

The background of the page is a grayscale abstract composition. It features several overlapping, concentric circular patterns that create a sense of depth and motion. In the center, there are three prominent, semi-transparent spheres that appear to be floating or interacting with the circular patterns. The overall effect is a complex, layered visual texture.

**Faculty of  
Engineering**

## RESEARCH PROJECTS

### Reconstruction of Generic Curved Surface from Stereo Views

- ✉ CHUNG Chi Kit Ronald
- 1 December 1999
- ❖ CUHK Research Committee Funding (Direct Grants)

Recovering three-dimensional (3-D) information of a scene from its images is a visual sensing capability that can add tremendous versatility to our machines in industry and society. Stereo vision cue that achieves 3-D reconstruction from two images taken at widely displaced positions. The key problem to solve in stereo vision is the correspondence problem, which is to decide which features in the two images are projected by the same entity in space. The classical approach of solving the correspondence problem is rooted at the assumptions that the scene is smooth and that features have the same topological relationship in the two images. However, occlusions in the scene cause violations to the two assumptions and thus present great difficulty to the approach. In a previous work, we explored a new approach that does not make those assumptions. The correspondence problem is solved instead by exploiting the existence of some image-to-image mappings named homographs, each induced by a planar surface in the scene. However, the work can reconstruct only planar surfaces. This project is a sequel to the work. It aims at extending the approach to reconstruct even curved surfaces. The researchers propose to apply the piecewise-linear approximation to the entire scene, thereby representing each surface in it as a set of homographies over the stereo images -- one homography for a planar surface, and multiple homographies for a curved surface. The resolution in the piecewise-linear approximation would be hierarchical -- a surface in the scene is regarded initially as a single planar patch, and progressively as more planar patches where necessary. The project not only addresses the fundamental problem of stereo correspondence in computer vision. It also has direct applications in tasks that require 3-D sensing, examples of which are robot grasping for industrial automation, autonomous navigation in unknown environments, object recognition, and even acquisition of 3-D real scenes for cartography or virtual reality purposes. (EE99018)

### Practical Output Regulation for Nonlinear Systems

- ✉ HUANG Jie
- 1 December 1999
- ❖ Research Grants Council (Earmarked Grants)

The nonlinear output regulation problem (also known as servomechanism problem) aims to achieve asymptotic tracking with disturbance rejection in nonlinear systems via feedback control. Research on this topic has led to a powerful nonlinear control methodology that can handle a large class of nonlinear systems including nonminimum phase nonlinear systems. Solvability of this problem has been well understood due to the work of Isidori and Byrnes. However, the practical computation of the control law has not been well addressed due to the reliance of the control law on the solution of a set of mixed nonlinear partial differential and algebraic equations known as the regulator equations. The objectives of this project are:

- (1) to explore the possibility of using a class of feed forward networks to approximately solve the regulator equations;
- (2) to develop a methodology that can solve the nonlinear output regulation problem approximately and practically; and
- (3) to evaluate and validate our approach by applying it to some practical control systems. (CU99400)

### Deformation of Solid Models for Design Applications

- ✉ HUI Kin Chuen
- 1 February 2000
- ❖ CUHK Research Committee Funding (Direct Grants)

An essential feature of a CAD (computer aided design) system that can be used for industrial design is the ability to create and to modify free form objects. Existing techniques for industrial design usually relies on surface modeling in which users have to manipulate individual surfaces in order to obtain the desired shape. This poses difficulties for designers who may not be acquainted with the mathematical concept of surfaces. Besides, most advanced CAD/CAM systems for engineering design and manufacture usually rely on solid modeling techniques. However, automatic conversion of a surface model to a solid model is in general not possible so that the industrial design, and the engineering design and manufacturing process are not integrated. The objective of this research is to develop a deformation technique that can be integrated with a solid modeling system. The technique will allow designers to bend, twist, or deform a solid locally without ever being concerned with the continuity between surfaces which occurs frequently in surface modeling. This allows designers to modify the shape of a solid model directly so that they are released from the tedious task of manipulating surfaces. Since no conversion between systems is required, a better integration

between the industrial design and the engineering design and manufacturing process can be expected. (EE99019)

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#### A MEMs Vibration Electric Power Generator

- ✉ LI Wen Jung • LEONG Philip Heng Wai (Dept of Computer Science and Engineering) • TANG William C.\*
- 15 September 1999
- ❖ Research Grants Council (Earmarked Grants)

The researchers propose to build a mechanically based integrated MEMS power generator which will convert vibration kinetic energy transferred from the immediate environment to electrical energy usable by a low-power CMOS circuit chip. At the conclusion of this project, they will demonstrate a functional temperature data logging CMOS chip, which will store maximum and minimum temperature data for a given time span, co-packaged with a MEMS vibration-based power generator. This self-powered sensing system can be used to record the temperature of many vibratory machinery components such as water pumps and robotic arms. However, the successful development of an efficient integrated mechanical power supply will potentially have applications in vibration monitoring of manufacturing equipment, implantable medical devices, mobile communication systems, free-moving micro robotic systems, and space-based MEMS components. Micromachining techniques will be used to build the vibration electric generator because they offer two distinct advantages: 1) precise control of the mechanical resonance which is necessary to produce an efficient generator, and 2) batch fabrication which will allow low-cost mass production of commercially viable generators. The current trend in very large scale integration (VLSI) circuits design is in minimization of power consumption to extend battery life in portable systems and heat removal in larger systems. Coupling with the recent advent in low-power MEMS sensors, MEMS integrated mechanical power generators with life span far greater than its chemically based counterparts will be imperative in diverse sensor and circuit applications in the near future. (CU99416)

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#### Active-Passive Hybrid Structural Control Using Enhanced Self-Sensing Piezoelectric Actuators

- ✉ LIAO Wei Hsin
- 1 October 1999
- ❖ CUHK Research Committee Funding (Direct Grants)

Vibration control is crucial to today's increasingly high-speed and lightweight complex mechanical

structures. In recent years, the idea of applying smart materials to structure systems has been studied in various disciplines. In particular, a self-sensing actuator technique has been developed so that a single piece of piezoelectric element can be used simultaneously as a sensor and an actuator. Since the sensor and actuator are in the same location, they are perfectly collocated. Moreover, space requirement and weight penalty are reduced in comparison to the structure with separate sensor and actuator. In this research, an enhanced self-sensing piezoelectric actuator is proposed. The objective of this research is to investigate this active-passive hybrid adaptive structure for vibration suppressions. Models and control algorithms will be developed for the structural systems with self-sensing actuators. The researchers will evaluate actuating and sensing abilities individually and then their concurrent sensing/actuation performance. The design methods will be developed to synthesize structures and maximize the system performance with the least effort for the purpose of vibration control. Experimental efforts will be carried out to implement the optimally synthesized and controlled active/passive structures with self-sensing piezoelectric actuators. The project will address the fundamental research issues relating to structural systems. The scientific knowledge created through this project will facilitate the full realization of smart structures for vibration control and stimulate continuing research efforts in this area. The results of this study are essential for advancing the technology of various complex systems such as machine tools, robots, and computer hard disc drives. (EE99020)

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#### Multisensor Based Control of Dexterous Robots

- ✉ LIU Yunhui • XU Yangsheng • KNOLL Alois\* • ZHANG Jianmei\*
- 1 June 2000
- ❖ Germany/Hong Kong Joint Research Scheme

This research aims to jointly develop an intelligent and reliable real-time controller for multi-robot systems and/or multi-fingered robot hands. Noises and uncertainties in sensor readings decrease reliability and performance of sensor-based robot control so that the use of sensors is avoided in industry. This project proposes to develop a robust controller by fusing information from joint position sensors, force sensors, tactile sensors and vision. The proposed work includes not only theoretical development but also experimental verification of the controller on the multi-robot system and the multi-fingered hand at The Chinese University of Hong Kong and University of Beilefeld. (EE99036)

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**Recurrent Neural Networks for Real-time Force Optimization of 3D Frictional Form – Closure Grasps with Multi-fingered Robotic Hands**

- ✉ WANG Jun • LIU Yunhui
- ☐ 1 October 1999
- ❖ CUHK Research Committee Funding (Direct Grants)

Grasping force optimization of multi-fingered robotic hands is very important to maximize the efficiency and dexterity of robotic manipulations. The objective of the force optimization is to minimize the magnitudes of grasping force applied to an object while holding the object against slippage and balancing external forces due to gravity, acceleration and others. The existing force optimization algorithms are time-consuming and put heavy computational burden on robotic control processors. In addition, it is difficult for the existing force optimization algorithms to optimize real-time robotic manipulations effectively and efficiently when external force is time varying. For real-time force optimization, parallel and distributed optimization approaches are more desirable. In recent years, the neural network approach has demonstrated its great promise for real-time optimization. As parallel and distributed computational models, neural networks can serve as local co-processors for real-time force optimization. In this project, recurrent neural networks are to be developed for the grasping force optimization of multi-fingered robotic hands. By applying and extending the previous results obtained by the principal investigator on recurrent neural networks for convex programming, the research will focus on the analysis, design, simulation, and experimentation of recurrent neural networks for real-time grasping force minimization of multi-fingered robotic hands. The proposed recurrent neural networks are conceived to be capable of solving the time-dependent grasping force optimization problems autonomously in real time and suitable for optimal force control of multi-fingered robotic hands in uncertain environments.  
(EE99021)

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**A Single-wheel, Gyroscopically Stabilized Robot**

- ✉ XU Yangsheng
- ☐ 1 September 1999
- ❖ Research Grants Council (Earmarked Grants)

The researchers will develop a novel concept of mobile robot, i.e., a single-wheel, and gyroscopically stabilized robot, based on the principle of gyroscopic precession. The robot can be considered as a single wheel, actuated through a spinning flywheel attached through a two-link manipulator at the wheel bearing and a drive motor. The spinning flywheel acts as a

gyroscope to stabilize the robot, and at the same time it can be tilted to achieve steering. This configuration conveys significant advantages over multi-wheel, statically stable vehicles, including insensitivity to attitude disturbances, high maneuverability, low rolling resistance, ability to recover from falls, and amphibious capability. Potential applications for Gyrover are numerous. We may find amphibious use on beaches or swampy areas, for transportation, rescue, frontier inspections, mining detection, environment monitoring or recreation. As a surveillance robot, Gyrover could use its slim profile to pass through doorways and narrow passages, and its ability to turn in place to maneuver in tight quarters. It can also be used as a high-speed lunar vehicle, where the absence of aerodynamic disturbances and low gravity would permit efficient, high-speed mobility. The nature of the system is nonholonomic, underactuated, and nonlinear, providing a rich array of research issues in dynamics, control, and sensing, which we propose to study in this project to establish a foundation of the science of dynamically stabilized robotics.  
(CU99403)

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**Developing an Intelligent On-line Monitoring System for Metal Stamping Operating**

- ✉ XU Yangsheng • DU Ruxu\*
- ☐ 1 September 1999
- ❖ Industrial Support Fund, Industry & Technology Development Council

Metal stamping operation plays an important role in Hong Kong's economy. According to the government statistics, there are well over 2,700 metal manufacturing establishments in Hong Kong employing approximately 20,000 persons. In recent years, with ever-increased product complexity and tightened manufacturing tolerance, it has become necessary for these companies to use advanced technologies such as on-line monitoring to maintain their global competitiveness. The objective of the project is to develop an intelligent, reliable, and cost effective on-line monitoring system for metal stamping operations. The system consists of two modules: an on-line monitoring and diagnosis module, and a material and product quality inspection module. The monitoring and diagnosis modules will be developed based on a combination of advanced signal processing techniques (wavelet transform, holospectrum and etc.) and intelligent decision theory. It can automatically set up alarm threshold and diagnose the root cause of the defects. The material and product quality inspection module will use two CCD cameras to capture and analyze the dimensions, scrapes, and strain distributions of the parts. The two modules can be used separately or together to ensure the product quality and to reduce the production cost.  
(EE99004)

**A Geometric Approach for Sparse Rule Base Interpolation and Extraction**

- ✉ YAM Yeung
- ☐ 1 December 1999
- ❖ CUHK Research Committee Funding (Direct Grants)

The process of fuzzy approximation faces an inherent dilemma when applied up to a certain limit. On one hand, the need for accuracy calls for using dense rule bases with large numbers of antecedent variables and linguistic terms. On the other hand, however, many problems in computational time and storage space are created as these numbers get large. To resolve this dilemma, researchers have proposed the use of sparse rule bases, and an interpolation method to generate conclusion for observations lying in area not covered by any antecedent membership functions. Numerous works have been pursued along this line but so far, they have all focused on manipulating the membership functions directly to arrive at a conclusion. The present project proposes a new geometric approach to tackle this dimensionality problem. The project focuses on rule bases with membership functions comprising a finite number of characteristic points and calls for using the characteristic locations as coordinates in representing the membership functions in high dimensional Cartesian space. As a result, a fuzzy rule base can be viewed as mappings from a set of points in the antecedent space to another in the consequent space, and the interpolation problem thus becomes searching for an image in the consequent space of the antecedent observation. The abnormality problem associated with some previous methods can also be avoided by focusing the search in region of the Cartesian space corresponding to well-defined membership functions. Additionally, extraction of sparse rule base can also be explored by applying clustering technique to generate point centers in the antecedent and consequent spaces. (EE99022)

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

<u>Edition</u>	<u>Title/Investigators</u>
1997-98	Stereo Vision and Motion Analysis in Complement Using SVD (CU97507) ✉ CHUNG Chi Kit Ronald
1998-99	Homography-based Stereo Vision for Polyhedral Reconstruction (CU98169) ✉ 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-infinity Control Laws (CU97508) ✉ HUANG Jie
1998-99	An Approximation Method for the L2 Gain Attenuation Problem in Discrete-time Nonlinear Systems (CU98168) ✉ HUANG Jie
1997-98	Interacting with a Virtually Deformable Object with an Instrumented Glove (CU97542) ✉ HUI Kin Chuen
1998-99	Volume Modeling of Deformable Objects (EE98027) ✉ 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
1998-99	Integrated Micro Six-Dimensional Force Sensor (EE98028) ✉ 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
1998-99	Inchworm Motor Systems for Ultraprecision Positioning (EE98029) ✉ LIAO Wei Hsin
1997-98	Mapping Human Hand Motion to Robotic Hands: Learning and Optimizing (CU97544) ✉ LIU Yunhui
1998-99	A Haptic Tactile Display Design System Integration and Applications (CU98166) ✉ 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		✉ XU Yangsheng • LIU Yunhui • TSO S. K.* • LANG Y. T. Sherman* • So Ting Pat Albert*
1997-98	Multilayer Recurrent Neural Networks for Real-time Synthesizing and Optimizing Robust Linear and Nonlinear Control Systems (CU97543) ✉ WANG Jun • HUANG Jie	1993-94	A Next-Generation Intelligent Robot with Creativity (EE94001) ✉ YAM Yeung • SHI Xiaolun# • HUI Kin Chuen • CHUNG Chi Kit Ronald • KWONG Chung Ping
1998-99	Multilayer Recurrent Neural Networks for Real-time Optimization and Their Applications to Optimal Control of Kinematically Redundant Manipulators (CU98165) ✉ WANG Jun • XU Yangsheng	1997-98	Singular Value-Based Fuzzy Identification (CU97531) ✉ YAM Yeung
1998-99	Human Control Strategy Learning and Transfer (CU98164) ✉ XU Yangsheng	1997-98	A Reduction Procedure for Neural Networks (EE97011) ✉ YAM Yeung
1998-99	Service Robotics (EE98038)	1998-99	A Geometric Approach for Fuzzy Interpolation (EE98030) ✉ YAM Yeung

## RESEARCH OUTPUTS AND PUBLICATIONS

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**see also** <P998759>

## RESEARCH PROJECTS

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### Intersection Graphs and Their Recognition Algorithms

✉ CAI Leizhen

☐ 1 December 1999

❖ Research Grants Council (Earmarked Grants)

The concept of  $(X,Y)$ -intersection graphs, where  $(X,Y)$  is a pair of fixed graphs, was introduced by Cai, Corneil and Proskurowski in an attempt to capture the intersection relation of subgraphs in a graph. This notion generalizes the classical notion of line graphs, and is useful in studying generalized packing, independence of subgraphs, as well as  $P_4$ -structures in perfect graphs. Some interesting and important results about  $(X,Y)$ -intersection graphs have been obtained recently and there is a growing interest in the subject.

In this project, the researchers investigate graph-theoretic and algorithmic issues concerning  $(X,Y)$ -intersection graphs. To understand the structures of  $(X,Y)$ -intersection graphs for various pairs of  $(X,Y)$ , they wish to characterize the family of  $(X,Y)$ -intersection graphs through a set of forbidden induced subgraphs. They will also study the relationships among all families of  $(X,Y)$ -intersection graphs. For the algorithmic part, their aim is to design efficient algorithms to recognize the family of  $(X,Y)$ -intersection graphs, or to prove that the recognition problem is NP-complete. (CU99410)

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### A Portfolio Management System for the Hong Kong Market

✉ CHAN Lai Wan • KING Kuo Chin Irwin

☐ 31 December 1999

❖ Research Grants Council (Earmarked Grants)

Application of neural networks to financial forecasting has been shown to be a promising approach. In this project, the researcher will apply neural networks and data mining techniques to portfolio trading in Hong Kong stocks. The theoretical aspect of this project will be to improve the prediction ability of neural network models and to investigate the building of a trading system based on a financial training criterion. The result would be applied to the trading of a portfolio of stocks in the Hong Kong market. The developed technique may provide an alternative to current trading systems. (CU99428)

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### An Intelligent System for Satellite Meteorological Data Mining and Its Applications

✉ FU Wai Chee Ada • LIN Hui (Dept of Geography) • KING Kuo Chin Irwin • HUANG Qian\*

☐ 1 October 1999

❖ Research Grants Council (Earmarked Grants)

In search of greater control over the environments, the researchers seek to understand geographical and in particular atmospheric phenomena. Geographical information systems have been found to be of great values in providing important information for this kind of analysis. A remote sensing system such as a satellite can generate Gigabytes of data in digital images and other information cache day. However, current techniques in analyzing the data have been limited. Many methods rely heavily on human judgement and experience and can handle only a limited amount of data. They propose to develop an intelligent system for data mining on the meteorological data collected by satellites. Querying, transmission and visualization can also be studied in order to analyze and utilize these data. They will focus on automatic knowledge acquisition and knowledge discovery in mining the meteorological data for analysis of geographical phenomenon and planning. The system can have potential use in establishing useful relations of weather and productivities for certain industries, environmental studies, land-use, weather forecast, city planning, understanding and prevention of natural disasters, etc. It can also serve as a tool for training and research in meteorological studies or data mining. (CU99436)

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### Apparel Manufacturing Knowledge Portal Site

✉ KING Kuo Chin Irwin • FU Wai Chee Ada • CHAN Lai Wan • NEWTON Edward\* • FAN Jin Tu\* • NG Roger\*

☐ 1 October 1999

❖ Industrial Support Fund, Industry & Technology Development Council

Apparel Manufacturing is a traditional industry. Much of the knowledge resides in books, magazines, University, Associations, publications as well as minds of experienced people from different countries, which has or had possessed an apparel industry. With the advent of a global communications media—the Internet, it is now possible to access that knowledge by creating a *Portal Site*.

This project is proposed to develop a knowledge site in the Internet, called *Apparel Manufacturing Knowledge Portal Site*, for the Hong Kong textile and clothing industries to have instant world-wide access to market information, authoritative expertise, knowledge and information (whether past or new) about the manufacturing, development, merchandising and distribution of apparel products.

The *Apparel Manufacturing Knowledge Portal Site* will be a part of the larger Apparel Community Portal Site linked to HK-TAIGA, a super portal site for textile and apparel information. It is believed that all Hong Kong textile/garment manufacturing/trading firms (about 30,000) as well as any member joining the HK-TAIGA will benefit from the outcome of the project. If Hong Kong becomes the *de facto* gateway to textile and apparel manufacturing knowledge centre, greater business will be generated for Hong Kong companies.  
(EE99031)

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**The Design and Analysis of Stochastic Clustering Methods for Generating Indexing Structure for Information Retrieval in Image Database Applications**

- ✉ KING Kuo Chin Irwin • FU Wai Chee Ada • CHAN Lai Wan
- ☐ 1 December 1999
- ❖ Research Grants Council (Earmarked Grants)

The combination of advanced database indexing and image-processing techniques have expanded the frontier of image database with content-based retrieval research in recent years.

Montage, an image database commissioned by the Hong Kong government's Industry Department in 1995 for the textile and fashion industry, is a content-based image retrieval system designed and implemented by the Principal Investigators (PIs) that allows users to access image information based on color, texture, shape, and sketch. As the PIs continue to upgrade and improve the montage system with more advanced features, they have found that scalability of data objects in Montage is a major issue. As more and more images are acquired and processed, currently available indexing techniques are not fully adequate to satisfy the performance requirement of the image retrieval system. Hence, a more efficient indexing structure suitable for image features is needed to improve the performance of the system by decreasing the image retrieval time.

To research into more efficient indexing structures for image information retrieval, they propose:

*Design of Novel Algorithms:* To extend PIs' current theoretical framework on non-adaptive stochastic competitive learning algorithm for indexing to an adaptive indexing scheme based on Rival Penalized Competitive Learning (RPCL).

*Analysis of Algorithms:* To develop a more suitable software metric to measure the performance of various indexing schemes. Application of Algorithms--To apply this proposed stochastic adaptive RPCL clustering algorithm in generating the indexing structure in Montage.  
(CU99407)

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**Adaptive Transform Domain Video Indexing**

- ✉ LEE Moon Chuen
- ☐ 1 December 1999
- ❖ CUHK Research Committee Funding (Direct Grants)

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 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. The researchers characterize the video scene in terms of its complexity based on the motion and activity in the scene. Then, using the characterization, they 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, 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 multimedia database systems.  
(EE99011)

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**To Develop a New Class of Fast Genetic Based Evolutionary Algorithms Using Splicing/Decomposable Representation Scheme and Exclusion-based Operators**

- ✉ LEUNG Kwong Sak
- ☐ 1 November 1999
- ❖ CUHK Research Committee Funding (Direct Grants)

Simulated evolutionary computation is the metaphorical use of concepts, principles, and mechanism extracted from our understanding of how natural systems evolve to help solve complex computational problems. Genetic based evolutionary computation has been widely and successfully used to solve real-life problems. However, it suffers severely from computational inefficiency. The researchers have identified some of the main causes: re-sampling, inflexible coding schemes, elitist-based and selection-based models and passive evolution techniques. To overcome the shortcomings, the overall objective of the project is to develop a sound theory and an implementation strategy for a new class of fast genetic based evolutionary algorithms (f-GEAs). They will develop an adaptive and flexible problem representation (coding and decoding of the chromosomes with variable lengths and structures) scheme based on splicing and decomposition. They

will exploit *exclusion-based* operators and a new *environment-driven* population evolution model based on statistical inference and short-term memory to implement the new class of f-GEAs with substantial increase in efficiency. *Exclusion-based* operators exclude a group of potential candidates or a region in the search space successively in the search for the global optimal solution. In *environment-driven* evolution, the evolution (search) will be influenced or directed by the search environment perceived through the global information collected so far from the search history or otherwise. They will also study the theory of these models and operators. The developed theory and algorithms for f-GEAs will be applied to solve real-life data-mining problems. The project addresses the development of a series of new models and algorithms for fast genetic and evolutionary algorithms. The success of the project will impact on the current directions in GEAs. (EE99012)

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**Design, Analysis and Implementation of Mixed Workload Schedulers with Application to the Multimedia Digital Library System**

✉ LUI Chi Shing John

□ 1 October 1999

❖ Research Grants Council (Earmarked Grants)

Many modern computer applications can benefit from sharing of resources such as network bandwidth, disk bandwidth, system buffers, ... etc. One advantage of resource sharing is to effectively utilize the system and thereby making the system more cost-effective. In addition, modern information systems (e.g., such as digital libraries) would like to store data that can be of use to many different classes of applications. Part of the difficulty in efficient resource management of such systems can then occur when these applications have vastly different performance and quality-of-service (QoS) requirements as well as resource demand characteristics. In this research, the researchers propose to design, analyze and implement some efficient "mixed workload scheduling algorithms" for a multimedia storage system (with a target application being the computer digital library) which has to serve multiple types of workloads. This research will help the computer system designers to understand the issues and tradeoffs associated with mixing multiple workloads on the same server and explore the possibility of maintaining reasonable performance and QoS requirements without having to partition the resources. (CU99430)

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**Architecture-based Software Reliability Engineering Techniques**

✉ LYU Rung Tsong Michael • LAPRIE Jean Claude\*

□ 1 October 1999

❖ Research Grants Council (Earmarked Grants)

The subject of reliability engineering for software systems has been mostly approached by "black-box" schemes without looking into the structure of the systems. In this project, the researchers propose to investigate architecture-based methods for a series of generic software reliability problems, including reliability allocation, testing, integration, and analysis. They 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 software module dependencies. They 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. They plan to design and implement a systematic environment to encapsulate the techniques they 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 particularly critical to the software acquisition and integration effort of most 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 turmoil of the opening of the new Hong Kong International Airport, mostly due to poor software integration, testing and reliability assessment efforts, is an agonizing lesson to both the government and industry. It shows that the issue of software reliability is too critical to be overlooked. (CU99432)

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**Architecture-based Techniques and Tools for Software Reliability Engineering**

✉ LYU Rung Tsong Michael • KANOUN Karama\*

□ 31 January 2000

❖ France/Hong Kong Joint Research Scheme

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. The researchers propose to investigate architecture-based, white-box methods for a series of generic software reliability problems in this project. They 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. They 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. They 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 industries 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. The recent turmoil in the opening of the new Hong Kong International Airport was done to software system errors and reinforced the urgency of this software reliability engineering work.  
(EE99030)

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#### The Effect of Diversity in Large-scale Distributed Systems

- ✉ LYU Rung Tsong Michael • LORENZO Strigini\* • BEV Littlewood\*
- 1 March 2000
- ❖ UK/Hong Kong Joint Research Scheme, the British Council

Diversity is the key factor for a system to expand effectively and dependably. Lack of planned diversity, such as that experienced in most large-scale distributed systems (e.g., Internet), may cause serious concerns about dependability including reliability, availability and security. The researchers propose to investigate diversity issues in large-scale distributed systems and define the concepts and ingredients of diversity in such systems. This exploratory study will define a research agenda to formalise procedures for achieving diversity, to quantitatively evaluate, via modelling and experiments, the effects of diversity and its impacts on large-scale systems, and to make use of diversity in distributed systems for achieving reliability, safety, and security. This investigation will rely on research techniques to which the investigators have made essential contributions, including software fault tolerance, software reliability engineering, testing and evaluation.  
(EE99033)

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#### High-level Synthesis Framework and Tools for Dynamically Reconfigurable Systems

- ✉ NG Kam Wing • LUK Wayne\*
- 31 December 1999
- ❖ Research Grants Council (Earmarked Grants)

Reconfigurable computing involves computations implemented in advanced field-programmable gate arrays (FPGAs) technology, which combines the flexibility of general-purpose computers with a speed approaching that of application-specific integrated circuits. There are three common problems that we face in implementing reconfigurable systems on currently available FPGAs chips. First, the available hardware resources on FPGA chips are rarely large enough to synthesize entire interesting systems all at once. Second, a full configuration bitmap must be loaded into the FPGA to effect even the smallest change in its function. This makes reconfiguration slower than is necessary, adversely impacting the overall performance of the system. Third, reconfigurable systems development are still largely an art involving tedious and error prone crafting of low-level design. One solution to address these problems is to use dynamically reconfigurable FPGAs (DR FPGAs). DR FPGAs offer important benefits for the implementation of high performance reconfigurable systems, while minimizing the hardware resource required. However, new applications and research of DR FPGAs are hindered by an almost complete absence of appropriate high-level tools. This project is to provide a high-level synthesis framework for developing and optimizing dynamically reconfigurable designs with much less effort and specialized knowledge than is required now. The research results of this project will be integrated in a Configuration Partitioning and Synthesis Environment (COPSE) for dynamically reconfigurable systems. The COPSE tool-set takes the result of a VHDL behavioral compiler, generates multiple structural reconfigurations and a reconfiguration controller.  
(CU99408)

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#### New Stochastic Approaches for Job Shop Scheduling

- ✉ WONG Chak Kuen
- 1 October 1999
- ❖ Research Grants Council (Earmarked Grants)

Project Summary Scheduling is concerned with the allocation of limited resources to tasks so as to optimize certain cost functions. The researchers plan to study a specific class of scheduling problems called job shop scheduling problems. In this case, the goal is to find a schedule that minimizes the overall time, which is called the makespan. In this project, they intend to develop new approaches to solve job shop scheduling problems by simulated annealing-based algorithms. The problem



will be described in a disjunctive graph model and we plan to develop simulated annealing heuristics whose cooling schedules can be controlled precisely by an appropriate setting of the parameters. The cooling schedules will be considered together with a new, non-uniform neighborhood relation where the transition probabilities depend on the number of longest paths in the underlying disjunctive graph. In general, it is hard to prove the convergence rate for fast annealing-based heuristics where a large but fixed number of steps are executed at each given "temperature". On the other hand, for the slower logarithmic cooling schedules, where the "temperature" is lowered according to a certain logarithmic function, some convergence results have been obtained. The researchers will use these logarithmic cooling schedules together with a neighborhood relation that ensures that any transition move leads to a feasible schedule. This neighborhood relation is non-reversible and therefore previous, general convergence results on logarithmic cooling schedules cannot be directly applied to our problem. The aim is therefore to derive a convergence rate that depends on characteristic features of the configuration space and on the probability of the makespan to be in a certain distance to the optimum values.

All these ideas will be incorporated in their algorithm design and the resulting algorithms will be implemented and tested on a number of difficult, unsolved benchmark problems.  
(CU99367)

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### Parallel and Distributed Computing for Job Shop Scheduling

- ✉ WONG Chak Kuen • Andreas Alexander ALBRECHT • U. Geske\*
- ☐ 16 April 2000
- ❖ Germany/Hong Kong Joint Research Scheme

This project focuses on the 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.  
(EE99037)

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### Applying Computer Vision Techniques in the Construction of a Virtual Walk-through System

- ✉ WONG Kin Hong • OR Siu Hang
- ☐ 1 September 1999
- ❖ Research Grants Council (Earmarked Grants)

The researchers plan to investigate how to apply computer vision techniques in the construction of a virtual walkthrough system. Such a system would be very useful in many areas such as education and entertainment. For example, we want to build a virtual museum for the history of Hong Kong and put it on the Internet for international access. It is more efficient, if we can utilize the pictures taken from the real museum and use it for the virtual counterpart. To achieve this goal two main research problems are identified, namely (a) structure recovery from an image sequence, and (b) image based rendering of objects which are highly irregular in shape.

(1) For the first problem we need to build an environment which is similar to the real museum. Since it is now easy to obtain high quality digital video streams and pictures of an environment by hand held cameras, it is hoped that we can use them for the reconstruction of the 3D structure of a scene. With this 3D information we can easily build a virtual walk-through system for our applications by mapping the images onto the appropriate positions in the virtual environment. Then a user can use a mouse to navigate oneself inside the virtual scenes. The main technical problem is to recover structure from motion which is an active area of research in computer vision.

(2) Another important issue is the rendering of irregular objects inside the museum. That means after the user navigates to an area of interest and would like to examine an object (for example a sculpture) in detail, he can use this system to examine an object in any viewing angle he chooses. Image based rendering techniques provide a way to interactively examine an object on a computer display, and will be used in our project.

A number of solutions for the above problems are included in this project. And the researchers will show how to build a virtual walk-through system from images taken from the real environment.  
(CU99389)

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### Indexing Methods for Numeric Sequence Databases

- ✉ WONG Man Hon
- ☐ 1 October 1999
- ❖ Research Grants Council (Earmarked Grants)

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 for similar patterns among sequence data is very important in many applications. For example, a scientist may want to find out a certain pattern in the change of temperature at the North pole in order to study its impact on global weather. Similarly, a financier may want to find certain patterns in the change of GDP and interest rate in order to predict the future economy. The objective of this research is

to derive new indexing methods to store sequence data so that the performance of finding a similar subsequence in a sequence database can be improved. The result will benefit the design of the next generation database systems to support scientific and business applications.  
(CU99437)

**Interactive Illumination Control for Image-based Computer Graphics**

- ✉ WONG Tien Tsin
- 17 August 1999
- ❖ CUHK Research Committee Funding (Direct Grants)

Traditional geometry-based computer graphics suffers from the inability of real-time rendering of arbitrarily complex scenery due to the scene-dependent nature of rendering algorithms. Image-based rendering received much attention in recent graphics research. The independence of its rendering time on the scene complexity is its major attractiveness. In other words, any arbitrarily complex scene can be rendered in a finite and fixed amount of time. Unfortunately, due to the lack of geometrical information, illumination control (the ability to change the lighting of the scene) is difficult. The researchers have proposed a general framework for controlling the illumination of image-based scene. User can introduce virtual directional and point light sources into the image-based scene. However the system is interactive only if the number of light sources is less than or equal to five because of the high computational cost. The plan of this research is to design an algorithm that accelerates the computation of pixel values. The algorithm will also be generalized to support the linear and area light sources which are more realistic light sources in real world. They also plan to design algorithm that supports environment mapping. The reason they want to support environment mapping is that it is an important step to achieve global illumination in image-based computer graphics. Global illumination in traditional geometry-based computer graphics has been proved that can synthesize the most realistic images. However performing global illumination in image-based computer graphics is extremely difficult due to the lack of geometrical information. Another direction to accelerate the algorithm is to implement part of the algorithm using a programmable hardware technology, Field Programmable Gate Arrays (FPGA).  
(EE99009)

**A Performance-driven Synthesis System Targeted for Deep Sub-micron Technology**

- ✉ WU Yu Liang • WONG Chak Kuen • MAREK-SADOWSKA Malgorzata\* • HONG Xian Long\*
- 31 December 1999
- ❖ Research Grants Council (Earmarked Grants)

Developing an effective design automation framework being able to narrow down the delay timing estimation gap between the logic synthesis and physical design layers is the major task of this project. The researchers will build such a new synthesis system targeting for deep sub-micron technologies atop a prototype place-and-route system. The candidate P&R platform system would be the one developed in TsingHua University, Beijing. Various post-layout optimization techniques such as gate sizing, buffer insertion, alternative-wiring restructuring will be implemented to serve as their basis system. Then a newly proposed graph-based synthesis technique will be implemented and experimented for comparisons. They will also try to develop some more efficient pre-layout synthesis scheme, based on more accurate statistical timing models built through the data gathered in experiments. They will then judge our model through extensive experiments on known benchmarks.  
(CU99412)

**High Dimensional Data Mining and Visualization: An Integrated Approach and Financial Data Mining Application**

- ✉ XU Lei
- 1 December 1999
- ❖ Research Grants Council (Earmarked Grants)

*Data Mining and Knowledge Discovery in Databases (KDD)* is rapidly emerging in past few years, targeting at identifying valid, novel, potentially useful, and ultimately understandable structure in data in order to support navigation, exploration, summarization or modeling of large databases. This new field consists of six major issues: *data/warehouse-- data selection/sampling--> cleaning/preprocessing--> transformation/reduction--> data mining--> visualization/interpretation/evaluation.* However, since the whole field is just in its infancy age, there is a lack of systematic studies on many problems almost in each of these issues. This proposal targets at conducting a systematic study on three core issues for "automated knowledge discovery", namely *dimension reduction--> data mining --> visualization/interpretation.* First, systematic investigation will be made on those existing methods and algorithms developed in the related literatures, with focuses on examining their possible direct or modified use in this new field. Second, a general framework or theory is expected to be built for

providing a systematic guidance on an integrated design and effective implementation of three issues as a whole, such that the performance of the entire KDD process can be improved. Then, effective implementing algorithms are developed and tested with preliminary applications on financial data mining for helping decision-making in capital markets.  
(CU99383)

**A Unified Method to Handle all Placement Constraints in Floorplan Design**

- ✉ YOUNG Fung Yu • CHU Chris C. N.\*
- ☐ 1 October 1999
- ❖ CUHK Research Committee Funding (Direct Grants)

Floorplanning is an important step in physical design of VLSI circuits to put the logic down onto a rectangular chip to minimize the total chip area and interconnect cost. Floorplanning used to be done manually by the designers but circuits nowadays are so complicated that "hand packing" can no longer afford the extra resources nor the delay in time to the market. The 1997 NTRS Roadmap predicts that 20M usable transistors will be available for autolayout by the year 2002. Automated floorplanning is of utmost need. Unfortunately, existing floorplanning algorithms and tools cannot yet handle the complex and stringent design requirements even in today's IC technology. Placement constraint is a common type of design requirement in floorplanning. A module may be constrained to be placed at certain absolute positions or at certain positions relative to some other modules in the final packing. For example, it is advantageous to abut or to align two modules if they have a lot of connections between them. Placement constraint in floorplan design can also be used to model keep-out regions, interface constraints and rectilinear block packing. It is an important kind of design requirement in floorplanning but for which no efficient method yet is available. The objective of this project is to study and develop a unified method to handle all kinds of placement constraints in floorplan design. The proposed method will be a pioneer for this problem. As part of the outcome, the researchers will develop a general technique to handle placement constraints which is applicable to other floorplanning system. The major outcome will be a slicing floorplanner that can handle all kinds of placement constraints efficiently.  
(EE99008)

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

Edition    Title/Investigators

1996-97	A Theoretical Study on Two New Types of Reliable Networks (CU96537) ✉ CAI Leizhen
1998-99	Winning Strategies for Colouring Games (EE98009) ✉ 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
1997-98	An Intelligent Virtual Environment for Bronchoscopy Simulation (CU97555) ✉ HENG Pheng Ann • LEUNG Kwong Sak • TSUI Hung Tat (Dept of Electronic Engineering) • YIM Ping Chuen Anthony (Dept of Surgery) • ABDULLAH Victor (Dept of Surgery)
1997-98	Image Based Rendering with Controllable Illumination (CS97005) ✉ HENG Pheng Ann • WU En Hua*
1998-99	An Intelligent System for Medical Data Mining and Visualization (CU98306) ✉ HENG Pheng Ann • FU Wai Chee Ada • LEUNG Kwong Sak • CHENG Chun Yiu Jack (Dept of Orthopaedics & Traumatology)
1998-99	Virtual Reality, Visualization and Imaging Research Centre (EE98037) ✉ HENG Pheng Ann • LEUNG Kwong Sak • SUN Hanqiu • TSUI Hung Tat (Dept of Electronic Engineering) • WONG Chak Kuen • XU Yangsheng (Dept of Auto. & Computer-Aided Engin.) • ZHANG Yuanting (Dept of Electronic Engineering) • HJELM Nils Magnus (Dept of Chemical Pathology)# • CHAM Wai Kuen (Dept of Electronic Engineering) • FU Wai Chee Ada • HUI Kin Chuen (Dept of Auto. & Computer-Aided Engin.) • KING Kuo Chin Irwin • LEE Tong (Dept of Electronic Engineering) • LI Wen Jung (Dept of Auto. & Computer-Aided Engin.) • LIAO Wei Hsin (Dept of Auto. & Computer-Aided Engin.) • WONG

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| <p>Kin Hong • XU Jianbin (Dept of Electronic Engineering)</p> <p>1998-99 Image Data Mining and Visualization for Cardiac MR (EE98042)<br/>         ✎ HENG Pheng Ann • YANG Guang Zhong* • FU Wai Chee Ada • TSUI Hung Tat (Dept of Electronic Engineering) • ZHANG Yuanting (Dept of Electronic Engineering)</p> <p>1998-99 A Pilot Scheme on “Q-Mark” Software for Hong Kong Quality Education (EE98051)<br/>         ✎ KAN Wing Kay</p> <p>1997-98 Content-Based Image Retrieval of Classical Chinese Paintings and Calligraphy (CU97569)<br/>         ✎ KING Kuo Chin Irwin • FU Wai Chee Ada • CHAN Lai Wan</p> <p>1998-99 Electronic Commerce Front End for Hong Kong Apparel Industry Community (EE98045)<br/>         ✎ KING Kuo Chin Irwin • FU Wai Chee Ada • CHAN Lai Wan • XU Lei</p> <p>1998-99 Using Stochastic Methods to Guide Search in Constraint Programming (CU98302)<br/>         ✎ LEE Ho Man Jimmy • LEUNG Ho Fung • STUCKEY P. J.*</p> <p>1997-98 CUVIR: Comprehensive and Uniform Access to Visual Information Repositories (CU97557)<br/>         ✎ LEE Moon Chuen</p> <p>1998-99 Adaptive Transform Domain Video Indexing (EE98010)<br/>         ✎ LEE Moon Chuen • ADJEROH Donald#</p> <p>1998-99 Architectures and Implementations of Constraint Systems on FPGA Hardware (EE98011)<br/>         ✎ LEONG Philip Heng Wai</p> <p>1998-99 Soft Constraint-Based Scheduling in Intelligent Multiagent Systems (CU98304)<br/>         ✎ LEUNG Ho Fung • LEE Ho Man Jimmy • CLARK K. L.*</p> <p>1996-97 Optimal Mappings Between Problem Models and Parallel Genetic Algorithms (CU96535)</p> | <p>✎ LEUNG Kwong Sak • WONG Chak Kuen • LEUNG Yee (Dept of Geography)</p> <p>1997-98 An Automatic Learning System Based on a Novel Generic Evolutionary Programming Framework (CU97554)<br/>         ✎ LEUNG Kwong Sak • WONG Man Leung*</p> <p>1998-99 Using Evolutionary Computation on Large Scale Information Fusion (ED98004)<br/>         ✎ LEUNG Kwong Sak</p> <p>1996-97 Operating System and Network Support for Distributed Multimedia Services (CS96016)<br/>         ✎ LUI Chi Shing John</p> <p>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)<br/>         ✎ LUI Chi Shing John</p> <p>1998-99 Design and Implementation of a Multi-users Virtual Exploration System (EE98013)<br/>         ✎ LUI Chi Shing John</p> <p>1997-98 A Phase-Based Approach for Software Reliability Engineering (CS97015)<br/>         ✎ LYU Rung Tsong Michael</p> <p>1998-99 Structure-Based Software Reliability Modeling Techniques (EE98003)<br/>         ✎ LYU Rung Tsong Michael</p> <p>1998-99 Architecture-Based Techniques and Tools for Software Reliability Engineering (EE98039)<br/>         ✎ LYU Rung Tsong Michael • KANOUN Karama*</p> <p>1998-99 High-level Synthesis for Dynamically Reconfigurable FPGAs (EE98014)<br/>         ✎ NG Kam Wing</p> <p>1998-99 Design Framework and Tools for Reconfigurable Computing (EE98043)<br/>         ✎ NG Kam Wing • LUK Wayne*</p> <p>1998-99 Pose-based Virtual Hand Input in VR Applications (EE98015)<br/>         ✎ SUN Hanqiu</p> <p>1994-95 Research on a New Class of Optimization Problems Related to the Handling of</p> |
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	Elastic 3-D Objects by Robots and Its Application in Industry (CS95008) ✎ WONG Chak Kuen • LEUNG Kwong Sak • HUI Kin Chuen (Dept of Auto. & Computer-Aided Engin.) • LEUNG Yee (Dept of Geography) • ALBRECHT Andreas*	1997-98	A New FPGA Architecture and Design Automation Methodology for High Chip Performance and Fast Circuit Mapping (CU97556) ✎ WU Yu Liang • WONG Chak Kuen • MAREK-SADOWSKA Malgorzata*
1998-99	On Algorithmic Fundamentals of Computer-Assisted Medical Diagnosis (CU98010) ✎ WONG Chak Kuen	1998-99	Tree-Structure Based Synthesis for Pseudo-Exhaustive VLSI Testing (EE98017) ✎ WU Yu Liang
1998-99	Parallel and Distributed Computing for Job Shop Scheduling (EE98049) ✎ WONG Chak Kuen • Andreas Alexander ALBRECHT	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) ✎ XU Lei
1997-98	Recovery for Transaction Failures in Object-Based Databases (CU97559) ✎ WONG Man Hon • FU Wai Chee Ada	1998-99	Adaptive Learning for Temporal Radial Basis Function Network and Financial Investment Analysis Environment on Microsoft Window (CU98297) ✎ XU Lei
1998-99	Indexing Methods for Sequence Data Searching (EE98016) ✎ WONG Man Hon • FU Wai Chee Ada		

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see also <P001108>, <P001954>, <P985067>

## RESEARCH PROJECTS

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### A Smart Wireless Telemetry System for Remote Metering Application

- ✉ CHAN Kam Tai
- ☐ 1 October 1999
- ❖ Industrial Support Fund, Industry & Technology Development Council

This proposal aims at developing a radio frequency telemetry system and smart transceiver devices for remote metering applications sought by utilities companies. In particular, the wireless data collection and control system to be delivered will be custom-made to suit the local high-rise building environment. This system collects and processes all meter data from an entire high-rise building and then forwards them to the database servers of the respective utilities companies through public telephone lines automatically. The smart transceiver devices to be delivered will transmit meter readings from utility meters to the control system in the radio frequency ISM band of 2.4GHz, hence there is no need of applying for any license. A unique proprietary communication protocol will be developed to enable data to be transmitted at 2.4GHz correctly from any floor of any high-rise building in Hong Kong to the basement of the building where they will be sent out through a telephone line to the utility company. The researchers' solution is overwhelmingly cost-effective and custom-made for the local environment. It will benefit all local utilities companies, as they no longer need to depend on importing expensive systems and then retrofitting them for the local environment. Local electronics industries will benefit as well because they will be responsible for manufacturing the smart transceiver devices. Hence, the deliverables of this project will ensure a win-win situation for both local utilities companies and electronics industries. (EE99002)

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### Stability Improvement Studies of Harmonic Active Mode-locking of Fiber Ring Lasers

- ✉ CHAN Kam Tai • HO HO-pui, Aaron\*
- ☐ 1 November 1999
- ❖ Research Grants Council (Earmarked Grants)

Actively mode-locked fiber ring lasers (AMFLs) are attractive laser sources for producing high repetition rate ultrashort pulses in the 1.53-1.57 $\mu$ m low loss window of silica fibers. However, since the cavity lengths of these lasers are commonly tens of meters or longer, the laser output is inherently unstable because of fluctuations in the signal polarization state and cavity length caused by mechanical vibration and temperature variation. Furthermore, in order to

achieve high repetition rates, harmonic mode locking is necessary which will create additional noise due to supermode competition. These problems will adversely affect the applications of these lasers and will therefore be addressed in this proposal. Firstly, the source of the amplitude and phase noises in harmonic AMFL will be studied and the methods for reducing them will be thoroughly investigated. Secondly, a novel passive method for stabilizing the cavity length of an AMFL will be presented. Thirdly, by combining this method with other conventional stabilizing techniques, a laser scheme that is designed to suppress the instability arising from most of the noise sources will be investigated experimentally. The relationship between laser stability and operating conditions will be determined in order that very stable ultrafast AMFLs can be demonstrated. (CU99434)

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### Design of Low Intermodulation Distortion Microwave Active Bandpass Filters

- ✉ CHENG Kwok Keung Michael
- ☐ 1 January 2000
- ❖ CUHK Research Committee Funding (Direct Grants)

Narrowband filters are widely used in many microwave systems. Traditionally, these filters have been realized using hybrid circuits, SAW and ceramic technologies. Recently, progress in Monolithic Microwave Integrated Circuit (MMIC) technology has led to further size reduction and higher functional integration. However, at microwave frequencies the Q-factor of practical on-chip inductors is typically low due to the inherent resistive losses. As a result, passive narrowband MMIC filters exhibit high insertion loss and poor selectivity. In recent years, several Q-enhancement techniques have been proposed to compensate for the dissipate losses in passive filter components. These techniques enable the design of filters with zero passband insertion loss and excellent selectivity. However, at large input signals level, the nonlinear active device produces undesirable intermodulation and cross modulation distortion. In this project, the researchers aim to investigate the nonlinear behavior of microwave active filters and to devise novel circuit techniques for the design of low intermodulation distortion active filters. (EE99013)

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### Chinese Speech Recognition Infrastructure for Hong Kong's Technology

- ✉ CHING Pak Chung • MENG Mei Ling Helen (Dept of Systems Engineering & Engin. Management) • LEE Tan
- ☐ 1 October 1999

- ❖ Industrial Support Fund, Industry & Technology Development Council

The researchers propose to develop the Chinese speech recognition infrastructure for Hong Kong's technology developers. The CUHK Cantonese speech database (CU Corpora), developed for microphone speech with ISF support since 1997, has provided the foundation for speech companies to port their technologies into Cantonese. However, there are many local non-speech companies who are nevertheless eager to embed speech technologies into their products and services. These companies need to prototype speech recognisers for their specific applications, and to test the viability of their new product ideas. To facilitate this process in a cost-effective manner, the researchers propose to develop these infrastructure elements: (1) recognition software building blocks, which utilize our speech corpora to enable easy prototyping of speech recognizers for concept demonstrations; and (2) CU Call, a Cantonese and Putonghua telephone speech database, to support the development of speech applications on both fixed-line and mobile telephone networks.

They believe that their deliverables will facilitate the growth of existing markets for Chinese speech technologies and the creation of new markets for speech products, and thereby bring greater opportunities to both speech and non-speech companies in the local industry.  
(EE99005)

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**To Develop a New Asynchronous Architecture Based on a High-speed Micro-coded Processor Core for Realizing DSP Algorithms**

- ✉ CHOY Chiu Sing Oliver
- ☐ 1 January 2000
- ❖ CUHK Research Committee Funding (Direct Grants)

With continuous advances in multimedia technology, the application of Digital Signal Processing (DSP) has grown in depth and breadth. This creates an ever-demanding need of fast and more complex DSP Integrated Circuits (ICs). The objective of this project is to develop a new methodology for designing high performance DSP ICs in the asynchronous mode of operation. This is based on an innovative architecture composed of asynchronous processor cores. Scalability, application specific and ease-of-design is the salient features of the architecture. The core itself will be designed from a new asynchronous technique based on dynamic logic. This technique will offer hundreds of MHz in data processing speed and will minimize the delay overhead in handshake circuits.

This project can be seen as a natural continuation of a past RGC funded project, where a specific

asynchronous image processor was designed. From the findings of this past project, we are able to formulate the new architecture and to develop an enhanced circuit technique. We aim to deliver a re-designed image processor with at least one magnitude better performance in the same IC processing technology.

(EE99014)

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**Investigation of Oxygen and Hydrogen Diffusion in Ferroelectric Thin Film Memory Devices by Using Ion Beam Analysis**

- ✉ Ian Howard WILSON • XU Jianbin
- ☐ 1 July 1999
- ❖ Research Grants Council (Earmarked Grants)

Ferroelectric thin film (FTF) memory devices have the potential to dominate the world memory markets of an annual US\$30 billion. Potential nonvolatile FTF applications include smart cards, RF tags, embedded memories etc. In device fabrication, a number of high temperature processes are required. During these high temperature processes, Oxygen (O) diffusion between FTF/electrodes takes place. This inter-diffusion produces significant degradation of FTF devices. Very recently, it has been shown that Hydrogen (H) diffusion during device fabrication and packaging will also influence the performance and reliability of devices. The main aim of this project is to investigate diffusion of O and H in FTF memory devices in detail by using Ion Beam Analysis (IBA) techniques. The advantages of IBA over other techniques are their non-destructive, quantitative, high depth resolution and isotope sensitive nature. By separately introducing  $^{18}\text{O}$  and  $^2\text{H}$ , isotopes of O and H, into FTF devices in various fabrication processes, the distribution and redistribution of  $^{18}\text{O}$  and  $^2\text{H}$  upon each fabrication step and post annealing can be monitored by Nuclear Reaction Analysis (NRA). Therefore, the O and H diffusion in each step can be studied separately and the confusion of other steps can be avoided. We anticipate that this project will enable us to fully understand the nature of O and H diffusion in FTF devices at each fabrication step. It will provide very important technical information to tolerant industries of device fabrication and packaging.

(CU99373)

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**Smart Antenna Technologies for Wireless Communication Systems**

- ✉ Ian Howard WILSON • CHENG Kwok Keung Michael • WONG Kainam Thomas • WONG Kon Max\*
- ☐ 1 August 1999
- ❖ Industrial Support Fund, Industry & Technology Development Council • Private Donation



The objective of this project is to develop and transfer generic smart antenna technologies for wireless communication systems to Hong Kong industry. Five engineers will be employed, two on hardware, two on software and one on system integration. System design guidelines, reference designs and end product examples will be delivered to the industry in three stages. Stage by stage deliverables include generic smart antenna system design guidelines (4 months), two generic reference smart antenna circuits and software (end of first year), and four end-product examples (throughout second year) including: digital cordless phone, wireless private branch exchange, fast acquisition and tracking satellite receiver and cellular phone network pre-test and debugging system. These four end products represent low-end, mid-end and high-end wireless communication products that can be manufactured by Hong Kong industry. Target users include home occupants, business companies with open-plan offices, recreational vehicles/leisure boat owners, and cellular network service providers. Market volume of all four-product categories together is around 12 million copies per year, with revenue up to 800 million USD. Smart antenna technology enhances the coverage range, interference rejection ability, and sensitivity and user capacity of wireless systems. It will improve the competitive edge of Hong Kong wireless communication industry in general. Immediate beneficiaries will be design houses and manufacturers of wireless communication systems in Hong Kong.  
(EE99010)

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#### **Automatic Speech-to-Speech Conversion Between Cantonese and Putonghua**

- ✉ LEE Tan
- ☐ 1 December 1999
- ❖ CUHK Research Committee Funding (Direct Grants)

Cantonese is the most commonly spoken language in Hong Kong while Putonghua (or Mandarin) is regarded as the official spoken Chinese. However, they are by no means mutually intelligible, without special language training. Indeed, a great population in Hong Kong can understand very little Putonghua, let alone speak it. In this project, the researchers are going to develop advanced spoken language techniques for automatic bi-directional conversion between spoken Cantonese and Putonghua. That is, the voice of a Cantonese speaker is translated, in a fully automatic way, to highly intelligible and natural Putonghua speech with exactly the same content, and vice versa. Such a system will remove the language barrier between Cantonese and Putonghua speakers and thus facilitate much easier and more efficient communication and interaction between Hong Kong, Mainland China and Taiwan.

The basic technological components include continuous speech recognition and text-to-speech synthesis for both Cantonese and Putonghua. The input speech is first converted into meaningful text by a speech recognizer for the corresponding language. This intermediate text needs to be analyzed and "translated" into the target output language. As a matter of fact, Cantonese and Putonghua are significantly different not only in phonetics and tones, but also in vocabulary and grammatical structure. A Cantonese sentence may become completely incomprehensible if it is converted into Putonghua on a character or syllable basis. A sophisticated linguistic analysis is required instead, and text translation must be performed for the whole sentence. Finally, the translated text will be converted into natural speech by text-to-speech synthesis techniques.  
(EE99015)

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#### **Novel Wavelength-tunable Devices for Broadband Optical Communications**

- ✉ SHU Ching Tat C. • MARSH H. John\*
- ☐ 1 May 2000
- ❖ UK/Hong Kong Joint Research Scheme, the British Council

Wavelength-tunable devices are key components in exploiting the potential of the enormous bandwidth of semiconductor optics for communications. Among the devices are tunable wavelength converters and high-bit-rate semiconductor lasers. The former devices are used in communication networks for wavelength reallocation to avoid channel contention. The tunable design offers the flexibility to select the output wavelength using a relatively direct and simple means. Wavelength tuning in high-bit-rate semiconductor lasers presents another challenge to enhance the effective bandwidth of an optical transmitter. The ability to configure the optical source to operate at any desired wavelength greatly simplifies the structure as compared to a conventional transmitter with multiple single-wavelength elements. Wavelength control is realized using a selective external cavity or injection locking, thus allowing a higher tolerance in the fabrication of the devices for a specific wavelength operation.  
(EE99034)

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#### **Ultrafast Optical Characterization of New Semiconductor Materials for Optoelectronics**

- ✉ TSANG Hon Ki
- ☐ 1 November 1999
- ❖ CUHK Research Committee Funding (Direct Grants)

The project involves ultrafast optical studies of novel optoelectronic materials. The investigation includes

pump - probe measurements of carrier lifetime and spectral measurements to determine the nonlinear optical Kerr coefficient by observing the self phase modulation of femtosecond pulses. Laser systems to be used for the measurements include a femtosecond Ti:sapphire laser and femtosecond mode locked erbium doped optical fiber lasers. Materials to be studied include beta-iron disilicides prepared by ion beam synthesis. Dependant upon the material properties, the project may also include attempts to fabricate optoelectronic devices (e.g. ultrafast all-optical switches or photodetectors) using the new materials.  
(EE99016)

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### 3-D Model-based Video Coding for Videoconferencing Applications

- ✉ TSUI Hung Tat • CHAM Wai Kuen • NGAN King Ngi\*
- 1 November 1999
- ❖ Research Grants Council (Earmarked Grants)

Multimedia communications will play a central role in future telecommunication systems. In multi-media communications, video is probably the most important as it enhances the quality of communications but it is also the most difficult to transmit as it requires enormous amount of bandwidth. Traditional approaches of video compression, i.e., predictive-transform coding techniques employed in the current video coding standards e.g., H.261 for videoconferencing and H.263 for video-telephony all have lower bit rate bounds below which annoying "blocking" artifacts begin to degrade the picture quality. New methods have to be found which will deliver higher compression, hence lower bit rate but maintain an acceptable quality. In this project, we propose a novel approach called 3-D model-based coding for use in videoconferencing and video-telephony applications. This approach assumes a 3-D wireframe model of the human head to be coded. Only the parameters which describe the changes in the model between successive frames are transmitted, thereby achieving a very low data rate. Key issues to be investigated include automatic detection and tracking of human head using facial colour information, motion analysis and estimation of model parameters using object-oriented approach, and coding of texture using content-based video compression techniques. The 3-D model-based coding technique has the potential of compressing the raw video data which needs hundreds of Mbits/s to transmit down to a few tens of Kbits/s with acceptable picture quality for the intended applications.  
(CU99402)

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### Electrical Transport Properties of Ion Beam Synthesized Low Dimensional Metal Silicide Structures

- ✉ WONG Sai Peng Joseph
- 1 November 1999
- ❖ Research Grants Council (Earmarked Grants)

In this project, the researchers will apply the ion beam synthesis technique to produce various low dimensional metal silicide structures, including very thin continuous layers, thin and narrow wires, and discontinuous quantum dot structures imbedded in silicon substrates. They will study how the electrical transport properties are dependant on the dimensional parameters of these structures, and will try to understand the electrical transport properties in correlation to the microstructures and formation kinetics of these structures.  
(CU99405)

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### Ion Beam Synthesis of Silicon Carbide

- ✉ WONG Sai Peng Joseph • Dr. Lindner J. K. N.\*
- 1 June 2000
- ❖ Germany/Hong Kong Joint Research Scheme

Thin SiC layers will be synthesised on and in Si substrates by high dose carbon implantation, either using a conventional implanter or a metal vapor vacuum arc ion source. The properties and structures of these SiC layers will be studied and compared.  
(EE99035)

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### Simulation and Design Methodology of Advanced Multi-chip Module (MCM) System for Wireless Communication Applications

- ✉ WU Ke Li
- 1 December 1999
- ❖ CUHK Research Committee Funding (Direct Grants)

This research project aims at developing design and prototyping capabilities for advanced MultiChip Module technology for wireless communication. In the competitive wireless market, the wireless products with greater functionality, higher operating frequencies increased cost effectiveness and decreased size are in high demand. A new technology called multichip modules (MCMs) to accommodate these drives is to switch from 2D printed circuits to 3-D structures. The MCMs are multilayer integrated systems that sandwich dielectric and conducting layers and integrate naked ICs, MMICs, and passive components into one package. Three key issues concerning design and manufacturing aspects of the technology will be addressed:

- (1) Development of an efficient systematic approach to model extraction for RF circuits;
- (2) Modeling methodology of mixed-signal circuits and packaging structures; and
- (3) Development of an advanced optimization strategy for designing MCMs.

Developing MCM technology will not only benefit building up the industry of electronic wireless products in Hong Kong by providing a design and prototyping base, but also give impetus to the technology development in other related areas, such as new system architecture design, advanced packaging and material process. The overall research outcome will also be useful in other high profile areas such as packaging of computer ICs and packaging of high pin-count of application-specific integrated circuits (ASIC's). (EE99007)

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### Design Methodology of Advanced Multi-chip Modules Using LTCC Technology for Wireless Applications

- ✉ WU Ke Li • CHENG Kwok Keung Michael  
□ 1 June 2000  
❖ CUHK Mainline Research Scheme

LTCC technology is widely considered as the next generation of integration technology for wireless communication system containing MultiChip Modules (MCM). An LTCC system sandwiches dielectric and printed circuit layers (up to 50 layers), within which passive components, such as resistors, inductors, capacitors and filters, are embedded while naked active chip sets such as RF ICs and digital ICs are directly mounted on top. One of the most attractive features of LTCC is that it supports very low loss for RF applications. Besides a significant deduction in size, the manufacture cost will be reduced remarkably.

To promote the new technology in Hong Kong electronic industry, the researcher have initialized new collaborations with two outstanding outside industrial companies:

- (1) "LTCC Division of National Semiconductor Corp" (USA), one of the top companies in IC design and LTCC technology in the world;
- (2) "Nanjing Electronics Device Institute" (China), the top manufacturer of RF ICs in China.

The objectives of the research are three folded:

- (1) to familiarize with the existing design methodology and to promote the new technology to Hong Kong local industry;
- (2) to initialize new research projects for developing more advanced design methodology for high frequency LTCC modules; and
- (3) to lay a good foundation for future applications of RGC grants and industry supported grants through hardware prototyping of high performance and super compact hardware

systems for wireless applications, e.g. integrated RF modules for smart antennas and complete RF transceiver at 2.4 GHz for HomeRF applications. (EE99040)

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### Passivation and Oxidation of Group IV Semiconductors Studied by Scanning Probe Microscopy

- ✉ XU Jianbin • KWOK Wai Man Raymund (Dept of Chemistry) • Ian Howard WILSON • Devine R.A.B.\*

□ 1 December 1999

- ❖ Research Grants Council (Earmarked Grants)

In this project the researchers propose to study the surface or interface electrical properties of the whole range of alloy compositions from pure Si through  $\text{Si}_x\text{Ge}_y$  to pure Ge. They will examine the layers and their interfaces with dielectrics. In particular they will perform atomic scale characterization of surfaces after hydrogen passivation, nitridation or oxidation *in-situ*. The use of *in-situ* techniques when combined with SPMs means that the surface modification will be examined on the manometer scale. Specific aims include:

- (1) preparation of passivated layers, thin oxides or nitrided layers on  $\text{Si}_x\text{Ge}_y$ , Ge or Si by different methods;
- (2) development of an electron cyclotron resonance (ECR) system suitable for *in-situ* passivation, oxidation, and nitridation;
- (3) modification of temperature-variable UHVSTM system suitable for *in-situ* atomic scale characterization and nano-fabrication; and
- (4) characterization and optimization of the passivated, oxidized, or nitrided group IV surfaces, and their MIS junctions.

(CU99390)

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

<u>Edition</u>	<u>Title/Investigators</u>
1998-99	Optical Recognition of Cursive Hand-written Chinese Characters by Relational Graph Matching (EE98018) ✉ CHAM Wai Kuen
1997-98	Injection Locked Digital Controlled Oscillator (EE97002) ✉ CHAN Cheong Fat • CHOY Chiu Sing Oliver
1998-99	A High Speed CMOS Asynchronous Memory (EE98019) ✉ CHAN Cheong Fat • CHOY Chiu Sing Oliver

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|---|---|
| <p>1996-97 Numerical Modelling and Experimental Studies of the Fiber Ring Laser for the Generation of Ultrashort Optical Pulses for Soliton Communication (EE96006)<br/>✉ CHAN Kam Tai</p>    | <p>1998-99 To Investigate and Design New Asynchronous Basic Cells and Fast Handshaking Scheme for Next Generation of Asynchronous Designs (EE98021)<br/>✉ CHOY Chiu Sing Oliver • CHAN Cheong Fat</p> |
| <p>1997-98 Selective Multi-wavelength Fiber Ring Lasers for Wavelength Division Multiplexed and Photoic Switching Applications (CU97566)<br/>✉ CHAN Kam Tai • LI Shenping#</p>                | <p>1996-97 Strained-layers Growth for Semiconductor Laser Applications (CU96551)<br/>✉ HSU Chung Chi • XU Jianbin • HARK Sui Kong (Dept of Physics)</p>   |
| <p>1998-99 High Repetition Rate Fiber Laser Source with Ultrashort Pulse Duration for Very Large Capacity Optical Communication (CU98311)<br/>✉ CHAN Kam Tai • LI Shenping# • LOU Caiyun*</p> | <p>1998-99 A study of metalorganic chemical vapor deposition (MOCVD) using nitrogen as the carrier gas (CU98346)<br/>✉ HSU Chung Chi • XU Jianbin</p>   |
| <p>1998-99 Advanced MMIC Design Based Upon GaAs Technology (EE98020)<br/>✉ CHENG Kwok Keung Michael</p>   | <p>1997-98 Scanning Probe Microscopy of the Impact of Energetic Beams on the Surface of Electronic Materials (EE97005)<br/>✉ Ian Howard WILSON</p>  |
| <p>1997-98 Transition Metal Silicides Synthesis and Devices Application by High Beam Current Ion Implantation (EE97004)<br/>✉ CHEUNG Wing Yiu • WONG Sai Peng Joseph</p>                      | <p>1998-99 Probing the Interface of Diamond Like Carbon/Magnetic Layers by Conducting Atomic Force Microscopy (CU98175)<br/>✉ Ian Howard WILSON • XU Jianbin • YAN Xiao*</p>                          |
| <p>1996-97 Development of an Automatic Recognition System for Continuous Cantonese Speech (CU96509)<br/>✉ CHING Pak Chung</p>   | <p>1995-96 A Novel Scheme of Wavelength-Multiplexing Using Self-Injection Locked Lasers (EE95005)<br/>✉ SHU Ching Tat C. • TSANG Hon Ki • ZHAO Yang*</p>  |
| <p>1997-98 Development of a Large Vocabulary Speech Database for Cantonese (EE97001)<br/>✉ CHING Pak Chung</p>  | <p>1997-98 Spectral Dynamics in Gain-Switched Distributed-Feedback Laser Diode under the Influence of Weak External Feedback (CU97517)<br/>✉ SHU Ching Tat C. • TSANG Hon Ki</p>                      |
| <p>1997-98 Advanced Signal Processing Techniques for Communications (CU97502)<br/>✉ CHING Pak Chung • WONG Kon Max</p>  | <p>1995-96 Fabrication and Characterisation of Magnetic Thin Films on III-V Semiconductors (EE95006)<br/>✉ TSANG Hon Ki • SCHWARZACHER Walther*</p>   |
| <p>1998-99 Wavelet Packet Division Multiplexing (CU98105)<br/>✉ CHING Pak Chung • WONG Kon Max</p>  | <p>1997-98 New Methods for Characterizing and Generating Ultrashort Optical Pulses (CU97515)<br/>✉ TSANG Hon Ki • SHU Ching Tat C.</p>  |
| <p>1997-98 Automatic Synthesis of Fault-Tolerant Asynchronous Circuits (CU97565)<br/>✉ CHOY Chiu Sing Oliver • CHAN Cheong Fat</p>  | <p>1997-98 Inferring 3D Shape Using Physics Based Techniques (CU97509)<br/>✉ TSUI Hung Tat</p>  |
| <p>1997-98 Microcode Automation Targeted at Asynchronous DSP Processors Design (EE97019)<br/>✉ CHOY Chiu Sing Oliver • CHAN Cheong Fat</p>  |   |

- 1998-99 3D Shape Reconstruction from an Image Sequence Captured by a Hand-Held Camera (CU98310)  
✉ TSUI Hung Tat • ZHANG Zhongying#
- 1998-99 Pilot Symbol Sequence Design for TDMA Fading-channel Wireless Communications (EE98005)  
✉ WONG Kainam Thomas
- 1998-99 Novel Algorithms for Self-calibration of Diversely Polarized Antenna Arrays (EE98048)  
✉ WONG Kainam Thomas • NEHORAI, Ayre\*
- 1996-97 Formation and Properties of Granular Structures by MEVVA Implantation (CU96534)  
✉ WONG Sai Peng Joseph • Ian Howard WILSON • WONG Hong Kuen (Dept of Physics)
- 1997-98 Photoelasticity Study of Stress Distribution in Semiconductors (CU97548)  
✉ WONG Sai Peng Joseph
- 1998-99 Magnetic-filtered Pulsed Metal Vapor Vacuum Arc Deposition of Magnetic Thin Films and Magnetic Multilayers (CU98152)  
✉ WONG Sai Peng Joseph • TSANG Hon Ki
- 1995-96 Investigations of Inorganic Ferroelectric Films by Scanning Probe Microscopy (CU95504)
- ✉ XU Jianbin • WONG Hong Kuen (Dept of Physics) • Ian Howard WILSON
- 1996-97 Development of Scanning Near Field Optical Microscopy and its Applications in Electronic Engineering (CU96512)  
✉ XU Jianbin • WONG Sai Peng Joseph • Ian Howard WILSON
- 1997-98 Nano-Characterization and -Fabrication of Dielectrics and MIS Junctions on Silicon (CU97530)  
✉ XU Jianbin • WONG Sai Peng Joseph • CHEUNG Wing Yiu • Ian Howard WILSON • KWOK Wai Man Raymund (Dept of Chemistry)
- 1998-99 Investigation of Low-dimensional Silicon Based Materials by Scanning Probe Microscopy (CU98172)  
✉ XU Jianbin • CHEN Kun Ji\* • WONG Sai Peng Joseph • Ian Howard WILSON • HARK Sui Kong (Dept of Physics)
- 1998-99 Investigation of Carbon Nanotubes by Modified Atomic Force Microscopy (EE98024)  
✉ XU Jianbin • WONG Sai Peng Joseph • Ian Howard WILSON
- 1998-99 Measurement and Analysis of Knee Vibroarthrography for Non Invasive Diagnosis of Joint Cartilage Pathology (EE98033)  
✉ ZHANG Yuanting • CHAN Kai Ming (Dept of Orthopaedics & Traumatology) • QIN Ling (Dept of Orthopaedics & Traumatology)

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see also <P000255>, <P000256>, <P001967>, <P992881>, <P992882>

## RESEARCH PROJECTS

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### **Turbo-Decoding of Combined Trellis-Coded Quantization and Trellis-Coded Modulation**

- ✉ HO Keang Po Ricky
- 1 September 1999
- ❖ Research Grants Council (Earmarked Grants)

This project investigates the soft decoding of combined trellis-coded modulation (TCM) and trellis-coded quantization (TCQ) for jointed source-channel coding. The goal of this research is to find a method to approach the rate-distortion limit of a communication channel: the minimum distortion of the transmission of analog signal through a communication channel. Significant performance improvement is found by using turbo-codes for combined source-channel coding.

Maximum a posteriori algorithm can be used as a soft-decoding minimum mean-squared error decoder for combined TCQ/TCM. The optimal TCQ can be derived for the fixed decoder. The TCQ encoder and the soft-decoder can be optimized iteratively for minimum overall distortion from transmitter input to receiver output.  
(CU99370)

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### **Design and Analysis of Scheduling Algorithms in Input-Queued Switches Supporting IP-over-ATM**

- ✉ LEE Tong Tony
- 1 August 1999
- ❖ Research Grants Council (Earmarked Grants)

The Internet Protocol (IP) is gradually becoming the de facto standard for computer communications due to the rapid increase in popularity of the Internet. Over the past few years, we have witnessed the emergence of many novel Internet applications and services such as streaming voice and video broadcast, multi-point video-conferencing and Voice over IP, to name a few. All these applications put stringent requirements on the underlying network in terms of bandwidth and delay bounds. In fact, the capacity of the existing network structure has been pushed to the limit. To meet future demands, researchers and network designers are considering replacing the underlying network by Asynchronous Transfer Mode (ATM) networks, which is high-speed, reliable and able to provide Quality-of-Service guarantees. However, although ATM is designed to carry any kind of traffic, it is not particularly suitable or optimized for carrying IP packets. To support IP-over-ATM more efficiently, existing algorithms and methodologies used in the ATM network may need to be redesigned. In this project, we will focus on designing scheduling algorithms in input-queued ATM switches to support IP-over-ATM. Efficient

and effective scheduling algorithms will increase the throughput of the switch, minimize the overheads involved in carrying IP packets over ATM, and drive down the costs and implementation complexity.  
(CU99398)

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### **Scalable and Fault-Tolerant Video-on-Demand Systems – Design, Analysis, Prototyping, and Performance Evaluation**

- ✉ LEE Yiu Bun
- 1 September 1999
- ❖ Research Grants Council (Earmarked Grants)

Conventional Video-on-Demand systems store compressed video streams in a video server for delivery to networked clients. Consequently, the number of concurrent video sessions that can be supported is limited by the server's hardware. As the capacity of a single server is ultimately limited, the researchers propose designing video servers using server-level parallelism. Designing video servers using parallel-server architectures not only breaks through the capacity limit of a single server, but also opens the way for server-level fault tolerance.

In this research programme, the researchers first investigate fundamental issues in designing scalable parallel video servers and analyze the performance of various design alternatives. Then they address fundamental issues in designing storage, retrieval, and transmission algorithms to support fault tolerance in parallel video servers. The research programme is expected to contribute not only to the area of video systems, but also to the more general area of distributed multimedia systems where video presents the biggest challenges.  
(CU99095)

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### **A Bit-Rate Profile Archive for VBR-encoded MPEG2 Video Streams**

- ✉ LEE Yiu Bun • CHEN Lian Kuan • LIEW Soung Chang
- 1 January 2000
- ❖ CUHK Research Committee Funding (Direct Grants)

A lot of work has been done in recent years on research problems related to VBR video applications. However, most (if not all) of the published results are based on a few samples of VBR-encoded video streams. The lack of long VBR-encoded video streams has driven some researchers to resort to repeatedly combining several short video clips to form a longer video stream for their experiments. Clearly these approaches do not resemble real-world application scenarios and thus render generalization of the research results to bigger contexts more difficult. This motivates the researchers to propose

building an archive of bit-rate profiles for VBR-encoded videos of various types and lengths. These bit-rate profiles can then be used for analysis and for running trace-driven simulations to obtain more realistic performance results previously unobtainable. This project will result in three deliverables. The first and foremost being the bit-rate profile archive of real world VBR video streams. At the end of the project, the researchers will make the archive available to other researchers via a web site hosted at CUHK. The second deliverable is publications in international journals and/or conferences to publicize the archive to the research community. The final deliverable is a complete software toolset for extracting and analyzing bit-rate profiles from DVD discs. This toolset will enable the researchers and other researchers to continue expanding the archive. As realistic bit-rate profiles are fundamental to video systems design and implementation, the researchers expect the project to impart considerable impacts to the research area.  
(EE99006)

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#### Adaptive Multimedia Communications

- ✉ LIEW Soung Chang
- ☐ 1 January 2000
- ❖ CUHK Research Committee Funding (Direct Grants)

The delivery of multimedia materials, such as video, audio, speech, text, and images, over the Internet is a growing area of interest with the advent of World Wide Web. The heterogeneous nature of the Internet, in which some clients are connected to the server through a broadband channel while others through dial-up modems, presents a challenge. In addition, network traffic conditions may change and the available bandwidth to a communication session may vary with time. In this project, the researchers outline a framework for multimedia adaptive communication that adjusts the amount of information being delivered dynamically according to the available bandwidth to achieve best possible quality for multimedia presentation. Their preliminary experiments have shown that adding the adaptation mechanism is indeed worthwhile. As outlined, further investigations will yield refinements and enhancements that are essential for a complete adaptive-multimedia communication platform. The outcomes of this research will be integrated into a software application under development at CUHK called INTELLECT to serve two purposes:

- (1) to obtain insights based on the performance impact on a real application; and
- (2) to enhance the usability of the current INTELLECT system.

The research has both theoretical and practical values. The research output can be used by a whole host of Internet applications for performance enhancement.

(EE99017)

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#### MC/DS/CDMA as the Radio Technology for Wireless Multimedia Communication

- ✉ LOK Tat Ming • WONG Wing Shing
- ☐ 1 October 1999
- ❖ Research Grants Council (Earmarked Grants)

The main objective of this project is to investigate the use of multicarrier direct sequence code division multiple access (MC/DS/CDMA) as the underlying radio technology for wireless multimedia communication systems. The problems that would be encountered in an MC/DS/CDMA system with multimedia services include the allocation of resources, various forms of interference, and the detrimental effects of the wireless channel. The researchers would develop transmitter and receiver adaptation schemes to counteract these problems. Both centralized and decentralized schemes would be considered. These schemes should improve the performance of MC/DS/CDMA systems and enable wireless multimedia communication.  
(CU99420)

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#### Global and Structural Pattern Recognition for Large-Set Databases

- ✉ TANG Xiaou • Grimson William Eric Leifur\*  
• LIU Jian Zhuang\*
- ☐ 1 December 1999
- ❖ Research Grants Council (Earmarked Grants)

In this project, the researchers study the classification of large-set, high-variation, real-world, deformable, and complex patterns. Specifically, the researchers focus on two very large datasets representing two important areas of pattern recognition application. The first dataset consists of 30+ classes of more than several million-plankton images collected by a towed underwater microscopic video system called Video Plankton Recorder. Plankton forms the base of the food chain in the ocean and is fundamental to marine ecosystem dynamics. The rapid mapping of plankton abundance together with taxonomic and size composition is essential for understanding how climate change and human activities affect marine ecosystems. The second dataset is a Handwritten Chinese Character (HCC) database including 5000+ categories of characters. Automatic character recognition is one of the most natural ways to input Chinese character into computers. The two datasets share similar properties and challenges to pattern recognition research. They are diverse, deformable, complex, having high within-class variation, and many categories are similar to each other. In this project, the researchers intend to develop a high accuracy pattern recognition system using effective



combination of two fundamental classification approaches - global method and structural method. The algorithms developed based on the two large-set databases should be quite generic, and be applicable in such important areas as microscopic germ analysis, multimedia data retrieval, scene analysis, medical image classification, and many other computer vision areas.

(CU99378)

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**Design and Implementation of a Bi-directional Multiwavelength Ring Network**

✉ TONG Fuk Kay Franklin • HO Keang Po Ricky

☐ 15 August 1999

❖ Research Grants Council (Earmarked Grants)

Optical networks based on wavelength division multiplexing (WDM) are capable of fully exploiting the enormous bandwidth offered by the optical fiber. Most of the WDM networks studied thus far are based on unidirectional transmission, and bi-directional transmission capability of the optical fiber is largely ignored. Investigation of bi-directional WDM networks can be meaningful, as this scheme could provide an easy means to upgrade the bandwidth and efficiency using the existing fiber networks designed for unidirectional transmission.

There are several areas this project intends to cover. First, the researchers will investigate new designs of add-drop multiplexers. The impairment derived from crosstalk, back scattering, and other nonlinear fiber effects will be studied for bi-directional propagation. Furthermore, they will simulate the performance of a several node WDM ring network.

(CU99369)

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**Assessment study on a Fiber Optic Network**

✉ TONG Fuk Kay Franklin • CHEN Lian Kuan • HO Keang Po Ricky

☐ 11 October 1999

❖ 1 Trend.Net Limited

This is an assessment study requested by a company on its newly acquired fiber-optic network in China. The entire network will be completed in two stages. The first-stage network consists of 224 add-drop and repeater nodes with a total fiber distance of 22,076.47km. There are two parts in the assessment study. The first part deals with the testing of parts of the backbone networks that are already in operation. These include the Beijing-Wuhan-Guangzhou network and Yuedong-Yuexi networks. The Beijing-Wuhan-Guangzhou network serves as the main communications link from north to south, linking most major cities and towns in between. The Yuedong-Yuexi network connects east and west of the Guangdong province. The second part deals with

the testing of the installed fibers. There are altogether 23 nodes selected for fiber testing, representing about 10% in the total node number or 20% in the installed cables.

(EE99028)

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**On the Performance Bounds of Turbo Codes**

✉ WEI Keh Wei Victor

☐ 1 September 1999

❖ Research Grants Council (Earmarked Grants)

In this project the researchers intend to study theoretical and computational methods to obtain upper and lower bounds to the performance of turbocodes.

(CU99424)

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**Hong Kong Cyber Campus – Towards Networking all Schools in Hong Kong**

✉ WONG Po Choi

☐ 1 July 1999

❖ Quality Education Fund, HKSAR Government

This is an extension of the project Hong Kong Cyber Campus, and it aims to work towards the goal of networking all schools in Hong Kong. The new phase of the project will provide connection for an extra of 250 primary and secondary schools; a total of 600 schools will be connected this year. Apart from school dial-up, it also provides networking equipment and service, free dial-up connections for teachers at home and free email and web accounts for students as well as teachers. An extra 2000 free dial-up accounts will also be provided for students in need. A Multimedia Teacher Centre will be set up in the downtown area, which will provide both training and multimedia equipment for teachers.

(ED99003)

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**MoLi & ANSeRS / MySQL Integration**

✉ WONG Wing Shing

☐ 15 December 1999

❖ Asia Corporate Information Limited

The project aims to integrate part of MoLi & ANSeRS on the MySQL database.

(EE99029)

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**Efficient Multicast Routing for Multimedia Videoconferencing**

✉ YUM Peter Tak Shing

☐ 1 October 1999

❖ Research Grants Council (Earmarked Grants)

Videoconferencing has been around for many years. Growth is slow and we do not see the common use of it. After much research effort, the technology is matured now and how conferencing stations should 'talk' to each other in different communication networks was finally agreed upon by members of the International Telecommunications Union in 1996. Development effort was then started in earnest by the many computer companies, telecommunications companies, semiconductor companies and consumer electronics companies.

Quality of service (QoS) guaranteed multicast routing is essential for supporting the widespread use of multiparty videoconferencing in BISDN networks. New requirements such as high bandwidth consumption, interactivity, connection dynamics and setup speed need to be added in the design of these routing algorithms. In this research, the researchers propose to design and analyze efficient source-based multicast routing algorithms in BISDN networks. The objective is to minimize the multicast tree cost while maintaining a bound on multicast delay. There are many types of videoconferencing such as common-media, selectable media, virtual space and speaker-video conferencing. Coupling with different user performance requirements and the interference from other traffic types such as voice and data, it is conceivable that there is no single well performing multicasting algorithm that is good for all situations. The generic properties of the multicast routing algorithms will be studied and their performance will be evaluated under realistic network and traffic conditions.

(CU99371)

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

<u>Edition</u>	<u>Title/Investigators</u>
1997-98	Surveillance Schemes for Passive Branched Optical Networks with Erbium-Doped Fiber Amplifiers (CU97533) ✍ CHEN Lian Kuan • TONG Fuk Kay Franklin
1998-99	Bandwidth Management Device for All-Optical Links and Networks (CU98153) ✍ 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 (Dept of Computer Science and Engineering) • LEUNG Hong Chung (Dept of Electronic Engineering)# • HO Keang Po Ricky • CHING Pak Chung (Dept of Electronic Engineering) • CHAM Wai Kuen (Dept of 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)

1998-99 The Development of Mobile Computing and Connectivity Technologies (EE98052)  
✍ CHEUNG Kwok Wai • FONG Chi Bun (Centre for Innovation and Technology)# • CHEUNG Lawrence\* • PANG Stephen\*

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

1998-99 Combined Source-Channel Coding Using Multicarrier Modulation (EE98025)  
✍ HO Keang Po Ricky

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

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|---------|---|---|
| 1997-98 | The Principle of Multi-dimensional Switching and Its Applications in High-speed ATM Packet Switches (CU97570)<br>✍ LEE Tong Tony  | ✍ TANG Xiaoou   |
| 1998-99 | Traffic Control Strategies for Quality-of-Service Guarantees in Cross-Path ATM Packet Switches (CU98349)<br>✍ LEE Tong Tony • TO Pak Tung Philip#   | 1998-99 Intelligent Image Coding for Underwater Optical Survey (EE98006)<br>✍ TANG Xiaoou   |
| 1998-99 | An Interactive Multimedia Exchange with Open Software Interface for Media Industry and Digital Library (EE98046C)<br>✍ LEE Yiu Bun • YEN Jerome (Dept of Systems Engineering & Engin. Management) • LYU Rung Tsong Michael (Dept of Computer Science and Engineering) | 1997-98 Component Surveillance and Error Detection in Multi-Wavelength Networks (EE97015)<br>✍ TONG Fuk Kay Franklin • MARZ Reinhard*   |
| 1996-97 | Control-Theoretic Approach to Adaptation of VBR Compressed Video for Transport over a CBR Communications Channel (CU96506)<br>✍ LIEW Soung Chang  | 1998-99 A High-Capacity WDMA Local and Metropolitan-Area Ring/Bus Network (CU98157)<br>✍ TONG Fuk Kay Franklin • CHEN Lian Kuan • HO Keang Po Ricky                                   |
| 1997-98 | Lossless Transmission of Multiple Video Streams (CU97532)<br>✍ LIEW Soung Chang   | 1997-98 Theoretical Study of Partitioning Techniques for Iterative Methods in Circuit Simulation (CU97540)<br>✍ WING Omar • LUK Wai Shing (Dept of Computer Science and Engineering)# |
| 1997-98 | Signal Processing Techniques in Spread Spectrum Systems with Adaptive Antenna Arrays (EE97007)<br>✍ LOK Tat Ming  | 1998-99 Hong Kong Cyber Campus (ED98019)<br>✍ WONG Po Choi  |
| 1998-99 | Joint Design of Signal Format and Interference Suppression Scheme for CDMA Systems (EE98026)<br>✍ LOK Tat Ming  | 1997-98 Wireless ATM: Issues in Multi-Rate Multiple Access (CU97538)<br>✍ WONG Wing Shing • HUI Yu Ngai   |
| 1997-98 | Preliminary Study of Image Compression by Automatic Recognition (CS97014)   | 1998-99 Network Information Flow Theory (CU98342)<br>✍ YEUNG Wai Ho Raymond   |
|         |   | 1998-99 Multiparty Videoconferencing in Virtual Path Based ATM Networks (CU98159)<br>✍ YUM Peter Tak Shing • WONG Po Choi   |

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see also <P000355>, <P000613>, <P985118>, <P992967>

## RESEARCH PROJECTS

### Earliness/Tardiness Scheduling Subject to Known Due Dates and an Unknown Deadline

- ✉ CAI Xiaoqiang • ZHOU Xian\*
- ☐ 1 December 1999
- ❖ Research Grants Council (Earmarked Grants)

The researchers investigate a class of scheduling problems where an event may occur with uncertainty. The event can be regarded as a deadline for all jobs. Each job is subject to its due date and this deadline. On the one hand, a job should be completed as close to its due date as possible, as it will incur an early (or tardy) cost if it is completed before (or after) its due date. On the other hand, if a job is not completed when the event occurs, then it may be struck heavily by the event. The processing time of a job may be a random variable, and the machine(s) used to process the jobs may also break down stochastically. The decision maker should determine how to properly schedule the jobs by taking into account the available information including the possible arrival time of the deadline, the probabilistic distributions of the job processing times, the due date and the relative importance of each job, and the patterns of the machine breakdowns, so as to minimize the total loss. This is a class of new scheduling problems. The objective of this project is to develop an in-depth study of these problems. Topics to be addressed include those on modelling, basic properties, and algorithms.  
(CU99418)

### On the U-shaped Production Line Problem

- ✉ CHENG Chun Hung
- ☐ 1 December 1999
- ❖ CUHK Research Committee Funding (Direct Grants)

Just-In-Time (JIT) manufacturing is proposed to eliminate wastes of material, labor, and space in their manufacturing systems. The purpose of this research is to develop new knowledge for designing and operating JIT production. In particular, the researchers explore and evaluate the use of various algorithms.  
(EE99023)

### AICAMS Implementation

- ✉ LAM Kai Pui
- ☐ 1 July 1999
- ❖ Unisys China/Hong Kong Limited

AICAMS (Artificial Intelligence Crime Analysis and Management System) Implementation:

To advise and to participate in the software implementation of two AICAMS components: FIT (Facial Identikit Tool) and FIK (Formation Information Kiosk) for the Hong Kong Police Force. Based on our refined prototype for three police divisions in North Point, Sha Tin, and Sau Mau Ping, the implementation for other divisions is expected to complete by March 2000 or earlier.  
(EE99003)

### Integrative Intelligence Techniques for Money Laundering Detection

- ✉ LAM Kai Pui
- ☐ 1 December 1999
- ❖ Research Grants Council (Earmarked Grants)

The researchers' proposed research is to formalize the "Know Your Customer" (KYC) approach using a heuristics rule base, and to apply case-based reasoning for capturing essential information in the feedback reports. These techniques will be integrated with data mining and neural network technologies for uncovering abnormal input patterns from the millions of accounts and transaction records. However, the detection is no easy task that tests the technology limits, and the academic challenge lies in the novel integration of computational intelligence methodologies that take account of the different nature of the information sources.  
(CU99396)

### Learning Classification Knowledge From High Dimensional Data and Its Application To Intelligent Text Filtering

- ✉ LAM Wai • LING Charles X.\* • CHOI Philip L.S.\*
- ☐ 1 December 1999
- ❖ Research Grants Council (Earmarked Grants)

Many learning tasks can be formulated as discovering classification knowledge from data. The classification knowledge discovered can be used for performing intelligent tasks. Some applications such as intelligent text filtering, automatic text categorization, and direct marketing typically involve data sets with a large number of attributes. This project aims at developing a new approach for tackling the learning problem under high dimensionality. The researchers also develop an intelligent content-based text filtering system by adapting our new learning approach to automatically construct filtering profile from past user interactions.  
(CU99385)



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**Gain-Sharing in Third-Party Logistics Alliances: Game-Theoretic Models and Empirical Investigations**

- ✉ LEUNG May Yee Janny • LAM Ko Kin\*
- 1 December 1999
- ❖ Research Grants Council (Earmarked Grants)

There has been a growing recognition of the strategic importance of the logistics and distribution function. Coupled with the management trend of focusing on core competencies, this has led to an explosive growth in logistics out-sourcing to third parties.

In Hong Kong and South China, goods distribution and transportation have typically involved many layers of brokers, consolidators, freight-forwarders, etc. This research project aims to:

- (1) study the current industry structure of third-party logistics, with particular emphasis on cross-border traffic;
- (2) explore potential streamlining and function integration, which may engender new transaction modes and alliances between different links in the supply chain;
- (3) in-depth (theoretical and empirical) analysis of the incentive-compatibility issues involved in these new logistics services and alliances; and
- (4) dissemination of the results to the Hong Kong logistics distribution industry.

The empirical study includes in-depth interviews with major stakeholders (e.g. transportation providers - Hong Kong Shippers' Council, cross-border manufacturers) and a mail survey of shippers, freight-forwarders and brokers. The theoretical investigation includes the development of game-theoretic models to study how different types of compensation schemes, operational modes, service and quality requirements affect the incentives to the different partners in their effort towards efficiency improvement and cost-reduction for the entire supply chain.

(CU99375)

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**Multiobjective Differential Dynamic Programming**

- ✉ LI Duan • LIAO Li Zhi\*
- 1 November 1999
- ❖ Research Grants Council (Earmarked Grants)

Sequential decision making problems arise in fields of operations, management, control, finance, and economics often result in a multiobjective control formulation. In the real world, however, a direct application of multiobjective dynamic programming has often been handicapped by a large-scale nature. Such existed in many sequential decision making problems due to the well-known curse of dimensionality in dynamic programming. A new

numerical solution methodology entitled multiobjective differential dynamic programming will be developed in this project for multiobjective optimal control problems with a general separable structure. Recognizing prominent features in multiobjective dynamic programming, the proposed multiobjective differential dynamic programming methodology combines a search process, which identifies an optimal time-varying weighting sequence for multiple performance indices along the time horizon, with the successive solution concept in the conventional differential dynamic programming. The overall research goal will be achieved by carrying out the following three research tasks:

- (1) Establishment of an auxiliary model with a time-varying scalar objective function;
- (2) Development of an efficient numerical solution scheme of a differential dynamic programming type for the auxiliary model; and
- (3) Investigation of the convergence for the iteration process.

The research outcome from this proposed research should be applicable to a wide range of real-world sequential decision making problems, and the derivation of multiobjective differential dynamic programming for the above-mentioned academic challenge will advance the state-of-the-art in both dynamic programming and multiobjective optimization.

(CU99392)

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**An Inference Network Approach to Automated Reasoning**

- ✉ LOW Boon Toh
- 31 December 1999
- ❖ Research Grants Council (Earmarked Grants)

Intelligent information systems can be used to automate aspects of decision making in a wide variety of settings. One of the main problems constraining their advancement is that current systems do not exhibit robust exception-tolerance, nor do they handle inconsistent information in a principled fashion. This stems from the absence of a general formal framework for modeling the behaviour of uncertainty, incompleteness and exceptions under change.

This project aims at formulating a general inference network to retain the expressiveness of logic but capitalize the computational efficiency of neural networks, to integrate different reasoning style including closed-world assumption, default and argumentative reasoning, and to perform knowledge update and reasoning under different consistency reasoning modes. This system with the integrated functions can be used as a mean for improving reasoning and decision making processes with one or more (potentially inconsistent) knowledge bases.

This research will have significant impact on automated reasoning, knowledge representation and common- sense reasoning, belief revision, and cognitive science. The system can be used to help solve practical problems in business and scientific domains such as decision support, planning and scheduling.  
(CU99397)

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**From Language to Information: A Hybrid Approach for Understanding Spoken Queries**

- ✉ MENG Mei Ling Helen
- 15 October 1999
- ❖ CUHK Research Committee Funding (Direct Grants)

Human-computer interfaces emerge in many shapes and forms, but the speech interfaces remain one of the most natural and efficient, especially in the settings of mobile computing. To interpret spoken queries requesting specific information, speech recognition (SR) *alone* is often insufficient. The researchers will also need the capability of *understanding* by the computer. Here, "understanding" is defined as transforming the recognized text string into machine-readable semantics, to effect retrieval of relevant information. As such the spoken language understanding (SLU) component becomes an indispensable part of a *comprehensive* human-computer speech interface. They propose to devise a framework for *understanding spoken queries*, and interpreting the *informational goals* therein. The complexity of the SLU problem demands the following design considerations:

- (1) *robustness* towards disfluencies and ungrammatical constructs populating spoken queries, as well as errors from SR;
- (2) ability to handle the *inherent variability and ambiguity* in spoken language, e.g. the infinite ways to express an underlying meaning, even within restricted domains; and
- (3) extensibility to accommodate evolving knowledge domains, and *portability* across domains and languages.

Their hybrid approach augments a compact rule set with extensive data-driven strategies. Novel aspects of other proposed work include the applicability toward *both* English and Chinese (predominant languages in Hong Kong), as well as the use of probabilistic inferencing to aid understanding.  
(EE99024)

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**Chinese Broadcast New Retrieval Engine**

- ✉ MENG Mei Ling Helen • LAM Wai • TANG Xiaou (Dept of Information Engineering)
- 1 January 2000

- ❖ UGC Area of Excellence

This project develops a demonstration system that supports cross-media information retrieval (textual queries, audio documents) in Cantonese. The researchers have collected a video archive of Cantonese television broadcasts, and the audio tracks in the archive are indexed by a Cantonese speech recognizer. This project integrates speech recognition with information retrieval technologies to support real-time retrieval of relevant news clips, based on a Chinese text query typed into the system by the user.  
(EE99042)

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**Chinese Database Systems, Query Language and Interface**

- ✉ WONG Kam Fai William • WANG Shan\* • TANG Shi Wei\*
- 1 January 1997
- ❖ National Science Foundation of China

The primary objective of the project is to research and develop a full-fledged Chinese database management system suitable for both casual and expert users.

As a result of the endeavour, a restricted natural Chinese query language with data definition and manipulation functionalities has been defined and a Chinese database management system built-in with this language has been developed. The system itself has been accepted by many database experts in mainland China; the concept of a home-brewed Chinese database system and its importance to the Chinese society have been widely recognised.

Note that this is a collaborative project between the Chinese University of Hong Kong, Renmin University and Beijing University of China.  
(EE96020)

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**Extracting Temporal Information from Chinese Financial News**

- ✉ WONG Kam Fai William • LAM Wai • LI Wenjie (Centre for Innovation and Technology)
- 1 November 1999
- ❖ CUHK Research Committee Funding (Direct Grants)

The growing volume of information renders conventional information retrieval techniques impractical. One common way to mediate the situation is to present the information in a digest form. This is, in fact, the goal of information extraction (IE). Hitherto, the target information extracted in most IE research prototypes focuses on events or activities, e.g. a "take- over" event in a financial document. Nonetheless, "time" is an equally, if not more,

important piece of information that should not be overlooked. For instance, an investor attempts to find out the history of a company before deciding whether to put money on it. This lays down the objective of this project: to design and develop a temporal IE system. The researchers' target application domain is financial news and the underlying language is Chinese. These choices are in-lined with the local culture of Hong Kong. Thus, their research result will be significant to the promotion of Hong Kong IT. This project will involve a number of challenging research issues, which have not been addressed in detail previously. These include (a) temporal information extraction; and (b) Chinese natural language processing for temporal information. (EE99025)

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**OCF – Open Component Foundation**

- ✉ WONG Kam Fai William • CHEUNG Kwok Wai (Dept of Information Engineering) • LYU Rung Tsong Michael (Dept of Computer Science and Engineering)
- 1 January 2000
- ❖ Industrial Support Fund, Industry & Technology Development Council

The researchers propose to set up the Open Component Foundation (OCF) to provide across-the-broad quality software development components to local independent software vendors (ISVs). OCF will provide:

- (1) an OCF repository and management system which facilitates software users to check-out existing components and to check-in (i.e. introduce) new ones; and
- (2) a set of component quality assurance guidelines, which specifies how OCF components be adopted for ensuring high reliability and usability of the final software system.

Software components are self-contained software building blocks. They facilitate code re-usability and sharing as well as high reliability and flexibility in software development. As a result, development cost will be lowered and development time reduced, leaving ISVs with more time in strategic planning and business engineering. Moreover, through OCF, a wealth of cost-effective, reliable, "home-brewed" software resources will be built-up for sharing between local ISVs. This will help raise the competitiveness of the ISVs in both the local and overseas software markets. (EE99001)

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**Translingual Access of Chinese Text Using English**

- ✉ WONG Kam Fai William • LAM Wai
- 3 April 2000

- ❖ Queens College, City University of New York

This is a collaborative proposal between Queens College, City University of New York (CUNY) and the Chinese University of Hong Kong (CUHK), Hong Kong to focus attention on the issues of translingual access of Chinese free text material using English. Three broad topics are addressed:

- (a) English-Chinese cross language information retrieval (CLIR) including document summarization;
- (b) topic detection; and
- (c) entity and temporal extraction.

Part (a) is conducted in CUNY, and (b) and (c) in CUHK. (EE99041)

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**Information Updates and Supply Chain Management with Application to Electronic Device and Equipment Industry**

- ✉ YAN Houmin
- 1 September 1999
- ❖ Research Grants Council (Earmarked Grants)

Information about demands is critical for companies in planning raw materials and inventories, production, and distribution. Because of uncertainties in the market place and demand information distortion in the supply chain, companies, in many cases, have to make decision based on the incomplete, even distorted, demand information. In this project, the researchers study how an updated forecast affects a manufacturer's decision in ordering raw materials, production commitment, and choice of distribution alternatives. In particular, they model the problem of optimal order quantity from two modes of suppliers with forecast updates as a dynamic optimization problem.

Issues that are going to be addressed in this project include: (1) building a dynamic, multiple stage decision making model with considerations of the information update and the increasing cost structure; (2) analyzing the optimal decision making in such circumstances; (3) generating conditions and insights into better supply chain management with considerations in information updates; (4) demonstrating why companies need a system better than traditional approaches, such as JIT and MRP; and (5) developing efficient methodologies and algorithms in helping local companies to make better logistic decisions (CU99417)

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**Supply Chain Structure and Information Dynamics**

- ✉ YAN Houmin • YAO David Da Wei • CHEN Jian\* • LIU Lu\*

□ 1 January 2000

❖ NSFC/RGC Joint Research Scheme

The structure of a supply chain is fundamentally a reflection of a firm's business model. For example, one issue in the supply chains of the personal computer (PC) industry is to identify the right point that separates the "vanilla box" from the "featurization" process, which adds the highly customized features into the vanilla box. Ideally, the vanilla box should be built to stock, and the featurization built to order; and this is essentially the famous Dell model. To deploy this business model, however, a careful design is needed so as to coordinate the build-to-stock and the build-to-order segments. Furthermore, managing the coordination between the PC producers and the suppliers of the components that go into the PC is an other important aspect of the supply chain. Should the PC producer go for dual/multiple sourcing, or to seek strategic partnership with one particular supplier? What are the right kind of incentive schemes that will result in win-win collaboration between partners? What is the role of information sharing in supply contracting, so that an efficient flow of information will enhance the distribution of materials?

The researchers' objective is to address the above issues through formal models involving stochastic networks, dynamic programming, and game theory. The researchers expect the research to contribute significantly to the research literature.  
(BS99004)

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**Constraints Based Reasoning Approach for Tolerance Analysis and Tolerance Synthesis**

✉ YANG Christopher Chuen Chi

□ 1 September 1999

❖ Research Grants Council (Earmarked Grants)

Tolerance design plays an important role in the relationship between performance and the manufacturing cost of a product. Decreasing the tolerance range will improve performance but will also increase the manufacturing costs. It is desirable to optimize the tolerance range under such constraints of product design as the relationship between the dimensions of entities of a component and the functional requirement of the design. The investigators propose a constraint-based reasoning mechanism to analyze a given set of design tolerances and synthesize a new set of tolerances to satisfy the functional requirements of a product. They will also consider the minimization of manufacturing cost during the tolerance propagation in interval constraint networks.

In this project, they propose a hierarchical interval constraint network and interval propagation techniques for automatic tolerance design. The nodes in interval constraint networks represent the entities,

the attributes, and the functional requirements of the mechanical parameters or the constraint functions. The arcs represent the relationships between the entities, the attributes, the functional requirements and the constraint functions. In tolerance analysis, given the entity tolerances, the goal is to ensure that the functional requirement tolerances are met. In tolerance synthesis, given the functional requirement tolerances, the goal is to synthesize a new set of entity tolerances. They propose to use the forward propagation technique for tolerance analysis and the backward propagation technique for tolerance synthesis. In backward propagation, the minimization of the manufacturing cost will also be considered. In the hierarchical interval constraint network, techniques for parallel propagation will be also investigated.

(CU99031)

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**Bilingual Internet Search Engine**

✉ YANG Christopher Chuen Chi

□ 1 June 2000

❖ CUHK Research Committee Funding (Direct Grants)

Although network protocols and software such as HTTP and Netscape support easy importation of online information sources, the users find it difficult to find what they want in an enormous information space. This is mainly due to the problems of information overload and vocabulary differences.

Most of the current search engines are using online database indexing and searching. These online databases are only updated once a week or less frequently. Moreover, their precision and recall are poor. A client-based real-time search is desired to improve their performance.

The prevailing search engines are mostly designed for English documents. Some have developed search engines for other languages, such as Chinese, Japanese, Korean, German, and Spanish, etc., however, a search engine that is capable to search bilingual documents has not been developed yet. Hong Kong is a colony used to be governed by the British HK government, but is now governed by the HKSAR government. Due to its history, people are fluent in both English and Chinese, and therefore, documents on the web are usually bilingual. Using a search engine in either Chinese or English may not be able to retrieve the desired documents. A search engine that is capable to search cross the border of language is needed.

The objectives of this project are to create a search engine that has the following characteristics:

- (1) Real time searching;
- (2) Searching based on semantics of documents;
- (3) Capability to search bilingual documents.

(EE99032)

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**Performance Analysis and Optimization of Assemble-to-Order Systems**

✉ YAO David Da Wei

☐ 1 August 1999

❖ Research Grants Council (Earmarked Grants)

An assemble-to-order (ATO) system is an emerging business model in supply chain management. Examples of engineering and service systems that apply the ATO concept include the direct-sales models of Dell Computer and its variation - the "hybrid" model (of PC producers using distributors to interface with customers), fast-food chains, and many electronic commerce services and operations. In an ATO system, the time and effort in assembling all the components into the end product is quite negligible in comparison with the time and effort in making the components. Hence, keeping an adequate level of component inventory is the key to providing responsive supplies to customer demand. On the other hand, excessive inventory will surely dilute the profit margin and diminish the firm's competitive edge.

The objective of this project is to develop models and methodologies for an in-depth study of the ATO system and its operations, and to generate solutions that achieve optimal tradeoffs between inventory and service. The research output is expected to have a significant impact on decision and software technologies that support supply chain management, and in particular benefit the industry and commerce in Hong Kong, a global nexus in the distribution of goods and services.

(CU99376)

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**Sensitivity Analysis and High Performance Optimization Methods**

✉ ZHANG Shuzhong

☐ 1 December 1999

❖ CUHK Research Committee Funding (Direct Grants)

This project aims at a thorough investigation into issues related to sensitivity analysis for optimization models such as linear programming and semidefinite programming, by means of modern high performance optimization techniques including the primal-dual interior point methods. While traditional approach is based on an arbitrary optimal solution of the model, the researchers propose to study the sensitivity and parametric analysis from the perspective of interior points, in particular, the analytic central path. By virtue of the recent advances in interior point methods, this enables a fast and effective way of testing the sensitivity and trustworthiness of the solution and the model, which is very often of utmost importance in engineering applications.

(EE99026)

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**Optimal Controls of Forward-Backward Stochastic Systems with Financial Applications**

✉ ZHOU Xunyu

☐ 1 October 1999

❖ Research Grants Council (Earmarked Grants)

Stochastic optimal control covers a variety of applications in engineering, communication, management, and especially in financial economics. The conventional research in this area has been concerned with controlled stochastic systems that evolve forwardly over time with prescribed initial states. However, in many applied situations particularly in dealing with the so-called contingent claims (or derivatives) in finance, one is faced with stochastic systems with prescribed terminal conditions. This calls for the research on *backward* stochastic systems as well as on evaluating and optimizing the performance of such systems. This project aims to solve optimal control problems for systems with both forward and backward dynamics. Specific objectives include full or partial characterizations of optimality for general nonlinear models, complete solutions to a linear-quadratic specialization, and derivation of the efficient frontier for a mean-variance portfolio selection problem with random interest and volatility rates that exemplifies the general model.

(CU99435)

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

<u>Edition</u>	<u>Title/Investigators</u>
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 (Dept of Computer Science and Engineering)
1997-98	New Models in Capacitated Lot Sizing Decisions (CS97009) ✉ CHENG Chun Hung
1998-99	Solving the U-line Balancing Problem (EE98031) ✉ CHENG Chun Hung

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|---|--|
| <p>1996-97 Knowledge Engineering Laboratory - Applying Artificial Intelligence Research to Industrial Applications (CS96014)<br/> <i>✍</i> LAM Kai Pui • LOW Boon Toh • LAM Wai</p> | <p>1997-98 A Logic Based Intelligent Information Retrieval Framework (CS97001)<br/> <i>✍</i> WONG Kam Fai William • CHENG Chun Hung • LAM Wai • HE Jia (Dept of Finance) • LOW Boon Toh • HO Kei Shiu Edward#</p>  |
| <p>1997-98 Self-tuning Neural Control Systems and their VLSI Implementation (CU97525)<br/> <i>✍</i> LAM Kai Pui • POON Chi Sang*</p>  | <p>1997-98 Legal Reasoning for Distributed Information Retrieval (CS97012)<br/> <i>✍</i> WONG Kam Fai William</p>  |
| <p>1997-98 AICAMS Prototype Development (EE97014)<br/> <i>✍</i> LAM Kai Pui</p>   | <p>1997-98 Computerized Qualitative Research Analysis (EE97013)<br/> <i>✍</i> WONG Kam Fai William • SO York Kee Clement (School of Journalism and Communication) • SO Lai Man Stella (Dept of Marketing)</p>  |
| <p>1998-99 Knowledge Engineering for Crime Analysis and Management (CU98185)<br/> <i>✍</i> LAM Kai Pui • BRAHAN J. W.* • CHAN Hilton*</p>   | <p>1996-97 Robust Production Scheduling in High Tech Manufacturing (CU96532)<br/> <i>✍</i> YAN Houmin • SETHI Suresh P.*</p>   |
| <p>1997-98 A Bayesian Framework for an Intelligent Information Filtering System under Dynamic Environments (CS97011)<br/> <i>✍</i> LAM Wai</p>                                      | <p>1997-98 Manufacturing Logistics with Application to Electronic Equipment Assembly and Distribution (EE97012)<br/> <i>✍</i> YAN Houmin</p>   |
| <p>1997-98 Global Logistics Management: Combinatorial Optimisation Methods for Supply / Distribution Network Planning (SS97069)<br/> <i>✍</i> LEUNG May Yee Janny</p>               | <p>1998-99 Manufacturing Logistics Re-engineering : Sequencing and Merging - with application to Electronic Equipment Assembly and Distribution (CU98181)<br/> <i>✍</i> YAN Houmin • LEE Chung Yee*</p>  |
| <p>1998-99 Polyhedral Combinatorial Methods for Planning Problems with Interaction Costs (EE98034)<br/> <i>✍</i> LEUNG May Yee Janny</p>  | <p>1998-99 Color Image Retrieval and Visual Thesaurus (CU98034)<br/> <i>✍</i> YANG Christopher Chuen Chi • LI Victor*</p>  |
| <p>1997-98 Variance Minimization in Stochastic Systems (CU97523)<br/> <i>✍</i> LI Duan</p>  | <p>1998-99 Dynamics and Optimization in Production Logistics (EE98007)<br/> <i>✍</i> YAO David Da Wei</p>  |
| <p>1998-99 Successive Solution Scheme for Constrained Redundancy Optimization in Reliability Networks (CU98056)<br/> <i>✍</i> LI Duan</p>   | <p>1998-99 Strategic Research in Risk and Optimization (EE98040)<br/> <i>✍</i> YAO David Da Wei • CAI Xiaoqiang • CHENG Chun Hung • HE Jia (Dept of Finance) • LEUNG May Yee Janny • LI Duan • LIU Ming (Dept of Finance) • YAN Houmin • YEN Jerome • ZHOU Xunyu</p> |
| <p>1998-99 Interactive Parametric Minimax Method in Multiobjective Optimization (EE98044)<br/> <i>✍</i> LI Duan</p>   | <p>1998-99 The Next-Generation Digital Library Initiative at CUHK (EE98012)<br/> <i>✍</i> YEN Jerome</p>   |
| <p>1998-99 A Predicate Network for Automated Reasoning (EE98032)<br/> <i>✍</i> LOW Boon Toh</p>   | <p>1995-96 Asymptotic Optimality of Hierarchical Production Policies in Discrete Event Manufacturing Systems (CU95520)</p>   |
| <p>1998-99 Semantic Processing for Spoken Language (EE98008)<br/> <i>✍</i> MENG Mei Ling Helen</p>  |  |
| <p>1998-99 Research and Development of Spoken Language Interfaces for the Hong Kong Bilingual Environment (EE98041)<br/> <i>✍</i> MENG Mei Ling Helen</p>                           |  |

- ✉ ZHOU Xunyu
- 1997-98 New Challenges in Optimization of Stochastic Diffusion Processes (CU97518)  
✉ ZHOU Xunyu
- 1998-99 Optimal Dividend Distributions and Risk Controls for Financial Companies (CU98054)  
✉ ZHOU Xunyu

## RESEARCH OUTPUTS AND PUBLICATIONS

- <P001060> **Yang, Christopher C. and Winter Chan.** "Metadata Design for Chinese Medicine Digital Library Using XML". *Proceedings of the 33rd Annual Hawaii International Conference on Systems Sciences* Hawaii, USA, 2000.01.
- <P001061> **S.H. Kwok; Christopher C. Yang and K.Y. Tam.** "Watermark Design Pattern for Intellectual Property Protection in Electronic Commerce Application". *Proceedings of the 33rd Annual Hawaii Conference on Systems Sciences* Hawaii, USA, 2000.01.
- <P001068> **Meng, Helen; Oard D.; Khudanpur S. and Wang H.M.** "Mandarin-English Information (MEI)". *Proceedings of the Topic Detection and Tracking Workshop* p.4. Washington D.C., USA: NIST NSF DARPA, 2000.02.
- <P001069> **Meng, Helen; Oard D.; Khudanpur S. and Wang H.M.** "Mandarin-English Information (MEI): Investigating Translingual Speech Retrieval". *Proceedings of the NAACL Embedded Machine Translation Workshop* p.4. Seattle, USA, 2000.05.
- <P001070> **Fung, T.Y. and Meng H.M.** "Concatenating Syllables for Response Generation in Spoken Language Application". *Proceedings of the International Conference on Acoustics, Speech and Signal Processing* p.4. Istanbul, Turkey: IEEE, 2000.06.03.
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- <P001072> **David, D. Yao.** "Stochastic Models". *Operations Research* vol.48. 2000.
- <P001073> **Ettl, Markus; Gerald E. Feigin; Grace Y. Lin and David D. Yao.** "A Supply Network Model with Base-Stock Control and Service Requirements". *Operations Research* vol.48, pp.216-232. 2000.
- <P001098> **Yan, Houmin; Houzhong Yan and Hanqin Zhang.** "Demand Allocation Analysis for Energy Purchasers in Deregulated Energy Markets". *the International Conference on Electric Utility Deregulation and Restructuring and Power Technologies 2000* pp.344-348. London, UK: IEEE, City University of London, 2000.
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- <P001102> **Yan, Houmin; Sheldon Lou and Suresh P. Sethi.** "Robustness of Various Production Control Policies in Semiconductor Manufacturing". *Production and Operations Management* vol.9 no.2, pp.171-183. USA, 2000.06.
- <P001108> **Sha, D.; X. Cai and C.K. Wong.** "The Maximum Flow in a Time-Varying Network". *Lecture Notes in Economics and Mathematical Systems* vol.481, pp.437-456. Berlin, Germany, 2000.01.

- <P001109> **Yang, Christopher C.C.; Stanley K. Yang; J.W.K. Luk and Jerome Yen.** "Combination and Boundary Detection Approaches on Chinese Indexing". *Journal of American Association of Information Sciences* vol.51 no.4, pp.340-351. 2000.
- <P001118> **Meng, Helen; Lee S. and Wai C.** "CU Forex: A Bilingual Spoken Dialog System for Foreign Exchange Inquiries". *Proceedings of the International Conference on Acoustics, Speech and Signal Processing* p.4. Istanbul, Turkey: IEEE, 2000.06.03.
- <P001289> **Zhou, X.Y. and D. Li.** "Continuous-Time Mean-Variance Portfolio Selection: A Stochastic LQ Framework". *Applied Mathematics Optimization* vol.42, pp.19-33. USA, 2000.04.
- <P001294> **Kohlmann, Michael and Xun Yu Zhou.** "Relationship Between Backward Stochastic Differential Equations and Stochastic Controls: A Linear-Quadratic Approach". *SIAM Journal on Control and Optimization* vol.38 no.5, pp.1392-1407. USA, 2000.05.
- <P001295> **Yang, Christopher C.; Jerome Yen and Hsinchun Chen.** "Intelligent Internet Searching Agent Based on Hybrid Simulated Annealing". *Decision Support Systems* vol.28 no.3, pp.269-278. The Netherlands, 2000.05.
- <P001296> **Yen, Jerome; Yonghe Yan; Javier Contreras; Pai-Chun Ma and Felix F. Wu.** "Multi-Agent Approach to the Planning of Power Transmission Expansion". *Decision Support Systems* vol.28 no.3, pp.279-290. Elsevier, The Netherlands, 2000.
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