functions are necessary, but algorithmic developments have lagged behind practical needs for such problems. In this project, the researchers would like to develop a polyhedral combinatorial approach to solving combinatorial optimisation problems with quadratic or higher order cost-functions. Computational testing of the method will be performed and modelling issues will also be investigated. The models and algorithms developed here can be used as a decision-support tool in many contexts.

The polyhedral approach involves two major steps. The first is the identification of the polyhedral structure (specifically facets and valid inequalities) of the 'linearised' integer programming formulation of these problems. For each class of valid inequalities identified, the 'strength' of the inequalities needs to be assessed by determining its dimension. The next step is the development of an effective cutting-plane algorithm, that selectively incorporates some of these inequalities *as needed* iteratively, in the solution of the problem. Computational tests for related problems have shown that strong cutting-plane methods substantially reduce the solution time compared to more tradition branch-and-bound approaches. Through their theoretical investigation and computational study, they can gain some understanding into the difficulty of planning problems with interaction costs, and also gain some insights into the modelling adaptability of the various formulations.
(EE98034)

Successive Solution Scheme for Constrained Redundancy Optimization in Reliability Networks

- ✍ LI Duan
- ❑ 1 December 1998
- ❖ Research Grants Council

While the modern technological advances have propelled the world to higher levels of productivity, affluence, and health, our society becomes more

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delicate and vulnerable due to the increasing dependence on modern technological systems that often require complicated operations. From any respect, systems reliability is a crucial measure to be considered in risk management. Systems reliability can be improved by placing redundant components. Determination of the optimal redundancy assignment among various subsystems under limited resource constraints leads to a nonlinear integer programming problem. Research results on constrained redundancy optimization have been dominated so far by heuristic algorithms that do not guarantee the optimality of the solution. A better solution methodology to the constrained redundancy optimization problem is essential to a more skilled and thoughtful management of the risks inherent in large-scale technological systems in Hong Kong as well as in the world. A novel approach using a successive solution scheme is proposed in this research proposal to identify exact optimal solution(s) for constrained redundancy optimization problems in a mathematically tractable setting. An auxiliary parametric problem formulation significantly reduces the search region, while a "concavification" transformation guarantees the global optimality. This proposed research is expected to be generalized to a class of nonlinear integer programming problems and the research outcome from this research would advance the state-of-the-art in nonlinear integer programming.
(CU98056)

Interactive Parametric Minimax Method in Multiobjective Optimization

- ✍ LI Duan
- ❏ 1 April 1999
- ❖ UK/Hong Kong Joint Research Scheme, the British Council

Many real-world optimization problems involve multiple performance objectives, which are often nonlinear and non-separable functions of decision variables. It makes the interactive solution process to identify the decision maker's most preferred solution difficult to construct. This project is aimed to develop a new solution scheme of interactive parametric minimax method in finding the most preferred solution in multiobjective optimization and to explore its applications in engineering and management. The research outputs will also include the development of a software package for the new interactive multiobjective optimization method.
(EE98044)

A Predicate Network for Automated Reasoning

- ✍ LOW Boon Toh
- ❏ 1 December 1998

- ❖ CUHK Research Committee Funding

Intelligent information systems can be used to automate aspects of decision making in a wide variety of settings. In science and engineering, they can be used in applications that model dynamic systems in imprecise environments where the information is uncertain. For business and finance sectors, typical applications include the discovery of consumer spending patterns, insurance risk assessment and stock price prediction. The range of applications is increasing rapidly and corporations are now using intelligent systems to automate parts of their core decision making processes.

In this project, researchers will formulate a predicate network to retain the expressiveness classical logic but capitalize the computational efficiency of neural networks for dynamic and automated reasoning. A new theory for automated reasoning will be formalized and a powerful system based on the theory will be developed. This research will have significant impact on automated reasoning, knowledge representation and commonsense reasoning, belief revision, and cognitive science. The theory and system can be used to solve practical problems in business and scientific domains such as decision support, planning and scheduling.
(EE98032)

Semantic Processing for Spoken Language

- ✍ MENG Mei Ling Helen
- ❏ 30 September 1998
- ❖ CUHK Research Committee Funding

Our information age is characterized by the convergence of computing, communication and content. Hence a seamless and secure infrastructure supporting the unfettered flow of information (or content) is undoubtedly of prime importance. Closely related to developing the infrastructure is another direction which should be pursued in tandem - developing the interface. The ideal interface should provide the user with ease-of-access to relevant, decision-critical information, in a timely and precise manner, and in a digestible form.

One of the more natural interfaces of conveying ideas among people is spoken language. Hence researchers propose to conduct research which leads to a human-computer interface with spoken language understanding capabilities. Spoken language understanding is distinct from speech recognition. While the goal of speech recognition is to transform the acoustic signal into a string of words, spoken language understanding pushes further in order to derive meaning from the word string(s). Spoken language understanding is also distinct from conventional natural language processing techniques, which have generally focused on written text. Spoken language differs from written text in the

frequent occurrence of agrammatical constructs, filled pauses, false starts and other spontaneous phenomena.

Researchers propose to conduct research in spoken language understanding for restricted domains. Their goal is to derive an ontology for the chosen domain, which can sufficiently capture various kinds of knowledge involved. Researchers also plan to adopt a strategy which enhances portability across different restricted domains, as well as robustness towards the various extemporaneous characteristics of spoken language.

(EE98008)

Research and Development of Spoken Language Interfaces for the Hong Kong Bilingual Environment

- ✍ MENG Mei Ling Helen
- ❑ 6 January 1999
- ❖ SpeechWorks International, IVRS (International) Ltd.

We have developed a system known as CU FOREX, which is the first bilingual spoken language system which can freely handle Cantonese and English. It is a telephone-based system, which allows the caller to speak with the computer, and ask about real-time foreign exchange rates, which we have directly captured from the Reuters satellite feed.

CU FOREX can support two kinds of inquiries-a directed dialog for new users, where the user gets step-by-step guidance from the computer, regarding what can be said at which time. The system can also handle natural language queries from power users (frequent users familiar with the system) - the user can ask a full question and receive the relevant response in one single step.

The CU FOREX system is now running continuously within the Human-Computer Communications Laboratory, Department of Systems Engineering and Engineering Management. The public can call the experimental system, to gain first-hand experience with the state-of-the-art spoken language technologies. Details can be found in our project web page: http: //www.se.cuhk.edu.hk/cu_forex.

(EE98041)

Manufacturing Logistics Re-engineering : Sequencing and Merging - with application to Electronic Equipment Assembly and Distribution

- ✍ YAN Houmin ● LEE Chung Yee*
- ❑ 1 September 1998
- ❖ Research Grants Council

Process re-engineering in manufacturing logistics is the search for a radical change in manufacturing processes to achieve remarkable improvements. In this project, we plan to analyze and develop models for manufacturing logistic re-engineering.

Issues we are going to address in this project are:

(1) build a manufacturing logistics model which captures lead time and safety stock investment considerations with applications to electronic device and equipment industry;

(2) analyze how to sequence operations, and how to combine (merge) operations in a product family;

(3) generate conditions and insights for a better manufacturing logistic management; and

(4) develop efficient algorithms to help product and process engineers in identifying what processes need to be re-engineered, and how the process re-engineering will be done.

We expect that this research will generate a new analytical model and interesting results which contribute to the fields of manufacturing logistics and supply chain management. We also expect that our research will lead to effective methods which provide strategic and operational benefits to the electronic device and equipment industry in the region.

(CU98181)

Color Image Retrieval and Visual Thesaurus

- ✍ YANG Christopher Chuen Chi ● LI Victor*
- ❑ 1 September 1998
- ❖ Research Grants Council

The investigators propose a new content based color image retrieval technique and develop a visual thesaurus to assist users in searching for relevant images. Such development could improve the recall and precision in color image retrieval and one of the applications can be geographic information systems. In most of the color image retrieval systems, images in a database are recorded with textural descriptions. Such descriptions are inadequate for characterizing the images in order to obtain acceptable recall and precision. Currently, several color image retrieval systems that are based on image contents, such as QBIC by IBM Almaden Research Centre, have been developed. However, many of them are using low color resolution, for examples, 256 or 64 colors. The characteristics of luminance, hue and saturation have not been effectively used to retrieve the textural features and chromatic features. In this project, they propose techniques to retrieve the textural features based on the luminance component and chromatic features based on the hue and saturation components. Gabor filters will be used for retrieving textural features and histogram indexing will be used to retrieve chromatic features. A visual thesaurus is also proposed for categorizing the images based on Kohonen's self-organizing maps. Such thesaurus should allow users to search for similar images more efficiently and provide a two-dimensional map for visualization.

Investigation on the color coordinate systems such as LHS, YIQ, and RGB will also be conducted. Processing techniques on luminance and saturation using these color coordinate systems will be derived. Impact of luminance processing or saturation processing on the color images will be studied and experiments will be conducted.
(CU98034)

Dynamics and Optimization in Production Logistics

- ✍ YAO David Da Wei
- ❑ 1 October 1998
- ❖ CUHK Research Committee Funding

This proposal will enable the researcher to continue his work in production logistics, focusing on three broad but related issues:
(1) stochastic scheduling,
(2) quality dynamics in multi-stage systems, and
(3) supply chain performance analysis and optimization.

Together, these studies will contribute new methodologies and new insights to some of the most important aspects of today's productive enterprise: efficient resource allocation schemes, high-quality customer service, and a responsive distribution network.

The studies will use approaches in stochastic dynamic programming, polymatroid optimization, and network modelling and analysis. Several performance optimization models will be developed to generate operating policies that are simple and easy to implement, as well as optimal or near optimal.
(EE98007)

Strategic Research in Risk and Optimization

- ✍ YAO David Da Wei ● CAI Xiaoqiang ● CHENG Chun Hung ● HE Jia (Finance) ● LEUNG May Yee Janny ● LI Duan ● LIU Ming (Finance) ● YAN Houmin ● YEN Jerome ● ZHOU Xunyu
- ❑ 1 January 1999
- ❖ CUHK Strategic Research Program

The objective of this proposal is to address the theme of risk and optimal decision making in two broad areas: financial engineering and supply chain logistics. In the first area, the necessity for risk management and intelligent decisions has been borne out by the recent financial setbacks in the region and worldwide. In the second area, risk and decisions often take the form of optimal trade-offs between inventory and service. Our plan is to launch six focal projects, in a period of three years, starting from January 1, 1999. Collectively, these projects, which aim at competing for HK$25 million from external funding sources, will combine the expertise of the

SEEM faculty across several disciplines and application areas, and significantly sharpen the strategic focus of the Department.

A major component of the proposed projects is to transfer SEEM faculty's research output into decision and software technologies that can benefit Hong Kong industry and business in financial services, investment banking, electronic commerce, supply chain management, and distribution and logistics planning. In this endeavor, SEEM's two state-of-the-art laboratories, the Financial Engineering (FE) Lab and the Enterprise Resource Planning (ERP) Lab, which are peerless among Hong Kong universities, will provide a cutting-edge vehicle for research and development. We also expect these mission oriented projects to motivate, through the synergistic interactions and collaborations among the participating faculty, a set of new basic research projects that otherwise might never be undertaken.
(EE98040)

The Next-Generation Digital Library Initiative at CUHK

- ✍ YEN Jerome
- ❑ 1 March 1999
- ❖ CUHK Research Committee Funding

As stated in Chief Executive's Policy Addressing, it is critical to make Hong Kong SAR the Internet hub of the Asia. To echo such vision, the researchers propose to set up an international initiative aimed at, as part of a large-scale effort, to support Hong Kong SAR, especially, the Chinese University of Hong Kong, the Internet hub in the Far East Asia. In order to reach this goal, there are four critical successful factors: high-bandwidth networking infrastructure, rich contents, sufficient applications, and attractive business models. This initiative can be divided into two major projects: the Next-Generation Internet Architecture and Digital Library. This proposal will focus on digital library.

Digital Library focuses on the development of applications to support content conversion and collection, indexing and organizing, value-adding analysis, searching and retrieval, as well as delivery and dissemination. They plan to set up an Internet testbed linking the Chinese University of Hong Kong (CUHK), South China University of Technology (SCUT), the Academia Sinica in Taiwan, and the Carnegie Mellon University (CMU) for the following four research purposes:
(1) the testbed will be used to support advanced research in Digital Library applications. For example, interoperability, clustered servers and load balancing, quality of service (QoS), cross-lingual and trans-lingual content retrieval in texts, images, and video, etc.
(2) the testbed will promote tele-education or tele-medicine activities among the four institutions.

(3) the testbed will be an experimental platform for the Next-Generation Internet Architecture, such as, Ineternet-2.

(4) economic and managerial issues, such as, business model for information market and the integration of digital library with electronic commerce.

(EE98012)

Optimal Dividend Distributions and Risk Controls for Financial Companies

- ✍ ZHOU Xunyu
- ❑ 1 January 1999
- ❖ Research Grants Council

In this project we intend to explore a new area on risk and dividends distribution management for insurance companies. Specifically, we consider an insurance company which can choose a production/business policy among various alternatives with different expected profits and associated risks. In addition there is a choice of the timing and amount of dividends to be paid out to the shareholders. Notwithstanding any policy decision there is a constant payments of a corporate debt, such as bond liability or loan amortization. The objective is to find the policy which maximizes the expected total discounted dividends pay-outs until the time of bankruptcy. We propose to employ technique in stochastic optimal control theory to solve the problem. (CU98054)

Please refer to previous issues of this publication for more details of the following ongoing research at the department:

Edition	Title/Investigators
1996-97	New Scheduling Models with Applications to Berth Allocation (CU96543) ✍ CAI Xiaoqiang ● LEE Chung Yee
1997-98	A Class of New Time-Varying Network Models with Controllable Flow Departure/Arrival Times (CU97528) ✍ CAI Xiaoqiang ● WONG Chak Kuen (Computer Science and Engineering)
1997-98	New Models in Capacitated Lot Sizing Decisions (CS97009) ✍ CHENG Chun Hung
1995-96	Real-time Systems Diagnosis with Microprocessor Applications (CU95517) ✍ LAM Kai Pui

1996-97	Knowledge Engineering Laboratory - Applying Artificial Intelligence Research to Industrial Applications (CS96014) ✍ LAM Kai Pui ● LOW Boon Toh ● LAM Wai
1997-98	Self-tuning Neural Control Systems and their VLSI Implementation (CU97525) ✍ LAM Kai Pui ● POON Chi Sang*
1997-98	Knowledge-Based Chaotic Prediction for Financial Engineering Applications (CS97010) ✍ LAM Kai Pui
1997-98	AICAMS Prototype Development (EE97014) ✍ LAM Kai Pui
1996-97	Distributed Learning of Bayesian Inference Networks (CS96011) ✍ LAM Wai
1997-98	A Bayesian Framework for an Intelligent Information Filtering System under Dynamic Environments (CS97011) ✍ LAM Wai
1997-98	Global Logistics Management: Combinatorial Optimisation Methods for Supply / Distribution Network Planning (SS97069) ✍ LEUNG May Yee Janny
1996-97	Saddle Point Generation in Nonconvex Optimization (CU96545) ✍ LI Duan
1997-98	Variance Minimization in Stochastic Systems (CU97523) ✍ LI Duan
1995-96	A Chinese Database Management System Interface (CU94517) ✍ WONG Kam Fai William
1995-96	Towards a Natural Language-oriented Chinese Information Retrieval System (CU94519) ✍ WONG Kam Fai William
1996-97	Linguistic Knowledge Acquisition for a Chinese Noun Phrase Parser (CS96013) ✍ WONG Kam Fai William
1996-97	A Machine Tractable Chinese Thesaurus and its Application to Natural Language Processing (CS96019) ✍ WONG Kam Fai William ● LUM Yu Sun Vincent

1997-98   A Logic Based Intelligent Information Retrieval Framework (CS97001)
    ✍ WONG Kam Fai William ● CHENG Chun Hung ● LAM Wai ● HE Jia (Finance) ● LOW Boon Toh ● HO Kei Shiu Edward#

1997-98   Legal Reasoning for Distributed Information Retrieval (CS97012)
    ✍ WONG Kam Fai William

1997-98   Computerized Qualitative Research Analysis (EE97013)
    ✍ WONG Kam Fai William ● SO York Kee Clement (School of Journalism and Communication) ● SO Lai Man Stella (Marketing)

1996-97   Robust Production Scheduling in High Tech Manufacturing (CU96532)
    ✍ YAN Houmin ● SETHI Suresh P.*

1997-98   Manufacturing Logistics with Application to Electronic Equipment Assembly and Distribution (EE97012)
    ✍ YAN Houmin

1995-96   Dynamic Near-Optimization and Applications (CU94502)
    ✍ ZHOU Xunyu

1995-96   Asymptotic Optimality of Hierarchical Production Policies in Discrete Event Manufacturing Systems (CU95520)
    ✍ ZHOU Xunyu

1995-96   Maximum Principle for Singular Controls in Finance (CS95012)
    ✍ ZHOU Xunyu

1997-98   New Challenges in Optimization of Stochastic Diffusion Processes (CU97518)
    ✍ ZHOU Xunyu

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