RESEARCH PROJECTS

Design a Next Generation Industrial Sewing Machine

- ✍ DU Ruxu
- ❏ 15 March 2001
- ❖ CUHK Research Committee Funding (Direct Grants)

The ultimate goal of this project is to design a next generation industrial sewing machine. Invented over 100 years ago, sewing machine is one of the machines that changed our life today. Currently, China is the largest sewing machine manufacturer in the world. Hong Kong also plays an important role. It has some 20 companies that make, sell, and service various industrial sewing machines. Besides, Singer, the oldest and largest sewing machine makers in the world, has its headquarter in Hong Kong. Sewing machine is actually a complicated mechanical system consisting of 4 different mechanisms and hundreds of parts. Some problems, such as how the trajectory of material feeding mechanism affect the seam quality, still have not been fully understood. As an honorary member of the Chinese Sewing Machine Manufacturers Association, the researcher has been working for designing a next generation industrial sewing machine for a number of years. A feasibility study especially on how to use today's microelectronics to simplify the sewing machine design and to improve the product quality will be conducted.
(EE00837)

Approximation Methods for the Discrete Nonlinear Servomechanism Problem

- ✍ HUANG Jie
- ❏ 1 November 2000
- ❖ Research Grants Council (Earmarked Grants)

The nonlinear servomechanism problem, or alternatively, nonlinear output regulation problem has long been regarded as one of the most important nonlinear control problems since, unlike existing inversion based nonlinear control methods, the problem aims to handle asymptotic tracking and disturbance rejection for general nonlinear systems including nonmunimum phase nonlinear systems. The continuous nonlinear servomechanism problem has been well studied in both theory and application since 1990s, but the discrete nonlinear servomechanism problem has received relatively little attention, and many practical issues have not been addressed. It is known that the control law that solves the discrete nonlinear servomechanism problem necessarily (also sufficiently) relies on the solution of a set of nonlinear algebraic functional equations called discrete regulator equations (DRE). Since the DRE generally do not admit a closed-form solution due to its nonlinearity and complexity, it is vital to develop systematic approximation method to solve the DRE. In view of this, the researchers propose to develop two numerical methods based on Taylor series and neural networks, respectively, to solve the DRE. Additionally, they will establish a digital control strategy directly based on the approximate solution of the DRE, and thoroughly evaluate its performance with well some known nonlinear test-beds. Successful accomplishment of this research would not only lead to a practical solution of the discrete nonlinear servomechanism problem, but also offer an alternative for designing nonlinear digital controller for continuous nonlinear systems based on the discretized model of the continuous systems.
(CU00209)

Micromachined Nafion Actuators for Tactile-display Systems

- ✍ LI Wen Jung ● GUO Shuxiang* ● LIU Yunhui
- ❏ 1 September 2000
- ❖ Research Grants Council (Earmarked Grants)

In this project the researchers will use MEMS technologies to process ion-metal-polymer composites (IMPC) to build an IMPC tactor array and produce a novel tactile-display system. They aim to create a low-cost, mass-producible, tactile-display actuator chip integrable with IC control circuits. They will demonstrate a tactile-actuator chip that transduces shape information from a dynamic virtual environment and a teleoperated dexterous five-finger robotic hand. This chip will have applications in virtual presence, remote palpation, handling of surgical instrument, surgical robot controller, telemanipulation, and sensory substitution aids for the blind. MEMS technologies will be employed because they will allow the researchers to build distributed, dense, and highly precise tactors in a small surface, and will allow these tactors to be individually addressed and integrable with IC controller circuits.
The researchers will explore IMPC as a material for meso- and micro-scale actuators because it offers some very promising characteristics when compared with other smart and MEMS thin film materials:
(1) able to lift force 40 times their own weight;
(2) give greater than 2 to 100 times more displacement over shape memory alloys (SMA) and electroactive ceramics;
(3) a few orders of magnitude better in frequency response than SMA;
(4) can be actuated with CMOS compatible input voltage of 2 to 5V;and

(5) micromachinable and integrable with IC components.

By successfully micro-fabricate a tactor array using IMPC material the researchers will demonstrate a very compact, high resolution, large force, and IC integrable shape transduction device. This contribution will be very significant in advancing the state of robotics research in the areas of palpation and teleoperation by offering a compact, integrated, low-cost, batch-producible tactile-display system. (CU00206)

Novel Technologies for High-performance Vibration Damping and Compact Motion-stages for Electronics Manufacturing Equipment

- ✍ LIAO Wei Hsin ● WANG Michael Yu ● XU Yangsheng ● YAM Yeung
- ❑ 1 July 2000
- ❖ ASM Assembly Automation Ltd. ● University-Industry Collaboration Prog.: Matching Grant for Joint Research, ITF, Innovation & Tech. Commission

High passive damping is a cost-effective means to reduce structural vibrations. Particularly for a base-table of an electronics manufacturing machine, its damping factor is required to be especially high, while the cost for achieving the damping must be kept low. The base-table is typically made of granite for its structural and thermal stability. However, granite has relative low damping, making it necessary to incorporate additional high damping means. In this regard, the researchers propose a novel technique of using non-obstructive particle damping method. The key technical feature of the idea is to embed small-size movable mass particles inside holes or cavities made in the table structure. Induced vibrations cause the particles placed in the table structural holes to interact with one another and with the hole walls, thus transferring and dissipating vibration energy.

On the other hand, as the micro-electronic components rapidly become smaller in size and more complex in packaging techniques, they pose a particular challenge for equipment manufactures. Tool structures and motion drive devices have to become smaller in size and faster in response. Traditional concept of staggered x-y-z design will thus become inappropriate. In this project, the researchers also plan to develop small motion drive stages with 4 degrees of freedom via the use of non-traditional parallel mechanisms. While parallel mechanisms have been highly explored and utilized in robots, the researchers' interest here is in the unique application to miniature motion drive stages. The development of a novel design by combing a parallel mechanism with linear motor drives is required. (EE20004)

Active-Passive Hybrid Vibration Control Using Enhanced Self-sensing Piezoelectric Actuators

- ✍ LIAO Wei Hsin
- ❑ 1 October 2000
- ❖ Research Grants Council (Earmarked 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 adaptive 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 performance. The global design methods will be developed to synthesize structures and maximize the system performance for the purpose of vibration control. Experimental efforts will be carried out to implement the optimally synthesized and controlled structures with self-sensing piezoelectric actuators. The project will address the fundamental research issues relating to structural control systems. The results of this study are essential for advancing the technology of various complex systems such as machine tools, robots, computer hard disc drives, and space structures. (CU00205)

Real-time Control of Cooperative Robots via the Internet with Force Reflection

- ✍ LIU Yunhui ● NING Xi* ● WANG Yuechao*
- ❑ 1 October 2000
- ❖ Research Grants Council (Earmarked Grants)

In recent years, efforts have been devoted to the research in the robotic systems remotely controlled via the Internet. The accomplishment of the endeavors will make it possible to transfer actions to remote locations via the Internet. The success of the action transfer rests on synchronization of human operators' instructions with the remote robot's local controller as the synchronization will affect the dynamic performance as well as the stability of the system. The random communication delay, a fatal

factor of the Internet, makes the action synchronization a difficult problem. This study aims to develop a new planning and control method for human operators to control a remote system of cooperative robots with force reflection in real-time via the Internet communication. The researchers propose to introduce a non-time reference for task synchronization of the Internet based robotic system in order to cope with the random communication delays and to achieve a stable, robust, and dynamic performance.

This study will investigate and solve the following issues:

(1) based on the event-based planning and control theory, developing a non-time reference parameter for real-time control of cooperative robots via the Internet;

(2) analyzing the stability of the non-time referenced control; and

(3) implementing and testing the developed methods.

Theoretical results will be verified by three experiments via the Internet:

(1) human assisted cooperation of a mobile manipulator with an active camera;

(2) cooperation of two manipulators; and

(3) tele-Chinese medicine palpation.

The success of this proposed research could further enhance the applications of the Internet and contribute to the technology development in Hong Kong.
(CU00173)

Recurrent Neural Networks for Real-time Grasping Force Optimization of Dexterous Manipulations Using Multi-fingered Robotic Hands

- ✍ WANG Jun ● LIU Yunhui
- ❏ 1 December 2000
- ❖ Research Grants Council (Earmarked Grants)

The objective of the force optimization is to minimize the magnitude of grasping force from every finger 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 the external force is unknown *a priori* or 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 real-time grasping force optimization of highly dexterous manipulations using multi-fingered robotic hands. 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 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 dexterous manipulations using multi-fingered robotic hands in uncertain environments.
(CU00174)

Optimal Fixture Layout Design for Workholding Automation

- ✍ WANG Michael Yu
- ❏ 1 October 2000
- ❖ CUHK Research Committee Funding (Direct Grants)

Workholding (or fixturing) is an important tooling technology for product manufacturing. Fixtures are necessary to immobilize, support, and locate the workpieces, during the course of machining, assembly, or inspection. While today's CAD/CAM technology has made significant advances in a broad spectrum of applications, fixture design still relies on age-old heuristic guidelines (e.g., the "3-2-1" rule) and remains a major stumbling block in flexible manufacturing. The problem has become particularly critical for the industry of manufacturing delicate parts of complex shapes and assemblies.

The goal of the project is to develop a fundamental methodology and a *"CAM-centric"* computer system for automating the task of fixture layout design. The proposed approach is based on a novel technique of *optimal pursuit*, which is capable of handling the mixed continuous-combinatorial difficulties in the essential problem of fixture layout design.

From a practical point of view, the planned research is motivated by its applications in small-batch production and on-demand manufacturing. The project is aimed to significantly reduce the tooling lead-time and speed up the product realization process. This research will also open up a new exciting possibility of part-family fixtures to maximize the tool resource utilization. Thus, it is expected that the project will have a very high pay-off in the era of mass customization and agile manufacturing.
(EE20022)

A Croucher Chinese Visitorship

- ✍ WANG Michael Yu ● LIAO Wei Hsin ● CHEN Tian Ning*

❑ 18 December 2000

❖ Croucher Foundation Visitorship for PRC Scholars

The main objective of the visitorship programme for Professor Chen is for him to interact with the teaching and research staff and students of the Department of Mechanical and Automation Engineering and to exchange education and research ideas. During his six-month visit, Professor Chen will be able to continue his research activity in the area of non-obstructive particle damping (NOPD). (EE00372)

Smart Wheelchair

✍ XU Yangsheng ● NECHYBA Michael*

❑ 1 December 2000

❖ Research Grants Council (Earmarked Grants)

Nowhere do robots promise to enhance the quality of life of humans as much as in the area of rehabilitation. For a traditional wheelchair, an individual must navigate through close quarters in his/her home, which, like many homes, was not designed with handicapped people in mind, by carefully and slowly manipulating the wheelchair through a somewhat rudimentary joystick interface. Controlling his/her movements in this fashion may not only be frustrating and time-consuming, but may even be impossible for individuals who have only limited control of their arm, such as elderly persons who experience periodic tremors in their hands, or stroke victims who have been left with only partial dexterity and movement in their arm. On top of that, very similar maneuvering tasks are typically part of the individual's daily routine, as, for example, a trip from the bedroom to the bathroom which are notoriously difficult to successfully navigate. The researchers propose to develop a smart wheelchair which not only provides obstacle avoidance, but also allow the wheelchair to learn and record the human skill demonstrated by the wheelchair occupant or another human trainer. After initial learning, the human skill model can be refined through performance optimization, to minimize, for example, the "jerkiness" of the human control. In this way, handicapped people may significantly improve their day-to-day life, as they teach their wheelchair over time to perform maneuvers autonomously and with rider comfort in mind. (CU00197)

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

Edition   Title/Investigators

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

1999-00   Reconstruction of Generic Curved Surface from Stereo Views (EE99018)
✍ CHUNG Chi Kit Ronald

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

1999-00   Practical Output Regulation for Nonlinear Systems (CU99400)
✍ 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

1999-00   Deformation of Solid Models for Design Applications (EE99019)
✍ HUI Kin Chuen

1999-00   A MEMs Vibration Electric Power Generator (CU99416)
✍ LI Wen Jung ● LEONG Philip Heng Wai (Dept of Computer Science and Engineering) ● TANG William C.*

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

1998-99   Inchworm Motor Systems for Ultraprecision Positioning (EE98029)
✍ LIAO Wei Hsin

1999-00   Active-Passive Hybrid Structural Control Using Enhanced Self-Sensing Piezoelectric Actuators (EE99020)
✍ 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

1999-00 Multisensor Based Control of Dexterous Robots (EE99036)
✍ LIU Yunhui ● XU Yangsheng ● KNOLL Alois* ● ZHANG Jianmei*

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

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

1999-00 Recurrent Neural Networks for Real-time Force Optimization of 3D Frictional Form – Closure Grasps with Multi-fingered Robotic Hands (EE99021)
✍ WANG Jun ● LIU Yunhui

1998-99 Human Control Strategy Learning and Transfer (CU98164)
✍ XU Yangsheng

1998-99 Service Robotics (EE98038)
✍ XU Yangsheng ● LIU Yunhui ● TSO S. K.* ● LANG Y. T. Sherman* ● So Ting Pat Albert*

1999-00 A Single-wheel, Gyroscopically Stabilized Robot (CU99403)
✍ XU Yangsheng

1999-00 Developing an Intelligent On-line Monitoring System for Metal Stamping Operating (EE99004)
✍ XU Yangsheng ● DU Ruxu*

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

1997-98 Singular Value-Based Fuzzy Identification (CU97531)
✍ YAM Yeung

1998-99 A Geometric Approach for Fuzzy Interpolation (EE98030)
✍ YAM Yeung

1999-00 A Geometric Approach for Sparse Rule Base Interpolation and Extraction (EE99022)
✍ YAM Yeung

RESEARCH OUTPUTS AND PUBLICATIONS

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<P998086> **CELIKOVSKY Sergej and HUANG Jie.** "Continuous Feedback Practical Output Regulation for a Class of Nonlinear Systems Having Nonstabilizable Linearization". *Proceedings of the 38th*

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<P999009> **WANG Jin; HUANG Jie and YAU S.T.T.** "Approximate Nonlinear Output Regulation Based on the Universal Approximation Theorem". *Proceedings of the World Multiconference on Systems, Cybernetics, and Informatics* vol.7, pp.218-225. Orlando, USA: 1999 International Institute of Informatics and Systems, 1999.07.

<P999117> **HUANG Jie.** "Optimizing the Feedback Gains of the Robust Linear Regulator". *Transactions of ASME Journal of Dynamics, Control, and Measurement* pp.346-350. USA: ASME Press, 1999.09.

<P999715> **WANG Dan and HUANG Jie.** "Solving Discrete-Time Nonlinear Servomechanism Problem with Feedforward Neural Networks". *Proceedings of the 1999 International Joint Conference on Neural Networks* USA: IEEE Neural Network Council, 1999.07.

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<P000575> **XIA Yousheng and Jun WANG.** "A Recurrent Neural Network for Solving Nolinear Projection Equations". *Proceedings of IEEE-INNS-ENNS International Joint Conference on Neural Networks* vol.5, pp.492-497. USA: IEEE Press, 2000.07.

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see also <P008722>

RESEARCH PROJECTS

An Intelligent Virtual Environment for Chinese Acupuncture Learning and Training

- ✍ HENG Pheng Ann ● LEUNG Kwong Sak ● LEUNG Ping Chung (Dept of Orthopaedics & Traumatology) ● WONG Tien Tsin
- ❑ 15 November 2000
- ❖ Research Grants Council (Earmarked Grants)

As a key component of Chinese medicine, acupuncture, its philosophy and its practice is a large and complex subject. The researchers propose to develop an intelligent virtual environment for Chinese acupuncture learning and training, as a first step towards developing a comprehensive virtual human model for studying Chinese medicine.
Students can learn and practice acupuncture in the proposed 3D interactive virtual environment that supports force feedback interface for needle insertion. Highly informative and flexible visualization of acupuncture points of various related meridian and collateral can be highlighted based on the selected lesson topics or case studies. An expert system would be designed and implemented to train the learners about treating different diseases using acupuncture. The environment also supports knowledge based labeling and identification of acupuncture points as well as realistic muscle and skin modeling and rendering. Such an intelligent system can provide an interesting and effective learning environment for Chinese acupuncture.
The research issues involved in this project include: knowledge based visualization, intelligent haptic interface, data fusion of laser scanned data, MR/CT data, and atlas of 3D acupuncture points, automatic identification of acupuncture points, knowledge engineering of Chinese medicine, as well as realistic virtual human modeling and rendering. (CU00185)

Augmented Reality System for Endoscopic Surgery Simulation and Operations

- ✍ HENG Pheng Ann ● LEUNG Kwong Sak ● WONG Tien Tsin ● SUNG Joseph Jao Yiu (Dept of Medicine & Therapeutics) ● CHUNG Sheung Chee Sydney (Dept of Surgery) ● Prof. Tang Zesheng* ● Prof. Chai Jianyun*
- ❑ 2 January 2001
- ❖ NSFC/RGC Joint Research Scheme

In endoscopic surgery, the restricted vision, poor hand-eye coordination and limited mobility of surgical instruments easily cause unexpected injury to the patients. Therefore, the experienced skill and excellent hand-eye coordinate are necessary for surgeons to execute a minimally invasive surgery successfully and safely. Virtual environment based simulation systems provide a very elegant solution to train novice medical officers and interns to acquire the demanding endoscopic surgical skill. The overall objective of this project is to research the algorithms for endoscopic surgery simulation and operations in an intelligent augmented reality system. In order to develop the system successfully, the researchers will carry out the following original research as their sub-goals:
(1) To develop real-time soft tissue deformation algorithms.
(2) To develop realistic and real-time volume visualization algorithms for 3D models.
(3) To develop efficient algorithm for registration between the image of virtual models and video image acquired from the fiber-optic microscope.
(4) Knowledge-based surgical intervention in augmented reality simulation system.
Besides the knowledge of anatomic structures, the experience of the skillful surgeons can also be integrated in the knowledge base, in order to guide surgical intervention. For example, expert rules for performing sphincterotomy (a cut in the lower end of bile duct), removing bile duct stones, and excising (snaring) polyps with down endoscopes whether they are colonic or gastric polyps. The surgical manipulation rules in the knowledge base or the optimal surgery simulation scheme can be used to provide guidance for training and surgical operations. (CU00012N)

Collaborating Redundant Models in Constraint Satisfaction

- ✍ LEE Ho Man Jimmy ● LEUNG Ho Fung ● STUCKEY P. J.*
- ❑ 1 October 2000
- ❖ Research Grants Council (Earmarked Grants)

Constraint satisfaction problems (CSPs) occur in all walks of industrial applications and computer science, such as scheduling, bin packing, transport routing, type checking, diagram layout, among others. These are all difficult applications. Rapid growth of modern industrial sectors and higher degree of automation suggest the appearance of even more difficult constraint problems in the foreseeable future. Constraint problems are NP-hard in general. Freuder lists problem modeling among the seven most important future directions of constraint research. It is difficult to select the most appropriate formulation or model for a problem in general. It is in fact doubtful if an objective and general notion of the "best" formulation exists. The researchers observe that different models of a problem do not compete. The aim of this project is to investigate how the different models can collaborate with one another to improve solution efficiency using currently available

constraint-solving technologies. From the theoretical point of view, this research will further the understanding of how problem formulation can affect execution efficiency of constraint-solving algorithms. From the practical point of view, this research has immense potential in giving tractable modeling of some real-life complex constraint problems.
(CU00183)

A Micropower Analogue VLSI Implementation of a Scale Invariant Phase Encoded Neural Network and Its Application to a Wordspotting Speech Recognition System

- ✍ LEONG Philip Heng Wai
- ❑ 1 October 2000
- ❖ CUHK Research Committee Funding (Direct Grants)

The objectives of this research is to explore the feasibility of using biologically inspired phase encoding techniques in a wordspotting speech recognition system. Phase encoding of analogue signals allows for a particularly simple architecture for scale invariant template matching (SITM) without the need for normalisation. This research will develop new architectures for signal processing using phase encodings. A FPGA implementation of an electronic cochlea and a SITM chip will be developed and applied to the problem of real-time, duration invariant, low power speech recognition.

The proposed wordspotting system has a much simpler architecture than previous approaches and has applications in battery operated products which may have a speech input interface. The SITM chip will be general purpose and not limited to speech recognition. Other applications of this technology, such as low power biomedical signal processing will be investigated.
(EE20008)

Automatic Design and Prototyping of Digital Baseband Algorithms for Future Mobile Communication Applications

- ✍ LEONG Philip Heng Wai
- ❑ 1 January 2001
- ❖ Germany/Hong Kong Joint Research Scheme

The design of third generation mobile communications systems have conflicting goals of short time to market, low power consumption, low price and flexibility to cope with late specification changes and to support new services. The aim of this proposal is to develop automatic tools that can take a high level algorithmic description of a mobile communications system module and automatically produce an optimized hardware prototype intended for incorporation in hardware/software Systems-on-a-Chip (SoC) for future mobile devices. One central and important aspect to address these issues is an automatic floating-point to fixed-point conversion, specifically in the domain of digital filtering for mobile communications and this will be used as an example to demonstrate the feasibility of our approach.
(EE20025)

A New Class of Genetic Algorithms with Applications on Data Mining

- ✍ LEUNG Kwong Sak
- ❑ 1 October 2000
- ❖ CUHK Research Committee Funding (Direct Grants)

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, they have developed a sound theory and a prototype for a new class of fast genetic algorithms called f-GEAs. The researchers will further improve the adaptive and flexible problem representation (coding and decoding of the chromosomes with variable lengths and structures) scheme and algorithm 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. The researchers will develop new operators based on such information for data mining and other optimization problems. In *environment-driven* evolution, the evolution (search) will be influenced or directed by the search environment perceived through the global and statistical information collected so far from the search history or otherwise. The researchers will also evaluate these models and operators. The new algorithms and operators will be applied to solve optimization and real-life data-mining problems encountered such as high dimension multi-modal optimizations, the inverse problem of fractal encoding related to fractal image compression, clustering, and unsupervised learning problems.
(EE20009)

Design and Implementation of a Scalable Reliable Media Streaming Server

- ✍ LUI Chi Shing John
- ❑ 1 September 2000
- ❖ UGC Area of Excellence

Provide reliable streaming server to deliver on-demand multimedia information to users. System prototyping of continuous media server is the main core of this project.
(CS00477)

Providing Quality-of-Service on the Internet2 via the Differentiated Service Technique

- ✍ LUI Chi Shing John
- ❑ 1 September 2000
- ❖ CUHK Mainline Research Scheme

The goals of this research are:
(1) Examine the proper way to provide the DiffServ model. For example, should the researchers provide *absolute* performance QoS guarantees (e.g., tight end-to-end delay bounds) to different traffic aggregates or should they provide a relative performance QoS guarantees to different traffic aggregates. Note that relative guarantees can simplify the network design and at the same time, provide applications the flexibility to adopt to different network loadings.
(2) In the current Internet, shortest-path routing is used. For the new applications, the researchers need to consider QoS routing. This research will study various QoS routing policies and quantify their complexity and merits.
(3) Explore various design and engineering issues for providing interdomain IP differentiated services across for multimedia applications on wide-area internetworks. To this end, the researchers will perform analysis and implementation of different differentiated service protocols and a prototype QoS video server will be developed.
The researchers will bring in a "new technology (e.g., differentiated service) to Hong Kong research communities and Internet industries so various ISP companies can benefit from the research result". They believe many meaningful wide-area Internet experiments can be carried out so as to further understand the needs and requirements of the next generation Internet applications.
(EE20001)

Design, Analysis and Implementation of Resource Allocation and Object Synchronization Protocols for Collaborative Distributed Multimedia System

- ✍ LUI Chi Shing John
- ❑ 1 January 2001
- ❖ CUHK Research Committee Funding (Direct Grants)

In this research project, the researchers propose to study some important design issues of a collaborative distributed multimedia system (CDMS). Namely:

(1) Resource allocation algorithms for various system resources such as the disk I/O bandwidth at the server, the network transmission bandwidth and the associated packet scheduling algorithms.
(2) Admission control policies for different clients to the CDMS so that their quality of service can be guaranteed. Note that depending on the type of multimedia services and the QoS requirement, the CDMS needs to employ different admission control policies.
(3) Object synchronization protocols for the same group of clients who are receiving the same session of multimedia services and that all these clients will have a consistent view of the environment.

The goal of this research is to help computer system designers or engineers to understand various design issues and different tradeoffs for designing a CDMS system. The researchers expect this research will contribute both to the body of theoretical knowledge and give insight to the system implementation in the fields of computer and information technologies, such as distributed multimedia system, high performance network and storage system.

Since this is a one year research, the researchers will dedicate their effort on the following:
(1) developing the theoretical foundation: for example, given the requirement QoS vector d, how can one derive the sufficient condition for the associated feasible admission region D so that they have an understanding about some feasible resource allocation policies.
(2) Develop and analyze a family of resource allocation policies. Specifically, the type of resource allocation policy that can utilize their proposed resource management technique(e.g., the class of data sharing policy).
(3) Design and analyze a family of object synchronization policies. Based on the methodology the researchers propose, design a set of threshold-based object synchronization policies that can be adaptive to the variation of network traffic and individual client's computation workload.
(EE20010)

A Multilingual Digital Video Content Hub

- ✍ LYU Rung Tsong Michael ● YEN Jerome (Dept of Systems Engineering & Engin. Management) ● WONG Wing Shing (Dept of Information Engineering) ● KWAN Tze Wan (Dept of Philosophy) ● Shen Vincent*
- ❑ 1 September 2000
- ❖ Funding from Other Sponsors ● Innovation and Technology Support Programme, ITF, Innovation & Technology Commission

The researchers propose to develop a multilingual digital video content hub for culture exchange and commercial deployment. Three key objectives are identified:

(1) Video Technologies - To conduct research, development, and experimentation of the Internet-based video technologies for additional functionality, increased flexibility, and improved performance.

(2) Applications - To develop new multimedia applications to utilize the new infrastructure or functionality.

(3) Contents – To develop the technologies to support collection, conversion, indexing, organizing, storage, and dissemination of multimedia material. These technologies support content creation in education, medicine, business and culture exchange, preservation of historical artifacts, etc.

This study will include development of automated systems and tools that will enable multilingual and multimedia information capture, search, retrieval, summarization and reuse. The followings are major deliverables for this project:

(1) Multilingual video segmentation, categorization, indexing, searching, cashing, delivery, and presentation techniques.

(2) Software enabling schemes for content creation, information summarization and dissemination, security authentication, and wireless access.

(3) A multimedia content hub for one or more applications in distant learning, financial news, virtual Hong Kong tour, telemedicine, and culture exchange.

It is expected to create significant impacts to both local and greater China communities, especially in supporting culture and information exchange in this region.
(EE20006)

Dependability and Security Paradigms for Mobile Agent Systems

- ✍ LYU Rung Tsong Michael
- ❑ 1 October 2000
- ❖ Research Grants Council (Earmarked Grants)

The subject of mobile software systems has been actively pursued recently, but the dependability and security for mobile agents remain unexplored and unsolved for many issues. In this project, the researchers propose to investigate dependability and security paradigms for mobile software agents regarding their architectural support, functionality, development, testing, and evaluation. They propose to engage fault tolerance, fault removal, and fault analysis mechanisms to assure mobile agent dependability, and to apply advanced security encryption techniques to achieve mobile agent security. The researchers will further discuss a

reliable and secure mobile agent supporting infrastructure which can be applied to mobile clients (e.g., wireless laptops) and distributed servers (e.g., CORBA). Finally, they investigate the application of this infrastructure to digital library systems and E-commerce applications.

This research is important to the software industry for the development, testing and quality assurance of reliable and secure mobile agent systems. It is particularly critical to the software acquisition, integration, and operation effort of most major industry in Hong Kong, including the software vendors who provide E-commerce and IT integration solutions, and the corporations whose daily operations rely on the dependability and security of these integrated services. As Hong Kong is committed to lead Asia in the IT arena and is devoted to become the world's E-commerce center, the investigation in this advanced project plays a crucial factor for the success of this mission.
(CU00193)

The Development of a Chinese Linux Operating System for Embedded System

- ✍ MOON Yiu Sang
- ❑ 1 October 2000
- ❖ Innovation and Technology Support Programme, ITF, Innovation & Technology Commission

In product development, many local electronics manufacturers have been suffering a very high cost for the embedded OS royalty. Some of them can't even meet the minimum quantity required by vendors and have to turn to distributors at a much higher cost but with less support. These constraints greatly cut the manufacturers' profit margins which are usually low because of tough competition. Moreover, without any access to the OS source codes, manufacturers are difficult to make appropriate customization to their wish. On the other hand, Linux is getting popular among users and developers worldwide. Besides its stability and speed, the best advantage of Linux is that it is free. The source codes for most Linux programs are freely available under the GNU General Public License with its Open Source policy. However, Linux is originally developed for desktop PCs. Effort has to be made to construct Linux for embedded system which has limited hardware resources but demands usually a small footprint, headless, multitasking and real time environment. For the Greater China market, Linux needs to be enhanced with both traditional and simplified Chinese capabilities. Hence, a project is proposed to develop a Chinese Linux for embedded system. The proposed OS will be developed in a more generic form so that many more local manufacturers can make use of it. An API library will be developed as the development tools. The funding requested is HK$3,448,000. The core development

takes 12 months with another 12 months for promotion and technical support. Hong Kong Productivity Council will lead the project and The Chinese University of Hong Kong will provide the core technology required.
(EE00961)

Recovery in Mobile Agent Systems

- ✍ NG Kam Wing ● Rothermel K*
- ❑ 1 January 2001
- ❖ Germany/Hong Kong Joint Research Scheme

Mobile agents are autonomous software processes which can move from node to node in a network to access services provided there and to communicate with other mobile agents. It is widely agreed that mobile agents in conjunction with WWW technology will provide the technical foundation for future electronic commerce. A prerequisite for the use of mobile agents in a commercial environment is, that agents have to be executed reliably, independent of communication and node failure. This research aims to provide solutions for the fault-tolerant execution of mobile agents. The research will involve combining and further developing complementary techniques on fault-tolerant agent execution currently under development at the University of Stuttgart and the Chinese University of Hong Kong.
(EE20026)

Study on Image-based Virtual Reality

- ✍ SUN Hanqiu ● HENG Pheng Ann ● WU En Hua* ● LIU Xuehui*
- ❑ 1 January 2000
- ❖ University of Macau

A 3D world created by a computer, where a person can explore the environment, or even manipulate the objects as real, has become known as Virtual Reality (VR). Numerous industries could benefit from the VR systems created. For instance, a walk-through environment with realistic scenery enables people to preview a real construction environment or famous tourist attraction; walking through a virtual museum enables people to visit cultural relics conveniently. Traditionally, a virtual environment is created by modeling the geometric and surface attributes of objects, along with environmental lights. Despite the tremendous effort which has been made in modeling the geometric environment as well as in rendering realistic images, it remains difficult or impossible to recreate much of the complex geometry and subtle lighting effects in the real world, and moreover to render them in real time, as required in VR applications. However, creation of a VR environment by image-based rendering in the implementation of recent VR applications, provides a promising way forward. The approach in this aspect shows great advantages in the ease of acquiring high quality imagery independent of the environment complexity, cheap computation for real time rendering, and ease of setting up the virtual environment without expensive equipment.

This project will conduct the study on various topics in Image-based Virtual Reality, through joint research with the co-investigators from Chinese University of Hong Kong, and Institute of Software, Chinese Academy of Sciences. The related topics include the acceleration of virtual environment construction through images, multiple view generation from static images, environment generation from Layered Depth Images, user interface in image-based VR, navigating a virtual environment (VE) composed from images etc. The project is expected mainly to produce study result of research papers on the study topics. In addition, implementation will be also conducted on the related aspects to prepare for the future implementation of application-oriented image-based VR systems.
(CS99924)

Real-time Rendering of Large-scale Complex Virtual Environments

- ✍ SUN Hanqiu
- ❑ 1 July 2000
- ❖ Zhejiang University

在從事交互行為動畫，虛擬現實，超媒體，計算機輔助手術，基於 internet 的可視化和漫游和機器人仿真等方面取得了一系列成困。提出了一個 relationbased 的交互行為動畫型。該模型從復雜動態場景中抽取基本元素，然後通過分層交互編輯合成各種行為。給出了基於姿態的虛擬手輸入及其面向 VR 應用的真實感模型。提出了快速的 P-Buffer 算法，基於圖象的碰撞檢測算法，基於幾何和圖象的混合式分布實時圖形繪制算法等系列算法。
(CS00410)

A Multisensory Virtual Environment for Dental Surgical Simulation and Training

- ✍ SUN Hanqiu
- ❑ 1 November 2000
- ❖ CUHK Research Committee Funding (Direct Grants)

With recent advances in medical visualization, physics-based modeling and virtual reality (VR), it is now feasible to develop new algorithms and systems for dental VR training and simulation as well as optimal preoperative planning. Currently, dentists rely primarily on clinical examinations and a preliminary CT scan for guidance in performing

complex dental procedures. Without image-guided feedback, dentists are entirely groping in the dark while performing the procedures that demand high skills and precise control around the critical area of tooth layers. Improper handling of complex procedures can cause serious long-term patient suffering and irreversible side effects. Traditional training of dental professionals uses plastic tooth models that cannot provide optimal surgical simulation and can cause extra environmental pollution, in addition to the expense of using physical materials. We need better VR training tools to promote professional standards for more complex dental care and clinical-oriented sensational training.

In this project, the researchers will investigate effective multisensory display methods for presenting tactile positioning information in real-time interaction. They will focus their study on optimal control of integrated modalities that can best assist multi-sensory surgical interventions. They will investigate the mechanisms that transfer pose-based input to interactive metaphors for cutting focused data volumes and virtual tools for multi-resolution surface interaction. The researchers plan to develop constrained tools that can aid dentists to focus on infected surgical areas. The outcome of this research will enhance clinical training of dental professionals & medical students in Hong Kong, and promote the medicine industry to further develop advanced VR tools and systems for low-cost health care applications.
(EE20011)

Hybrid Approach in Virtual Reality Based on a Combination of Graphics and Images

- ✍ SUN Hanqiu
- ❑ 1 January 2001
- ❖ University of Macau

A virtual world created by a computer, where a person can explore the environment, or even manipulate the objects as real, has become known as Virtual Reality (VR). Virtual world could be modeled in two ways, by graphics or images. By the first way, a virtual environment is created by modeling 3D objects with their geometry, along with environmental lights. By the second way, creation of a VR environment is through composition of images.

This project will conduct the study on the creation of virtual environments by a hybrid approach in combining graphics and image, through joint research with the co-investigators from Institute of Software, Chinese Academy of Sciences and Chinese University of Hong Kong. The project aims at the study of system architecture and related techniques involved in the hybrid virtual reality systems constructed based on both image and graphics. The system will demonstrate the feature of hybrid systems, the high complexity of environment, high quality of

images and favorable interactive response in image-based VR, and the flexibility in model construction and ease of 3D environment generation in graphics-based VR.

The project will focus on the study of the following three aspects. The first aspect is the reconstruction techniques of objects from their images. The reconstruction method for irregular objects and the algorithms of reconstruction based on shading information are also the research concern in this aspect. The second aspect is the techniques for the combination of image and graphics in modeling virtual environments. The study issues include the construction of hybrid virtual environment and its data structure, the mechanism of light field and environment image production in the walk-through process etc. The last aspect is the study for the interaction techniques in the hybrid system. The study in this aspect will focus on the interaction model for the hybrid system.
(CS00928)

Advanced Knowledge Discovery & Spatial-temporal Visualization for Georeferenced Information

- ✍ SUN Hanqiu ● LEUNG Yee (Dept of Geography & Resource Management) ● LEUNG Kwong Sak ● LIN Hui (Dept of Geography & Resource Management) ● Dr. Peng Qunsheng* ● Dr. Bao Hujun*
- ❑ 1 January 2001
- ❖ NSFC/RGC Joint Research Scheme

Georeferenced information is crucial for predicting events, monitoring disasters, and planning sustainable development.

The primary goal of this project is to develop and integrate intelligent decision support system and visualization system for knowledge discovery and decision making with georeferenced information. The researchers will focus on the development of novel methods in data mining and knowledge discovery in spatial data sets to further strengthen their capability in seeking underlying structures and relationships in data pertinent to decision making. The system capability will be further enhanced by the realistic, high-resolution and consistent model of a geographic site using as wide a range of information sources as possible. The environmental information will be seamlessly fused with other types of digital sources, which creates the virtual space for advanced decision making based on explosive visualization.
(CU00016N)

Accelerating High-quality Volume Visualization with Image-based Computer Graphics

- ✍ WONG Tien Tsin ● HENG Pheng Ann

❑ 20 July 2000

❖ Research Grants Council (Earmarked Grants)

As the medical imaging modalities, such as computed tomography, magnetic resonance and ultrasound, become less expensive and widely used, visualization of patients' volumetric data are performed on daily basis. The current technology in volume rendering suffers from high computational cost. To trade for rendering speed, most volume rendering systems sacrifice the image quality. Some of the important visual cues such as shadowing are omitted.

The researchers propose to develop a set of algorithms and a workable system that offers "high-quality" image while trying to preserve the interactive rate of response. By saying "high-quality", they mean that important visual cues will be accounted for. To accomplish the goal, image-based computer graphics will be employed to reduce the computation of traditional volume rendering. Transforming the volumetric data to image space will decouple the rendering speed from the volume resolution, and hence interactive rendering is possible. The efficiency of compression and rendering will be carefully considered to handle the increase of data capacity after transforming the volume rendering problem to image space.

The researchers believe the set of algorithms and the workable system developed in this project can improve the quality of health care, climate observation and other visualization applications in Hong Kong. The techniques developed will also contribute research areas of both image-based computer graphics and volume visualization.
(CU00186)

A General Rewiring Based Circuit Transformation Framework for Deep Sub-micron Designs

✎ WU Yu Liang

❑ 1 October 2000

❖ CUHK Research Committee Funding (Direct Grants)

Today's many newly emerged VLSI Design Automation (DA) challenges are originated from the growing dominant factor of interconnect delays in the circuit designs. This new issue is caused by the continual scaling down of the device feature size that moves towards very deep sub-micron domains. Under these new process technologies, the interconnect could now contribute as high as 80% of the whole circuit delays. As a result, the actual interconnect delays known at the final layout stage are doomed to deviate larger and larger from what were estimated during those earlier DA phases for the yet to be deeper sub-micron technologies. Due to the lack of synthesis technique directly designed for interconnect, most of today's commercial tools simply apply some very costly trial-and-error iterative approaches looping over wide DA cycles or adding buffers for fixing timing violations. Such an approach has been shown to be unsatisfactory or even painful. In this project, the researchers propose to develop a powerful circuit re-synthesis technique directly targeted for interconnect. Based on this new technique they will build a flexible framework adaptable to various DA optimization stages ranging from the logical to the physical design phases. This framework will make use of the researchers' newly developed circuit transformation techniques: GBAW (an Award winner technique) and IBAW. GBAW is a newly proposed extremely fast graph-based rewiring scheme, while IBAW is a general ATPG-based rewiring scheme. An effective coupling of these two rewiring schemes should be able to explore an open domain of better solutions for today's imminent DA challenges.
(EE20012)

"Extending APT Financial Modeling by State Space Approach, Kalman Filtering and Temporal BYY Learning"

✎ XU Lei

❑ 1 December 2000

❖ Research Grants Council (Earmarked Grants)

In a rapidly developing internet-based information processing era, to get an efficient computational financial market model will provide not only a theory for understanding capital market but also an effective practical technique for financial analysis, investment management and portfolio optimization. The arbitrage pricing theory (APT) is a well known theory in the literature of capital market modeling for the past two decades. However, it is a simple linear model that can only explain the equilibrium relationship between the observed price series and some underlying factors up to second order statistics. This proposal targets at developing a generalized APT model that can be used as an efficient computational model, with new features in four aspects. First, a dynamic model is added for temporal relationship of the factors, which leads to a typical state space model that has been well studied in the literature of control theory and signal processing. Based on this state space model, for the purpose of analyzing market underlying factor such as market capitalization, asset liquidity, price earning ration, interest rate sensitivity, ... etc, the Kalman filter can be used to adaptively predict the dynamic changes of these fundamental factors. Second, high order statistical relations between the observed price series and those underlying factors are taken into consideration in help of temporal BYY learning and some recent rapid advances on independent component analysis. The new tools are more

powerful than the traditional factor analysis method on which the APT is currently based on. Third, based on the recent results for model selection in the literature of statistical learning, effective criteria will be developed for determining the number of factors and for selecting a set of appropriate numbers. Finally, a further extension to a nonlinear APT model will be studied for modeling complicated relation between financial observations and factors. (CU00169)

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

                                  Faculty of Engineering

1998-99 Adaptive Transform Domain Video Indexing (EE98010)
  ✎ LEE Moon Chuen ● ADJEROH Donald#

1999-00 Adaptive Transform Domain Video Indexing (EE99011)
  ✎ LEE Moon Chuen

1998-99 Architectures and Implementations of Constraint Systems on FPGA Hardware (EE98011)
  ✎ LEONG Philip Heng Wai

1998-99 Soft Constraint-Based Scheduling in Intelligent Multiagent Systems (CU98304)
  ✎ LEUNG Ho Fung ● LEE Ho Man Jimmy ● CLARK K. L.*

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

1998-99 Using Evolutionary Computation on Large Scale Information Fusion (ED98004)
  ✎ LEUNG Kwong Sak

1999-00 To Develop a New Class of Fast Genetic Based Evolutionary Algorithms Using Splicing/Decomposable Representation Scheme and Exclusion-based Operators (EE99012)
  ✎ LEUNG Kwong Sak

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)
  ✎ LUI Chi Shing John

1999-00 Design, Analysis and Implementation of Mixed Workload Schedulers with Application to the Multimedia Digital Library System (CU99430)
  ✎ LUI Chi Shing John

1998-99 Structure-Based Software Reliability Modeling Techniques (EE98003)
  ✎ LYU Rung Tsong Michael

1999-00 Architecture-based Software Reliability Engineering Techniques (CU99432)
  ✎ LYU Rung Tsong Michael ● LAPRIE Jean Claude*

1999-00 Architecture-based Techniques and Tools for Software Reliability Engineering (EE99030)
  ✎ LYU Rung Tsong Michael ● KANOUN Karama*

1999-00 The Effect of Diversity in Large-scale Distributed Systems (EE99033)
  ✎ LYU Rung Tsong Michael ● LORENZO Strigini* ● BEV Littlewood*

1998-99 Design Framework and Tools for Reconfigurable Computing (EE98043)
  ✎ NG Kam Wing ● LUK Wayne*

1999-00 High-level Synthesis Framework and Tools for Dynamically Reconfigurable Systems (CU99408)
  ✎ NG Kam Wing ● LUK Wayne*

1994-95 Research on a New Class of Optimization Problems Related to the Handling of Elastic 3-D Objects by Robots and Its Application in Industry (CS95008)
  ✎ WONG Chak Kuen ● LEUNG Kwong Sak ● HUI Kin Chuen (Dept of Auto. & Computer-Aided Engin.) ● LEUNG Yee (Dept of Geography & Resource Management) ● ALBRECHT Andreas*

1998-99 On Algorithmic Fundamentals of Computer-Assisted Medical Diagnosis (CU98010)
  ✎ WONG Chak Kuen

1999-00 New Stochastic Approaches for Job Shop Scheduling (CU99367)
  ✎ WONG Chak Kuen

1999-00 Parallel and Distributed Computing for Job Shop Scheduling (EE99037)
  ✎ WONG Chak Kuen ● ALBRECHT Andreas Alexander ● U. Geske*

1999-00 Applying Computer Vision Techniques in the Construction of a Virtual Walk-through System (CU99389)
  ✎ WONG Kin Hong ● OR Siu Hang

1997-98 Recovery for Transaction Failures in Object-Based Databases (CU97559)
  ✎ WONG Man Hon ● FU Wai Chee Ada

1998-99 Indexing Methods for Sequence Data Searching (EE98016)
  ✎ WONG Man Hon ● FU Wai Chee Ada

1999-00 Indexing Methods for Numeric Sequence Databases (CU99437)
✍ WONG Man Hon

1999-00 Interactive Illumination Control for Image-based Computer Graphics (EE99009)
✍ WONG Tien Tsin

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 Tree-Structure Based Synthesis for Psendo-Exhaustive VLSI Testing (EE98017)
✍ WU Yu Liang

1999-00 A Performance-driven Synthesis System Targeted for Deep Sub-micron Technology (CU99412)

✍ WU Yu Liang ● WONG Chak Kuen ● MAREK-SADOWSKA Malgorzata* ● HONG Xian Long*

1998-99 Adaptive Learning for Temporal Radial Basis Function Network and Financial Investment Analysis Environment on Microsoft Window (CU98297)
✍ XU Lei

1999-00 High Dimensional Data Mining and Visualization: An Integrated Approach and Financial Data Mining Application (CU99383)
✍ XU Lei

1999-00 A Unified Method to Handle all Placement Constraints in Floorplan Design (EE99008)
✍ YOUNG Fung Yu ● CHU Chris C. N.*

RESEARCH OUTPUTS AND PUBLICATIONS

<P996376> **TSANG Ping Ki; CHEUNG Chak Chung; LEUNG Ka Ho; LEE Tak Kwan and LEONG Philip Heng Wai.** "MSL16A: An Asynchronous Forth Microprocessor". *Proceedings of the IEEE Region 10 Conference (TENCON)* vol.2, pp.1079-1082. IEEE, 1999.

<P996631> **LAO Tze Kin; WONG Kin Hong; LEE Kam Sum and OR Siu Hang.** "Automatic Generation of Virtual Environment from Vertical Panoramic Image". *Proceedings of the International Conference on Imaging Science, Systems, and Technology (CISST 2000)* vol.II, pp.373-379. CSREA Press, 2000.

<P996760> **OR Siu Hang; WONG Kin Hong; LEE Kam Sum and LAO Tze Kin.** "Segmenting Video by Panorama and Color Mixture Models". *Proceedings of the International Conference on Imaging Science, Systems, and Technology* vol.II, pp.653-658. CSREA Press, 2000.

<P999319> **CHEUNG Chi Chiu and XU Lei.** "Some Global and Local Convergence Analysis on The Information-theoretic Independent Component Analysis Approach". *Neurocomputing* vol.30, pp.79-102. Elsevier Science B.V., 2000.

<P999488> **CHUNG Chu Keung and LEONG Philip Heng Wai.** "An Architecture For Solving Boolean Satisfiability Using Runtime Configurable Hardware". *Proceedings of the 1999 International Workshops on Parallel Processing* pp.352-357. IEEE, 1999.

<P999505> **LAI Zhibin; CHEUNG Yiu Ming and XU Lei.** "Independent Component Ordering in ICA Analysis of Financial Data". *Computational Finance* pp.201-212. London, UK: MIT Press, 1999.

<P001957> **Fu, Ada Wai-Chee; Renfrew Wang-Wai Kwong and Jian Tang.** "Mining *N*-Most Interesting Itemsets". Paper presented in the 12th International Symposium on Methoodologies for Intelligent Systems (ISMIS), organized by Springer-Verlag. North Carolina, USA, 2000.10.

<P001981> **Wong, Wai-Chiu and Ada Wai-Chee Fu.** "Incremental Document Clustering for Web Page Classification". Paper presented in 2000 Int. Conf. on Information Society in the 21st Century: Emerging Technologies and New Challanges. Japan, 2000.11.

<P001982> **Cheung, David W.; H.Y. Hwang; Ada W. Fu and Jiawei Han.** "An Efficient Rule-Based Attribute-Oriented Induction for Data Mining". *Journal of Intelligent Information Systems, An International Journal* vol.15 no.2, pp.175-2000. 2000.09.

<P002167> **Wong, Man Leung; Wai Lam; Kwong Sak Leung; Po Shun Ngan and Jack C.Y. Cheng.** "Discovering Knowledge from Medical Databases Using Evolutionary Algorithms". *IEEE Engineering in Medicine and Biology 22nd Annual International Conference Magazine* vol.19 no.4, pp.45-55. Chicago, Illinois, 2000.07.

<P002893> **LEUNG Matthew; LUI John and YAU David.** "Characterization and Performance Evaluation for Proportional Delay Differentiated Service". *Proceedings of the International Conference on Network Protocols 2000* ed. by Pradip Srimani. pp.295-337. Osaka, Japan: IEEE Computer Society, 2000.11.

<P003681> **LEE T.O. and NG K.W.** "A Componentware for Distributed Agent Collaboration". *Proceedings of the 11th International Workshop on Database and Expert Systems Applications* pp.780-784. London: IEEE Computer Society, 2000.09.

<P003682> **ZHANG Xue-Jie; NG Kam-Wing and LUK Wayne.** "A Combined Approach to High-Level Synthesis for Dynamically Reconfigurable Systems". *LNCS 1896: Field-Programmable Logic and Its Applications* ed. by HARTENSTEIN Reiner W. and GRUNBACHER Herbert. pp.361-370. Springer-Verlag, 2000.

<P003683> **CHUNG Lui-Ming and NG Kam-Wing.** "Protecting Mobile Agents Against Tampering". *Proceedings of the ICSC Symposia on Intelligent Systems & Applications (ISA'2000)* ed. by Naghdy F., et al. p.7. Wollongong, Australia: ICSC Academic Press, 2000.12.

<P003750> **LEUNG K.W.; CHEN K.Y. and NG K.W.** "A Micropayment System Using Mobile Agents and Smart Cards". *Proceedings of the ICSC Symposia on Intelligent Systems & Applications (ISA'2000)* ed. by NAGHDY F., et al. p.7. Wollongong, Australia: ICSC Academic Press, 2000.12.

<P003947> **MOON Yiu Sang and NG Ka Lung.** "Biometric and Smartcard Security System" 12 pgs. 2000.07.31.

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RESEARCH PROJECTS

900 and 1800 MHz Digital Controlled Oscillators for Wireless Communication

- ✎ CHAN Cheong Fat ● CHOY Chiu Sing Oliver
- ❑ 1 September 2000
- ❖ Research Grants Council (Earmarked Grants)

In modern digital communication circuits, a conventional analog voltage-controlled oscillator (VCO) is replaced by a digital-controlled oscillator (DCO). A DCO changes its output frequency according to the binary weight of a digital control signal. A typical control signal is around 4 to 8 bits, with a resolution between 16 and 64. The major drawbacks of existing DCO designs are limited resolution and bandwidth. In addition, a DCO is very difficult to design, a typical DCO design requires several hundred more transistors than a VCO.

The researchers propose a new type of digital-controlled oscillator based on an Injection Oscillator technique. This new DCO circuit preserves all the advantages of a conventional VCO, such as simple design, for example less than 30 transistors for most applications, and higher resolution and bandwidth. In addition, the new circuit also has the added advantage that the output signal can be phase locked to a control signal. This new capability simplifies the design of digital communication circuits. The researchers design the new DCO with state of the art 0.35 micron and 0.6 micron CMOS technologies for 1.8 GHz and 900 MHz wireless communication applications.
(CU00218)

High-energy and High-repetition Rate Mode-locked Fiber Laser

- ✎ CHAN Kam Tai
- ❑ 1 October 2000
- ❖ CUHK Research Committee Funding (Direct Grants)

High-energy pulsed fiber lasers are of interest for various applications in medicine, range finding, remote sensing, optical communication systems and in particular nonlinear optics. It is because they have high pulse energy, ultra-short pulse width, broad spectrum, high repetition and quantum-limited pulse-to-pulse timing jitter. Moreover, they are potentially compact, stable and relatively inexpensive. Therefore, they have obtained much more attention recently. A novel technique for generating high-energy and high repetition rate pulses from an all-fiber structure is proposed here. In general, there are the two principal techniques for increasing pulse energy of fiber laser. One is using double-clad rare-earth-doped fiber as the gain medium, which can

decrease the cost of the laser and increase the pulse-energy. The other is utilizing special dispersive fiber devices to adjust the laser cavity's dispersion, thereby enabling the formation of higher pulse energies. The researchers will utilize the two techniques respectively in both an actively mode-locked fiber laser and a hybrid-type actively and passively mode-locked fiber laser for the first time. High pulse-energy will be obtained with all of the advantages of actively mode-locked fiber lasers or hybrid lasers. Next the researchers will combine the two techniques, that is they will introduce the dispersive devices into the laser with double-clad fiber, which will be helpful to obtain pulses with higher energy. Lastly, the researchers will optimize the novel laser structures in order to achieve high repetition rates, narrow pulse-widths and operational stability.
(EE20013)

Harmonic Tuning of Source and Load Impedance to Improve Phase Linearity of Microwave Power Amplifiers for Wireless Digital Communications

- ✎ CHENG Kwok Keung Michael
- ❑ 1 December 2000
- ❖ Research Grants Council (Earmarked Grants)

Future generation of wireless communication systems will support data rates many orders of magnitude higher than today's mainly voice applications. They will accomplish this with spectrally efficient modulation schemes, such as multi-level quadrature amplitude modulation (QAM) and also pack more channels into the available frequency band. While these modulation schemes have greater spectral efficiency, they are non-constant envelope signals and are subject to spectrum re-generation of power outside the transmission channel that gives rise to interfering signals in other channels. In addition, this same phenomenon creates in-band interference that causes increased bit error rate (BER). The origin of spectral regrowth is the nonlinearity of power amplifiers. Saturation and distortion in amplifiers cause an increase in spectral regrowth as input power increases. In the past, system designers have relied on output back-off of the RF power amplifier (PA) to ensure acceptable distortion performance. However, output back-off suffers from poor efficiency, poor output power and tight cooling requirement. In this project, a new circuit technique is proposed to reduce spectral regrowth in power amplifier operating near saturation. Optimization of source and load impedance at multiple harmonic frequencies is employed to compensate simultaneously for both spectral widening and constellation warping and clustering.
(CU00210)

Design of an IP Asynchronous Cross-pipelined 16x16-bit Multiplier

- ✍ CHOY Chiu Sing Oliver
- ❑ 1 January 2001
- ❖ CUHK Research Committee Funding (Direct Grants)

To build tomorrow's complex chips (system_on_chip), designs will rely on pre-designed cells (IPs). These IPs must be technology-independent (work in any fabrication process) and functional in a wide range of operation conditions. The asynchronous technique can satisfy these requirements and can also solve some problems of synchronous designs, which result from requirements of increasing device speed and lower power consumption. The problem of higher speed is mainly connected to clock skew problems and other aspects like worst case performance. The feature of asynchronous design, that energy is consumed only in the parts of the circuit with data activity can significantly influence power consumption. This is why asynchronous design has gained significant popularity in recent years.

The main objective of this proposal is to design an IP asynchronous 16x16-bit multiplier and in this way support the researchers' ongoing research in the area of asynchronous circuit technique, which has the potential of solving clock skew problem in today's synchronous circuits. For the proposed multiplier the researchers' estimate throughput speed is around 400 MHz, translating to two new multiplicands every 2.5ns. The multiplicands can be entered at different times from two different sources. It should be suitable for a DSP processor which requires high-speed arithmetic block to achieve high performance. The multiplier belongs to the category of self-timed circuit, where speed is normally self-adjustable to temperature, power supply and variation of technology parameters.

In this design the researchers want to use a new handshake designed in their laboratory. The handshake is designed to communicate in a four-phase protocol. The handshake generates signals to control evaluation, precharge and hold periods of dual-rail coded dynamic logic stages. This coding increases the silicon area for the logic part. However, the handshake replaces the clock distribution tree of synchronous circuits, where the clock distribution can occupy as much as 25% of the whole chip. The researchers' design technique promises high through-put and testability.

In addition, the researchers want to create cell library of our handshake circuits and dynamic logic cells. This should provide possibilities for automatic layout generation and it should open the way for designing other complex circuits based on the new handshake. To achieve technology-independence, they intend to describe the multiplier with a hardware description language called VERILOG so that the multiplier can be synthesized from the library.

For verification, the researchers want the multiplier to be fabricated in AMS 0.6 µ m CMOS technology, tested and compared with other current designs. (EE20014)

New Heterojunction Bipolar Transistors (HBT) with GaAsSb base for Wireless Communication Applications

- ✍ HSU Chung Chi
- ❑ 1 October 2000
- ❖ Research Grants Council (Earmarked Grants)

A1GaAs/GaAs HBTs have been widely used as the power amplifiers in mobile phones. The power amplifier is the most power-consuming part of the phone. Any improvement in the efficiency of the power consumption may help to increase the talk time, to reduce the battery/phone weight and size. In this project, the researchers will investigate two kinds of HBTs, which have better performance than the A1GaAs/GaAs HBT for wireless applications: the InP/GaAsSb/InP Double HBT and the GaAs/GaAsSb DHBT. (CU00212)

Development of a Cantonese Text-to-Speech System with High Naturalness

- ✍ LEE Tan ● MENG Mei Ling Helen (Dept of Systems Engineering & Engin. Management) ● ZEE Yun Yang Eric*
- ❑ 1 October 2000
- ❖ Research Grants Council (Earmarked Grants)

This project focuses on developing advanced text-to-speech (TTS) technology for spoken *Cantonese*, the most commonly used language in Hong Kong and Southern China. TTS technology is used to automatically convert text materials into acoustic speech signals. It enables direct, efficient and instantaneous delivery of pre-stored information from computer to human users through the natural human communication modality of speech. Many existing TTS systems are capable of producing synthetic speech with fairly good *intelligibility*. However, they often "don't sound natural". This project places strong emphasis on achieving *high naturalness* of synthetic speech. The researchers believe that the degree of perceived naturalness is crucial for TTS technology to be widely accepted in its many practical applications.

Naturalness of synthetic speech is determined by a number of factors, among which *prosody* has been generally regarded as being predominant. Prosodic parameters refer to the overlaid linguistic functions of the inherent acoustic features of speech sound segments, include timing, tone/intonation, and stress. Proper control of the prosodic parameters is the key

to making synthetic speech sound natural. This project addresses the problem of establishing such prosodic control in the process of synthesizing highly natural Cantonese speech.

Cantonese has many special linguistic features that present unique challenges to the researchers' investigation. This project is made successful via the collaboration between experienced linguists and speech engineers. As Cantonese is a typical Chinese spoken dialect, the researchers anticipate that the methodologies developed and the experiences acquired in this research can be readily applied to the other major Chinese dialects.
(CU00219)

A New Family of Electrically Wavelength-tunable Semiconductor and Fiber Lasers

✍ SHU Ching Tat C. ● TSANG Hon Ki ● CHIANG Kin Seng*

❑ 1 November 2000

❖ Research Grants Council (Earmarked Grants)

Wavelength-tunable laser sources are important for applications in different disciplines of science and engineering including optical sensing, spectroscopic measurements, optical communications, and optical testing of fiber components. While most commercial laser systems are tuned by piezo-electric control of the mechanical movement of a diffraction grating, the tuning speed is limited to about 100 nm/s. In this project, the researchers propose a new method of compensated dispersion-tuning applicable to both semiconductor and fiber lasers. The tuning mechanism is entirely electrical and does not depend on any mechanical movement. Preliminary studies show a tuning speed improvement upto several orders of magnitude. Other advantages offered by this tuning scheme include increased output stability and reproducibility, potential applications in high-speed wavelength switching, and fiber-optic configurations for convenient system assembly and handling. Unlike the use of multi-section DFB or DBR lasers, electrical wavelength-tuning can be performed over a large spectral range without depending on complicated device structures and parameters, thus relaxing the requirement for sophisticated design and crystal growth, as well as stringent fabrication steps.
(CU00220)

Measurement of All-optical Nonlinearities in Ion-Implanted Materials

✍ TSANG Hon Ki ● WONG Sai Peng Joseph

❑ 18 December 2000

❖ Research Grants Council (Earmarked Grants)

The project involves an experimental study of the nonlinear optical properties of novel silicon/silica based materials in order to assess their suitability for making ultrafast all-optical switches needed in future communication networks. Unlike previous studies, the proposed work will focus on the wavelength range of interest for optical communications. The proposed work will include measurement of the nonlinear optical properties (principally the Kerr coefficient and two photon absorption coefficient) and an assessment of the feasibility of and, if feasible, a demonstration of a nonlinear optoelectronic device e.g. an ultrafast all-optical switch.
(CU00221)

The Formation of Metal Nano-clusters in Dielectric Materials by Ion Gettering

✍ WILSON Ian Howard ● XU Jianbin

❑ 1 October 2000

❖ Research Grants Council (Earmarked Grants)

Metal quantum-dot composites (MQDCs), i.e. nano-sized metal (e.g. Ag, Au, Ct etc) clusters embedded in dielectric materials such as $LiNbO_3$, Al_2O_3 and glasses have attracted growing attention and interest from the point of view of both fundamental science and the development of new materials. Optical properties can be altered through the presence of nano-clusters due to quantum and dielectric confinement effects. These effects make it possible to tailor the optical properties of dielectric materials in a controllable way.

Ion gettering is currently being used to trap intrinsic oxygen and metallic impurities in Si by the formation of nano-cavities. These are produced by implanting light elements such as hydrogen and helium. Intuitively this method could be used to fabricate MQDCs but has not yet been explored. Therefore, the researchers will study the synthesis of MQDCs by ion gettering forming nano-cavities as the templates for nano-metal clusters.
(CU00215)

Nano-granular Metal-carbon Thin Films by Pulsed Filtered Vacuum Arc Deposition

✍ WONG Sai Peng Joseph

❑ 16 October 2000

❖ Research Grants Council (Earmarked Grants)

This project aims to synthesize novel nano-granular metal-carbon films using a newly developed Pulsed Filtered Vacuum Arc (PFVA) deposition method, to understand their properties, and to explore their potential applications. The PFVA system is a unique custom-designed system equipped with multiple arc sources various characterization techniques, including Rutherford back scattering spectrometry, x-ray diffraction, transmission election microscopy, scanning probe microscopy, electric, magnetic, and

optical measurements, will be employed to study the micro structural, electrical, magnetic and optical properties of these films, and to investigate how these properties vary with their composition and processing conditions.
(CU00216)

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

- ? WU Ke Li ● CHENG Kwok Keung Michael
- ❑ 1 September 2000
- ❖ Research Grants Council (Earmarked Grants)

This research proposal aims at developing simulation and design capabilities for advanced Multi-Chip Module technology for wireless communication. Three key issues concerning simulation and design 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.
Building up the design capability will not only benefit 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 application-specific integrated circuits (ASIC's).
(CU00213)

Size Effects of SrBi2Ta2O9 (SBT) Ferroelectric Thin Films

- ? XU Jianbin ● WILSON Ian Howard ● WONG Sai Peng Joseph
- ❑ 1 October 2000
- ❖ Research Grants Council (Earmarked Grants)

Research into and development of ferroelectric thin films is currently attracting worldwide attention because of their potential commercial application to a new generation of novel devices. Prime among these applications are non-volatile ferroelectric random access memories (NVFRAMs) that have high speed and extended endurance. The core of an NVFRAM is a capacitor composed of a ferroelectric film sandwiched between the two electrodes. The feroelectric layer can maintain an induced polarization after switching off the inducing field.

This is the important property: the non-volatility of NVFRAMs.
In the past two years, the researchers have developed a state-of-the-art processing technology for fabricating high quality $SrBi_2Ta_2O_9$ (SBT) films, one of two candidates for NVFRAM commercialization. Size effects are associated with degradation phenomena in the submicrometer NVFRAMs. To study the size effects, local structural and electrical properties of samples, techniques with high spatial resolution, including scanning probe microscopies (SPMs) will be used. In this project, the researchers propose to investigate the size effects in $SrBi_2Ta_2O_9$ (SBT) thin films by the state-of-the-art processing technology and characterization facilities that have been developed by The Chinese University of Hong Kong group.
(CU00214)

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

Edition	Title/Investigators
1998-99	High Repetition Rate Fiber Laser Source with Ultrashort Pulse Duration for Very Large Capacity Optical Communication (CU98311) ? CHAN Kam Tai ● LI Shenping# ● LOU Caiyun*
1999-00	A Smart Wireless Telemetry System for Remote Metering Application (EE99002) ? CHAN Kam Tai
1999-00	Stability Improvement Studies of Harmonic Active Mode-locking of Fiber Ring Lasers (CU99434) ? CHAN Kam Tai ● HO HO-pui, Aaron*
1999-00	Design of Low Intermodulation Distortion Microwave Active Bandpass Filters (EE99013) ? CHENG Kwok Keung Michael
1996-97	Development of an Automatic Recognition System for Continuous Cantonese Speech (CU96509) ? CHING Pak Chung
1998-99	Wavelet Packet Division Multiplexing (CU98105) ? CHING Pak Chung ● WONG Kon Max
1999-00	Chinese Speech Recognition Infrastructure for Hong Kong's Technology Developers (EE99005)

✍ CHING Pak Chung ● MENG Mei Ling Helen (Dept of Systems Engineering & Engin. Management) ● LEE Tan

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

1999-00 To Develop a New Asynchronous Architecture Based on a High-speed Micro-coded Processor Core for Realizing DSP Algorithms (EE99014)
✍ CHOY Chiu Sing Oliver

1998-99 A Study of Metalorganic Chemical Vapor Deposition (MOCVD) Using Nitrogen as the Carrier Gas (CU98346)
✍ HSU Chung Chi ● XU Jianbin

1999-00 Automatic Speech-to-Speech Conversion Between Cantonese and Putonghua (EE99015)
✍ LEE Tan

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

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

1999-00 Novel Wavelength-tunable Devices for Broadband Optical Communications (EE99034)
✍ SHU Ching Tat C. ● MARSH H. John*

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

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

1999-00 Ultrafast Optical Characterization of New Semiconductor Materials for Optoelectronics (EE99016)
✍ TSANG Hon Ki

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

1998-99 3D Shape Reconstruction from an Image Sequence Captured by a Hand-Held Camera (CU98310)
✍ TSUI Hung Tat ● ZHANG Zhongying#

1999-00 3-D Model-based Video Coding for Videoconferencing Applications (CU99402)
✍ TSUI Hung Tat ● CHAM Wai Kuen ● NGAN King Ngi*

1998-99 Probing the Interface of Diamond Like Carbon/Magnetic Layers by Conducting Atomic Force Microscopy (CU98175)
✍ WILSON Ian Howard ● XU Jianbin ● YAN Xiao*

1999-00 Investigation of Oxygen and Hydrogen Diffusion in Ferroelectric Thin Film Memory Devices by Using Ion Beam Analysis (CU99373)
✍ WILSON Ian Howard ● XU Jianbin

1999-00 Smart Antenna Technologies for Wireless Communication Systems (EE99010)
✍ WILSON Ian Howard ● CHENG Kwok Keung Michael ● WONG Kainam Thomas# ● WONG Kon Max*

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

1999-00 Electrical Transport Properties of Ion Beam Synthesized Low Dimensional Metal Silicide Structures (CU99405)
✍ WONG Sai Peng Joseph

1999-00 Ion Beam Synthesis of Silicon Carbide (EE99035)
✍ WONG Sai Peng Joseph ● Dr. Lindner J. K. N.*

1999-00	Simulation and Design Methodology of Advanced Multi-chip Module (MCM) System for Wireless Communication Applications (EE99007) ✍ WU Ke Li

1998-99 Investigation of Carbon Nanotubes by Modified Atomic Force Microscopy (EE98024)
✍ XU Jianbin ● WONG Sai Peng Joseph ● WILSON Ian Howard

1999-00 Design Methodology of Advanced Multi-chip Modules Using LTCC Technology for Wireless Applications (EE99040)
✍ WU Ke Li ● CHENG Kwok Keung Michael

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

1999-00 Passivation and Oxidation of Group IV Semiconductors Studied by Scanning Probe Microscopy (CU99390)
✍ XU Jianbin ● KWOK Wai Man Raymund (Dept of Chemistry) ● WILSON Ian Howard ● Devine R.A.B.*

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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RESEARCH PROJECTS

DINA Implementation

- ✍ CHEUNG Kwok Wai ● LUI Chung Yu (Centre for Innovation and Technology)# ● ZHOU Qun (Centre for Innovation and Technology)
- ❑ 1 March 2001
- ❖ Dinastech (HK) Limited

DINA is a newly developed large-scale VOD system which is based on several innovative patent-pending hybrid multicast-unicast streaming technologies that offer a lot of advantages over the current unicast based systems. In fact, the DINA architecture is a uniquely new way of providing large-scale VOD services in a cost-effective manner. First, the DINA architecture is a unique mix of centralized clustering and distributed networking that reduce the total system resources and backbone network bandwidth required, thus it tremendously lowers the overall engineering and service provisioning cost. Second, the DINA architecture allows the end users to perform any interactive functions without delay. Third, the system adopts a server array cluster approach that allows for more system capacity, higher scalability, and greater fault tolerance. (EE20027)

System Limitations of Optical Netwroks due to Crosstalk

- ✍ HO Keang Po Ricky ● CHEN Lian Kuan ● TONG Fuk Kay Franklin
- ❑ 1 July 2000
- ❖ Research Grants Council (Earmarked Grants)

Wavelength-division-multiplexed (WDM) based optical networks are indispensable to accommodate the exponential growth of data traffic due to the expansion of Internet. The performance of WDM optical networks is limited by crosstalk interference evolved from various sources, including homodyne crosstalk with the same wavelength, heterodyne crosstalk with different wavelength, various fiber nonlinearity effects, and their combination. This project focuses on the studies of homodyne crosstalk and nonlinear crosstalk arising from cross-phase modulation (XPM) and stimulated Raman scattering (SRS). The objectives are to derive very simple and useful analytical formulae for the optical network degradation and verify them by experimental measurement. While crosstalk interference is very difficult to analyze, the researchers' models are based on the statistical properties of crosstalk and some reasonable assumptions. (CU00225)

Hong Kong IP Multicast Initiative

- ✍ LEE Yiu Bun ● CHEN Lian Kuan ● LUI Chi Shing John (Dept of Computer Science and Engineering)
- ❑ 1 October 2000
- ❖ Funding from Other Sponsors ● Innovation and Technology Support Programme, ITF, Innovation & Technology Commission

This proposal aims at establishing a Hong Kong IP Multicast Initiative to jump-start the local IT industry to take advantage of the emerging IP multicast technologies. The overall goal is to improve the existing and to incubate new network services and applications to exploit benefits of IP multicast. Specific project objectives are listed below:
(1) to deepen local industry's know-how on multicast technologies through seminars, exhibitions, and the setup of an industry consortium;
(2) to setup an Inter-Operability Test-bed to verify compatibility and performability of multicast network hardware/software, with special consideration for the requirements of Hong Kong and the Greater China;
(3) to develop the essential tools to enable a service provider to manage network resources for multicast applications;
(4) to develop two demonstrative multicast-enabled applications to demonstrate the feasibility and superiority of multicast technologies.
Through education, training, and technology transfer, multiple local industry sectors will be benefited. These include Network Infrastructure Providers, Network Services Providers, Content Providers, Technology Providers, and ultimately the end-users. (EE20005)

Study of a Unified Architecture for Video-on-Demand Services

- ✍ LEE Yiu Bun
- ❑ 1 October 2000
- ❖ CUHK Research Committee Funding (Direct Grants)

Current video-on-demand (VoD) systems can be classified into two categories: true-VoD (TVoD) and near-VoD (NVoD). TVoD systems allocate a dedicated channel for every user to achieve short response time so that the user can select what video to play, when to play it, and perform interactive VCR-like controls at will. By contrast, NVoD systems transmit video streams repeatedly over multiple broadcast or multicast channels to enable multiple users to share a single video channel so that system cost can be substantially reduced. The

tradeoffs are limited video selections, fixed playback schedules, and limited or no interactive control.

TVoD systems can be considered as one extreme where service quality is maximized, while NVoD systems can be considered as the other extreme where system cost is minimized. The researchers propose a novel architecture (UVoD) that unifies the existing TVoD and NVoD systems by integrating multicast with client-side caching. In this research programme, the researchers investigate various architectural alternatives for UVoD and analyze their performance. Early results have already shown that the proposed UVoD architecture not only unifies TVoD and NVoD, but also exhibits significant performance gains (e.g. 400% more capacity for a 500-channel system) over TVoD under the same resource and latency constraints.
(EE20016)

Telecommunication Network Research

- ✍ LI Shuo-yen Robert
- ❑ 1 December 1995
- ❖ MTK Computers Ltd.

This project will undertake general research on the subject of "Telecommunication in the 21ˢᵗ Century". All work will be aimed at uniquely world-leading technology that is in market demand.
(EE95746)

Integrated Retransmission and Adaptation Scheme for Video Streaming over Legacy and Advanced Internet with QoS Guarantee

- ✍ LIEW Soung Chang ● LEE Yiu Bun
- ❑ 1 September 2000
- ❖ Research Grants Council (Earmarked Grants)

During the transition to broadband, the Internet will consist of legacy networks in which packets are delivered on a best-effort basis and advanced networks in which various grades of QoS (Quality of Service) are provided. What is needed is a framework for video streaming which incorporates situations ranging from no QoS guarantee to strict QoS guarantee.

In the current Internet, when network congestion occurs, packets are discarded and the video sender may attempt to retransmit them so that the receiver has a second chance of receiving them, avoiding degradation in video quality. Such retransmission also adds to the overall network traffic and may exacerbate network congestion and jack up packet loss rate even further. The greedy actions of individual sessions will bring about worse video quality for everyone. Under severe traffic congestion, it is more appropriate for video senders to go the other way: not only not retransmit, but also decrease the transmitted data rate (hence quality) voluntarily. However, it has also been observed that even without congestion, sporadic packet loss is normal. A question remains as to when retransmission should be tolerated and when adaptation should be effected. The researchers believe a more fundamental question to be asked is to what extent bandwidth available to a session is stable, and retransmission and adaptation should tune to this factor. For instance, to the extent that strong QoS guarantee is available and exclusive bandwidth is assigned to each and every video session, there will be no need for adaptation and retransmission.

This study aims:

(1) to establish a framework to integrate retransmission and adaptation to optimize video quality in legacy Internet; and

(2) to use the framework as a basis to study the same for future Internet in which different grades of QoS guarantee are available.
(CU00229)

Adaptive Transmitter Design for Wideband Communication

- ✍ LOK Tat Ming
- ❑ 1 November 2000
- ❖ CUHK Research Committee Funding (Direct Grants)

With the ever-increasing demand for multimedia communication, future wireless communication systems would necessarily be wideband communication systems capable of supporting high data rates. On the other hand, the usable frequency spectrum is quite limited. Communication engineers have been striving to increase the number of allowable users in these wideband systems. Previous efforts mostly focus on receiver design where different interference suppression receivers, possibly with antenna arrays, have been proposed. While these receivers can improve the performance of the communication systems, further improvement can be obtained if the transmitted signals are suitably designed to match with the conditions of the communication channels. In this project, the researchers will develop and investigate adaptive transmission algorithms. The transmitted signals are adaptively driven according to the conditions of the communication channel. The goals are to avoid the impairments of the channel, to support multirate transmission for each user, and to increase the total number of allowable users. Both centralized and decentralized adaptive transmission algorithms will be investigated. The results can be applied to future personal communication systems, as well as ad hoc communication systems that may be deployed in the ISM bands.
(EE20017)

Faculty of Engineering

Mobile Communication Enhancement through Fast Adaptive Signal Processing

- ✍ MOORE John Barratt
- ❑ 1 September 2000
- ❖ Research Grants Council (Earmarked Grants)

The researches' current and proposed research is to *generate a new class of filtering (channel equalization) algorithm which is more responsive and robust to uncertain and changing environments.* From preliminary studies on generic low order examples, their new algorithms appear to have faster adaptation due to their insensitivity to uncertainty.

The key new concept is to first seek best communication channel parameter and signal estimation for the worst case situation in the adaptation, and then subsequently to seek the best for the average situation. An adaptive trade off between the two cases can be designed to give better results than for either.

The algorithms the researchers propose for this are new and based on their evolving mathematical theory based on risk sensitive optimization. There also appears value in dualizing their recent new stochastic control results in the presence of multiplicative noise to the filtering setting for telecommunication applications.
(CU00227)

Towards Agency and Ontology for Web-based Information Retrieval

- ✍ SIM Kwang Mong
- ❑ 15 January 2001
- ❖ CUHK Research Committee Funding (Direct Grants)

As the number of websites available in the WWW is notoriously large and ever-increasing, users face the challenge of retrieving, filtering and monitoring ever-changing information of astronomical magnitude. Although several systems such as *Amalthaea, FAB* and *SIMS* attempted to resolve some of the issues, this research proposes an agent-based system that overcomes some of their limitations. The main goal of this research is to engineer a multi-agent testbed that can:

(1) locate appropriate number of URLs;
(2) browse multiple websites simultaneously to filter and retrieve relevant information; and
(3) monitor changes in selected websites.

Even though agents in Amalthaea and FAB can assist users filter and retrieve information via the WWW, they did not consider the issue that text documents may use different terms for the same concept. As the WWW is being used across many cultures, relevant and related information may come in different manifestations. Through the use of an ontology, this research plans to engineer information filtering agents (IFAs) that retrieve and filter information using ontological relations of words such as synonyms, specialized and generalized terms. Furthermore, while agents in Amalthaea and FAB only support retrieval of information, SIMS only assist users in selecting appropriate information sources. In addition to IFAs, this research plans to engineer a query processing agent (QPA) that helps user select desired number of URLs and information monitoring agents that constantly monitor contents of selected web sites and notify users of changes. What distinguishes the QPA from the SIMS project is that the QPA will employ an *ontology* to guide its search for information sources.
(EE20023)

Automatic Human Face Sketch Recognition

- ✍ TANG Xiaoou
- ❑ 31 December 2000
- ❖ CUHK Research Committee Funding (Direct Grants)

Automatic retrieval of face images from police mug-shot databases is critically important for law enforcement agencies. It can help investigators to locate or narrow down potential suspects efficiently. However, in many cases, the photo image of a suspect is not available and the best substitute is often a sketch drawing based on the recollection of an eyewitness. Despite the great need of such an automatic photo retrieval system using face sketches, little research can be found in this area, probably due to time and budget constrains in constructing a large face sketch database. In this project, the researchers plan to use an interactive facial sketch composing system to build a large face sketch database. Then through a systematic study of face image and sketch information in a multilevel structure, an efficient face recognition system capable of identifying both photos and sketches will be developed. The researchers expect this research project will not only make theoretical contribution to face recognition research, but also bring significant impact on the practical law enforcement in Hong Kong.
(EE20018)

Homodyne Crosstalk Reduction using FP Laser Diode

- ✍ TONG Fuk Kay Franklin ● HO Keang Po Ricky ● TSANG Hon Ki (Dept of Electronic Engineering)
- ❑ 3 October 2000
- ❖ Research Grants Council (Earmarked Grants)

Recent advances in optical technologies have made wavelength division multiplexing (WDM) an

attractive solution for future broadband networks. One formidable impairment, however, is the homodyne crosstalk derived from imperfections in filtering and demultiplexing elements, and from non-linear fiber effects such as four-wave mixing and other processes. Crosstalk will further be enhanced through the use of erbium dope dfiber amplifiers. While the crosstalk derived from filtering and demultiplexing elements can, in principle, be reduced through the design and use of better devices, those derived from nonlinear effects are intrinsic properties of the fiber material, as it is unlikely to replace all the installed fiber with fiber of low non-linearity. This will inevitably limit the system performance in terms of its size, total number of WDM channels, link distance, etc. Thus, means to reduce homodyne crosstalk is an important research topic and of significance to WDM systems.

The researchers propose the use of Farby-Perot laser diodes in several schemes to combat the homodyne crosstalk. For example, through injection locking of FP laser diode can be used to extract the data at the receiver while disregarding the homodyne crosstalk. (CU00228)

Photonic Packaging Laboratory

? TONG Fuk Kay Franklin ● SHU Ching Tat C. (Dept of Electronic Engineering) ● TSANG Hon Ki (Dept of Electronic Engineering) ● CHEN Lian Kuan ● CHAN Chun Kit ● CHEUNG Kwok Wai ● WU Ke Li (Dept of Electronic Engineering) ● CHAN Kam Tai (Dept of Electronic Engineering) ● WONG Sai Peng Joseph (Dept of Electronic Engineering) ● LI Wen Jung (Dept of Auto. & Computer-Aided Engin.) ● WANG Michael Yu (Dept of Auto. & Computer-Aided Engin.) ● HO Keang Po Ricky

❑ 1 June 2001

❖ Funding from Other Sponsors ● Innovation and Technology Support Programme, ITF, Innovation & Technology Commission

The world is experiencing a shortage in fiber optic components derived indirectly from the tremendous growth in Internet. Because of the labor-intensive process in photonic-component packaging, the researchers anticipate a migration of optoelectronic device and subsystem manufacturing to China to benefit from its low labor and material cost. Hong Kong can benefit from this global trend and can evolve to become a regional R&D and design center, and possibly a manufacturing site for high-end photonic products.

To help Hong Kong develop its high technology industry, the researchers propose to build, an addition to the existing facility at their university, a photonic component and subsystem prototype development laboratory. The facility aims at (1) developing processes and procedures for packaging photonic

components (2) talent pool build up through training and recruiting photonic packaging experts, and (3) support of local industry in photonics. The proposed infrastructure will also allow individual high-risk, high pay-off disruptive technologies to be developed. (EE00750)

Learning Hierarchical Shape Models for Boundary Finding

? WANG Yongmei

❑ 1 May 2001

❖ CUHK Research Committee Funding (Direct Grants)

Precisely locating objects' boundary in an image is of fundamental importance in a variety of image analysis applications, such as pattern recognition, multimedia computing and biomedical image processing. Since statistics of the sample images can be powerful tools to directly capture the character of the objects' variability, the proposed work is aimed at building hierarchical statistical models by learning the characteristic pattern of a shape class over the sample images. The resulting models trained at hierarchical levels allow the exploring of dominant global shape at coarse image scales, and local details are focused at fine image scales. This would therefore not only increase the likelihood of finding the global optimal match, but also the models are flexible enough to characterize fine variations by relaxing over iterations at decreasing scales. The hierarchical shape models are then used as prior shape knowledge for 2D boundary finding in a maximum *a posteriori* Bayesian formulation. Theoretical analysis as well as experimental validation for both general and medical images of the proposed approach will be carried out in this work. (EE00924)

Power Control for Wireless Multimedia System in a Fading Environment

? WONG Wing Shing ● YAU Shing Toung Stephen* ● CAINES Peter Edwin*

❑ 1 October 2000

❖ Research Grants Council (Earmarked Grants)

Wireless telephony has enjoyed a great success around the world as well as in Hong Kong. As the market moves from the 2nd Generation digital systems to the 3rd Generation or beyond, an increasing number of new services will be offered on wireless platforms. These new developments will definitely attract new users and promote more frequent and longer lasting usage of wireless communications. User to user interference is bound to increase at a time when there is a high demand on spectral capacity. Power control has been an

effective means to ameliorate the situation. it aims to determine the optimal power setting for various transmitters so as to optimize certain Quality-of-Service (QoS) or capacity criteria.

In this study, the researchers concentrate on studying power control problems in the presence of fading. The object of this project is to deepen our understanding of various power control algorithms, under fading conditions. Both centralized and distributed algorithms will be considered. Knowledge derived from this part of the project will provide the key to the design of effective and efficient power control algorithms under fading environments. In turn, such algorithms will allow for more capacity gain and better QoS performance for future wireless multimedia systems.
(CU00222)

Fundamental Limits in Information Storage Systems

- ✍ YEUNG Wai Ho Raymond
- ❑ 1 September 2000
- ❖ Research Grants Council (Earmarked Grants)

In an information storage system, information is first stored on a physical medium by a recording system and later retrieved from the medium by a playback system. In almost all such systems, the accuracy of the information reproduced during playback depends critically on the tracking ability of the playback system. For example, if an audio tape recorder runs out of battery when a music tape is being played, the music becomes awful because the pitch is lower than normal. In a digital magnetic recording system, only '0' and '1' can be written on the tape. Suppose there is a long run of the same symbol, say '0', on the tape. During playback, in the presence of timing jitter, which can be due to both the fluctuation of the speed of the motor drive as well as the elasticity of the tape, the total number of '0's of the run may be counted incorrectly. As a result, the information stored on the tape is reproduced incorrectly.

An information storage system can be modeled as a communication system, with the storage medium being the communication channel. The recording process is regarded as transmitting symbols at the input of the channel and the playback process is regarded as receiving symbols at the output of the channel. Motivated by the tracking problem in an information storage system, the researchers introduce what they call an asynchronous channel. In an asynchronous channel, it is assumed that the transmitter and the receiver are synchronized only at the beginning of the communication session. Subsequently, the relative timing between the transmitter and the receiver is modeled by a stochastic process whose distribution is known to the system designer.

In this project, the researchers aim to determine the capacity of an asynchronous channel, i.e., the maximum rate at which information can be communicated through the channel reliably. Various issues, including the alphabet size of the channel input, additive noise, input power constraint, etc, will be investigated.
(CU00165)

Architecture for IP Operating on WDM

- ✍ YUM Peter Tak Shing ● TONG Fuk Kay Franklin
- ❑ 1 December 2000
- ❖ Research Grants Council (Earmarked Grants)

This project proposes architecture for routing IP packets directly on optical networks. The use of label switching is assumed in the IP routers while a new routing architecture is introduced to transport IP packets across an optical backbone network. The architecture is based on a two-tier multiplexing approach, with Wavelength Division Multiplexing (WDM) addressing the number of regional exchanges and time division switching communicating among the hubs. Such architecture not only has the advantages of simple network management, high efficiency with low latency; it is also scalable by addition of regional exchanges, hubs and fibers.
(CU00223)

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

Edition	Title/Investigators
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
1999-00	Channel Tunable Mode-Locked Lasers for High Speed Optical Networks and Optical Signal Processing (CU99372) ✍ CHEN Lian Kuan ● TONG Fuk Kay Franklin ● HO Keang Po Ricky
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*

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

1999-00　Turbo-Decoding of Combined Trellis-Coded Quantization and Trellis-Coded Modulation (CU99370)
 ✎ HO Keang Po Ricky

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

1998-99　Traffic Control Strategies for Quality-of-Service Guarantees in Cross-Path ATM Packet Switches (CU98349)
 ✎ LEE Tong Tony ● TO Pak Tung Philip#

1999-00　Design and Analysis of Scheduling Algorithms in Input-Queued Switches Supporting IP-over-ATM (CU99398)
 ✎ LEE Tong Tony

1998-99　An Interactive Multimedia Exchange with Open Software Interface for Media Industry and Digital Library (EE98046C)
 ✎ LEE Yiu Bun ● YEN Jerome (Dept of Systems Engineering & Engin. Management) ● LYU Rung Tsong Michael (Dept of Computer Science and Engineering)

1999-00　Scalable and Fault-Tolerant Video-on-Demand Systems – Design, Analysis, Prototyping, and Performance Evaluation (CU99095)
 ✎ LEE Yiu Bun

1999-00　A Bit-Rate Profile Archive for VBR-encoded MPEG2 Video Streams (EE99006)
 ✎ LEE Yiu Bun ● CHEN Lian Kuan ● LIEW Soung Chang

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

1999-00　Adaptive Multimedia Communications (EE99017)
 ✎ LIEW Soung Chang

1998-99　Joint Design of Signal Format and Interference Suppression Scheme for CDMA Systems (EE98026)
 ✎ LOK Tat Ming

1999-00　MC/DS/CDMA as the Radio Technology for Wireless Multimedia Communication (CU99420)
 ✎ LOK Tat Ming ● WONG Wing Shing

1997-98　Preliminary Study of Image Compression by Automatic Recognition (CS97014)
 ✎ TANG Xiaoou

1998-99　Intelligent Image Coding for Underwater Optical Survey (EE98006)
 ✎ TANG Xiaoou

1999-00　Global and Structural Pattern Recognition for Large-Set Databases (CU99378)
 ✎ TANG Xiaoou ● Grimson William Eric Leifur* ● LIU Jian Zhuang*

1998-99　A High-Capacity WDMA Local- and Metropolitan-Area Ring/Bus Network (CU98157)
 ✎ TONG Fuk Kay Franklin ● CHEN Lian Kuan ● HO Keang Po Ricky

1999-00　Design and Implementation of a Bi-directional Multiwavelength Ring Network (CU99369)
 ✎ TONG Fuk Kay Franklin ● HO Keang Po Ricky

1999-00　On the Performance Bounds of Turbo Codes (CU99424)
 ✎ WEI Keh Wei Victor

1999-00　Hong Kong Cyber Campus – Towards Networking all Schools in Hong Kong (ED99003)
 ✎ WONG Po Choi

1997-98	Wireless ATM: Issues in Multi-Rate Multiple Access (CU97538)		

☜ WONG Wing Shing ● HUI Yu Ngai

1998-99   Network Information Flow Theory (CU98342)

☜ YEUNG Wai Ho Raymond

1998-99   Multiparty Videoconferencing in Virtual Path Based ATM Networks (CU98159)

☜ YUM Peter Tak Shing ● WONG Po Choi

1999-00   Efficient Multicast Routing for Multimedia Videoconferencing (CU99371)

☜ YUM Peter Tak Shing

RESEARCH OUTPUTS AND PUBLICATIONS

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<P007019> **HO Keang Po Ricky; YU Hai Tao; CHEN Lian Kuan and TONG Fuk Kay Franklin.** "High-Resolution Measurement and Spectral Overlap of Cross-Phase Modulation Induced Spectral Broadening". *IEEE Photonics Technology Letters* vol.12 no.11, pp.1534-1536. USA: IEEE, 2000.11.

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RESEARCH PROJECTS

On-line Scheduling of Multiprocessor Tasks with Partial Information

- ? CAI Xiaoqiang
- ❑ 1 December 2000
- ❖ CUHK Research Committee Funding (Direct Grants)

The researchers plan to explore a class of on-line scheduling models, where some partial information regarding future uncertainties is available. Specifically, they plan to investigate problems where a task may need to be processed by some parallel processors simultaneously, and uncertainties may be contained in three categories of task characteristics: the arrival time of a task, the processors to be occupied by a task, and the processing time that a task may need to take. The researchers will establish and examine models according to the available information on the three categories of task characteristics. The core of this project is algorithms design and development. The researchers will design on-line algorithms with the objective that the competitive ratios of these algorithms could match the lower bound of the problems or could be as close to it as possible. Approaches to be used include improving an on-line algorithm by utilizing the information known on the problem, or revising an off-line algorithm by removing the decision that depends on the information that is assumed to be known in the off-line model.

In general, the project is expected to contribute new results to both the area of on-line algorithms with partial information, and the area of on-line scheduling with multiprocessor tasks.
(EE20019)

Transformation Methods for Global Optimization

- ? LI Duan
- ❑ 1 November 2000
- ❖ CUHK Research Committee Funding (Direct Grants)

The existence of multiple local minimums in general nonconvex optimization problems makes global optimization a great challenge. Advancement in global optimization will have a significant impact on the economic benefits in operations and management. While there is a lack of understanding of general nonconvex optimization problems, successful algorithms have been developed for certain structured nonconvex optimization problems, such as concave minimization and D.C. programming problems. The aim of this project is to derive efficient transformation methods to convert general unstructured nonconvex optimization problems into equivalent better structured nonconvex optimization problems, thus facilitating the search of a global optimum via existing global search methods. The overall research goal will be achieved by carrying out the following three research tasks:

(1) to identify transformations such that a monotone optimization problem (with a monotone objective function and monotone constraints) can be converted into an equivalent concave minimization problem over a convex set or a reverse convex optimization problem;

(2) to develop transformation schemes such that a general nonconvex minimization problem over certain constraint sets can always be reduced to a monotone optimization problem, thus a concave minimization or a reverse convex optimization problem; and

(3) to derive efficient solution algorithms for the resulting monotone concave minimization and monotone reverse convex optimization problems.

The research outcome from this proposed research should be applicable to a wide range of real world optimization problems, and the derivation of the transformation methods for global optimization will advance the state of-the-art in the above-mentioned academic challenge.
(EE20020)

Parser Composition for Natural Language Processing

- ? MENG Mei Ling Helen
- ❑ 10 October 2000
- ❖ Intel Research Council

The researchers aim to devise an approach for natural language processing (NLP) which is *scalable* with task complexity, *efficient*, can handle *ambiguities* and *non-grammaticalities* in natural language. They also aim for a unified approach that can be applicable to *both* English and Chinese. State-of-the-art natural language understanding (NLP) techniques typically apply lexicalized parsing to textual input by referencing a grammar. As the task complexity increases, the grammar size grows and the number of parser states increases *exponentially*. This creates a roadblock in achieving *efficiency* and *scalability* in developing NLP systems. Furthermore, ambiguities and non-grammaticalities in natural language presents a need for *multiple parse generation* and *robustness*. Instead of using a single parser with a single grammar, the researchers propose to partition the grammar into multiple subgrammars. Each subgrammar operates with its specialized subparsers. Subparsers can be composed (or integrated) to produce an overall parse for an input sentence. This serves to circumvent the problem of exponential growth of parser states as grammar size increases.

Hence it provides a potential solution for developing efficient and scalable NLP system. The approach should be applicable to both English and Chinese. (EE20007)

Semi-Automatic Grammar Acquisition for Understanding Natural Language Queries

? MENG Mei Ling Helen • CHING Pak Chung (Dept of Electronic Engineering) • LAM Wai

❑ 1 December 2000

❖ Research Grants Council (Earmarked Grants)

Our current age of information is characterized by the convergence of computing, communication and content. Round-the-clock, ubiquitous access to information and services is increasingly becoming a necessity in our daily lives. We need to develop a human-computer interface which enables a broad range of users to consult computers for electronic information in a variety of application domains. One promising solution is the use of natural language, i.e. to ask verbal questions just as we do in human-human communication. Natural language understanding (NLU) is the core technology behind natural language interfaces. It can be applied as a front-end to a search engine for the Web, or interfaced with speech recognition in human-computer conversational systems. Natural language interfaces, and the NLU technology, will become indispensable in the provision of informational and transactional services, in (speech-enabled) electronic commerce and other similar applications.

The researchers propose an alternative two-step approach for NLU of information-seeking queries in restricted domains. It is a *unified* approach applicable to both English and Chinese (i.e. bilingual). The first step is *key concept extraction*, which analyzes the user's natural language query and produce a concept sequence. The researchers will devise a semi-automatic grammar induction technique for this task. The second step is *informational-goal inference*, which identifies the underlying informational goal(s) of the query in a probabilistic manner. A suite of Belief Networks will be used for this task. The integration of these two techniques constitutes the overall NLU component, which is suitable for future incorporation into conversational systems. (CU00177)

Extracting Temporal Information from Chinese Financial News

? WONG Kam Fai William • LI Wenjie (Centre for Innovation and Technology)#

❑ 1 November 2000

❖ 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 proposal: 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, our research result will be significant to the promotion of Hong Kong IT.

This project will investigate a number of challenging technology issues, which have not been addressed previously. These include (a) temporal information extraction; and (b) Chinese natural language processing for temporal information. (EE20021)

"Linear Quadratic Control via Semidefinite Programming, with Applications"

? YAO David Da Wei • ZHANG Shuzhong • ZHOU Xunyu

❑ 1 October 2000

❖ Research Grants Council (Earmarked Grants)

Linear quadratic (LQ) control possesses one of the most celebrated success stories in modern control engineering. A key to its success is the famous Riccati equation. Recent efforts in extending LQ control to new fields such as financial engineering and other service areas have, however, brought forth serious technical challenges as the Riccati approach may no longer apply to these new problems.

The researchers' preliminary studies have demonstrated the effectiveness of *semidefinite programming* (SDP) in solving this new class of LQ control problems. Their research plan calls for continuing the investigation in this direction. Specifically, the researchers will

(1) derive general theoretical results for stochastic LQ control with control constraints,

(2) connect the new class of LQ control problems to SDP and generate SDP algorithms that identify the optimal controls; and

(3) carry out the numerical implementation and testing of these algorithms.

Furthermore, to better motivate their investigation, as well as to extend the application frontier of the LQ control, the researchers will focus on three application problems: (1) asset allocation for long-term growth; (2) production planning under supply

uncertainty or yield loss; and (3) flow control of e-commerce traffic at web servers.
(CU00175)

Dynamic Aggregate View Selection and Maintenance for Large Financial Data Warehouses

- ✍ YU Jeffrey Xu ● LU Hongjun*
- ❑ 1 October 2000
- ❖ Research Grants Council (Earmarked Grants)

Today's markets are much more competitive and dynamic than ever. A data warehouse is a *subject-oriented, integrated, time-varying, non-volatile collection of data that is used primarily in organization decision making*. In order to efficiently support decision-support or on-line analytical processing (OLAP) queries, a data warehouse needs to precompute or materialize some of such OLAP queries. The outcome of such statistical analysis or summarization are of materialized aggregate views or simply materialized views in this context. The problem of selecting such a set of materialized views under a maintenance time constraint is nontrivial due to the fact a selected view has impacts on the previously selected views -- they may be less beneficial. In this project the researchers will study maintenance-time view selection for a large multidimensional data warehouse in a dynamic environment in which things change overtime.
(CU00198)

Large Incomplete Datacube Computation

- ✍ YU Jeffrey Xu
- ❑ 1 November 2000
- ❖ CUHK Research Committee Funding (Direct Grants)

Today's markets are much more competitive and dynamic than ever. Business enterprises prosper or fail according to the sophistication and speed of their information systems, and their ability to analyze and synthesize information using those systems. On-line analytical processing (OLAP) refers to a set of data analysis techniques developed for efficiently analyzing data. Computing a datacube on n attributes (n-dimensional space) in a relational database system requires the computation of an aggregate function over all $2^{**}n$ groups generated by the GROUP-BY in SQL. Even n is not large, computational cost can be very high if the data involved is large. An incomplete datacube is a datacube in which some points in the multidimensional space are missing. All existing datacube algorithms compute a complete datacube. The objective of this project is to find algorithms to minimize the total computational cost for computing a large incomplete datacube. The

problem is non-trivial because it involves how to select a set of smaller-sized datacubes to be computed, how to make an optimal or a suboptimal evaluation plan that guarantees the result remains unchanged, and how to provide a run-time memory management mechanism to compute multiple interrelated datacubes. In this project, the researchers will investigate new algorithms, implement a prototype system, and do extensive performance study in comparison with existing fast datacube algorithms.
(EE20024)

Conic Optimization: Theory and Methods

- ✍ ZHANG Shuzhong
- ❑ 1 October 2000
- ❖ Research Grants Council (Earmarked Grants)

Ever since mathematical methods were invented and applied in early human activities, mathematical optimization, both its theory and practice, have contributed much to the development of our society. This should not be considered accidental, as finding an optimal solution in an appropriate context is deeply rooted in human nature. A very useful tool in mathematical optimization is *linear programming*. In its fifteen years of existence, the so-called interior point method has been analyzed thoroughly; this has resulted not only in a deep understanding, but also in high performance software for solving linear programs. Recently this power has been extended to a much wider range of optimization models such as conic optimization including semidefinite programming (SDP) as a special case, which has already found enormous amount of applications in the real world. In particular, SDP is used for R&D in engineering, telecommunication, management, logistics, finance and economics, among others. However, many questions still remain unanswered in solving conic optimization problems. These questions concern the sensitivity to changes in the problem data, and the performance of conic optimization software in terms of numerical accuracy and solution time. Much research needs to be done in order to gain deeper insights into these crucial issues. In this project, a systematic study of the theory, the applications, and the implementation of high performance methods, such as the primal-dual interior point methods, for conic optimization including SDP will be conducted, which in the long-run serves both the academic interests of the university and the industrial relevance due to its practical applicability.
(CU00181)

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

Edition   Title/Investigators

1996-97 New Scheduling Models with Applications to Berth Allocation (CU96543)
  ✍ CAI Xiaoqiang ● LEE Chung Yee#

1997-98 A Class of New Time-Varying Network Models with Controllable Flow Departure/Arrival Times (CU97528)
  ✍ CAI Xiaoqiang ● WONG Chak Kuen (Dept of Computer Science and Engineering)

1999-00 Earliness/Tardiness Scheduling Subject to Known Due Dates and an Unknown Deadline (CU99418)
  ✍ CAI Xiaoqiang ● ZHOU Xian*

1998-99 Solving the U-line Balancing Problem (EE98031)
  ✍ CHENG Chun Hung

1999-00 On the U-shaped Production Line Problem (EE99023)
  ✍ CHENG Chun Hung

1997-98 Self-tuning Neural Control Systems and their VLSI Implementation (CU97525)
  ✍ LAM Kai Pui ● POON Chi Sang*

1998-99 Knowledge Engineering for Crime Analysis and Management (CU98185)
  ✍ LAM Kai Pui ● BRAHAN J. W.* ● CHAN Hilton*

1999-00 Integrative Intelligence Techniques for Money Laundering Detection (CU99396)
  ✍ LAM Kai Pui

1999-00 Learning Classification Knowledge From High Dimensional Data and Its Application to Intelligent Text Filtering (CU99385)
  ✍ LAM Wai ● LING Charles X.* ● CHOI Philip L.S.*

1997-98 Global Logistics Management: Combinatorial Optimisation Methods for Supply / Distribution Network Planning (SS97069)
  ✍ LEUNG May Yee Janny

1998-99 Polyhedral Combinatorial Methods for Planning Problems with Interaction Costs (EE98034)
  ✍ LEUNG May Yee Janny

1999-00 Gain-Sharing in Third-Party Logistics Alliances: Game-Theoretic Models and Empirical Investigations (CU99375)

  ✍ LEUNG May Yee Janny ● LAM Ko Kin*

1997-98 Variance Minimization in Stochastic Systems (CU97523)
  ✍ LI Duan

1998-99 Successive Solution Scheme for Constrained Redundancy Optimization in Reliability Networks (CU98056)
  ✍ LI Duan

1998-99 Interactive Parametric Minimax Method in Multiobjective Optimization (EE98044)
  ✍ LI Duan

1999-00 Multiobjective Differential Dynamic Programming (CU99392)
  ✍ LI Duan ● LIAO Li Zhi*

1998-99 A Predicate Network for Automated Reasoning (EE98032)
  ✍ LOW Boon Toh

1999-00 An Inference Network Approach to Automated Reasoning (CU99397)
  ✍ LOW Boon Toh

1998-99 Semantic Processing for Spoken Language (EE98008)
  ✍ MENG Mei Ling Helen

1998-99 Research and Development of Spoken Language Interfaces for the Hong Kong Bilingual Environment (EE98041)
  ✍ MENG Mei Ling Helen

1999-00 From Language to Information: A Hybrid Approach for Understanding Spoken Queries (EE99024)
  ✍ MENG Mei Ling Helen

1999-00 Chinese Broadcast New Retrieval Engine (EE99042)
  ✍ MENG Mei Ling Helen ● LAM Wai ● TANG Xiaoou (Dept of Information Engineering)

1999-00 Chinese Database Systems, Query Language and Interface (EE96020)
  ✍ WONG Kam Fai William ● WANG Shan* ● TANG Shi Wei*

1999-00 Extracting Temporal Information from Chinese Financial News (EE99025)
  ✍ WONG Kam Fai William ● LAM Wai ● LI Wenjie (Centre for Innovation and Technology)#

1999-00   OCF – Open Component Foundation (EE99001)
✏ WONG Kam Fai William ● CHEUNG Kwok Wai (Dept of Information Engineering) ● LYU Rung Tsong Michael (Dept of Computer Science and Engineering)

1999-00   Translingual Access of Chinese Text Using English (EE99041)
✏ WONG Kam Fai William ● LAM Wai

1998-99   Manufacturing Logistics Re-engineering : Sequencing and Merging - with application to Electronic Equipment Assembly and Distribution (CU98181)
✏ YAN Houmin ● LEE Chung Yee*

1999-00   Information Updates and Supply Chain Management with Application to Electronic Device and Equipment Industry (CU99417)
✏ YAN Houmin

1999-00   Supply Chain Structure and Information Dynamics (BS99004)
✏ YAN Houmin ● YAO David Da Wei ● CHEN Jian* ● LIU Lu*

1998-99   Color Image Retrieval and Visual Thesaurus (CU98034)
✏ YANG Christopher Chuen Chi ● LI Victor*

1999-00   Constraints Based Reasoning Approach for Tolerance Analysis and Tolerance Synthesis (CU99031)
✏ YANG Christopher Chuen Chi

1999-00   Bilingual Internet Search Engine (EE99032)
✏ YANG Christopher Chuen Chi

1998-99   Dynamics and Optimization in Production Logistics (EE98007)
✏ YAO David Da Wei

1998-99   Strategic Research in Risk and Optimization (EE98040)
✏ 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

1999-00   Performance Analysis and Optimization of Assemble-to-Order Systems (CU99376)
✏ YAO David Da Wei

1998-99   The Next-Generation Digital Library Initiative at CUHK (EE98012)
✏ YEN Jerome

1999-00   Sensitivity Analysis and High Performance Optimization Methods (EE99026)
✏ ZHANG Shuzhong

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

1999-00   Optimal Controls of Forward-Backward Stochastic Systems with Financial Applications (CU99435)
✏ ZHOU Xunyu

RESEARCH OUTPUTS AND PUBLICATIONS

<P001290> **LAM Kai-Pui.** "A Radial-Basis-Function Network with Fast Hebbian Preprocessing for Stock Price Prediction". *Proceedings of the 4th World Multiconference on Systemics, Cybernetics, and Informatics (Sci 2000)* vol.VI, pp.317-320. Florida, USA: International Institute of Informatics and Systematics, 2000.07.23.

<P001291> **Lau, Kwok-Kin and Kai-Pui Lam.** "Approaches to Facial Matching in Forensic Application". *Proceedings of the World Multiconference on Systemics, Cybernetics, and Informatics (Sci 2000)* vol.V, pp.145-150. Florida, USA: International Institute of Informatics and Systematics, 2000.07.23.

\<P001292\> **Lam, Kai-Pui and Muk-Yuen Law.** "Efficient Address Matching and Integration with Bilingual Voice Recognition in a Map-Based System". *Proceedings of the 4th World Multiconference on Systemics, Cybernetics, and Informatics (Sci 2000)* vol.VI, pp.321-326. Florida,USA: International Institute of Informatics and Systematics, 2000.07.23.

\<P001421\> **Wong, Kam-Fai; Chan Kun-Chung Timothy and Cheng Chun-Hung.** "An Investigation on Transformation-Based Error-Driven Learning Algorithm for Chinese Noun Phrase Extraction". *Proceedings of 2000 International Conference on Chinese Language Computing* pp.337-368. Chicago, USA: Knowledge Systems Institute, 2000.07.

\<P001918\> **IP Chun Wah Timmy and MENG Helen.** "Transformational Tagging for Topic Tracking in Natural Language (MPhil Thesis)". 149 pgs. 2000.08.01.

\<P001919\> **Siu, Kai-Chung and Meng H.** "Semi-Automatic Acquisition of Domain-Specific Semantic Structures" (MPhil Thesis). 125 pgs. 2000.08.01.

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RESEARCH PROJECTS

Open Secure Time-stamping Platform for E-commerce and Protection of Intellectual Properties

- ✍ HU Stanislaus Yung Chi ● LEUNG Philip Kwong Hon ● LAM Shing Yung Anton ● WONG Siu To ● LEUNG Tak Cheong# ● LING Ka Hong
- ❑ 1 October 2000
- ❖ Funding from Other Sponsors ● Innovation and Technology Support Programme, ITF, Innovation & Technology Commission

An open secure software platform and service model will be developed for digital notaries to offer highly trustworthy time-stamping service and for their customers to use their service more easily. This kind of service is very useful to business transactions which price or other important elements change from time to time. It is very valuable to have a trustworthy third-party to witness the transactions electronically by time-stamping them without knowing the details. This service is also very useful to companies that want to protect their intellectual property rights by time-stamping their ideas and inventions. Future disputes can be avoided by using the service. In fact, the same platform can be used in many other areas which are only limited by imagination. The side benefits of this service are that less paper is needed for saving the environment and the electronic time-stamping service will be much more inexpensive than the paper version provided by the existing conventional notaries.
(EE20003)