RESEARCH PROJECTS

Active Head-Eye System: Direct Estimation of its Binocular Geometry

- ✍ CHUNG Chi Kit Ronald
- ❑ 1 January 2004
- ❖ CUHK Research Committee Funding (Direct Grants)

A dual-camera head must have its binocular geometry known before it could be used for metric reconstruction of the surroundings. However, "active" dual-camera head, i.e. camera head in which each camera has its own independent pan/tilt mobility, could have the binocular geometry varying with time. In addition, the two cameras could move to a configuration with no overlap in the fields of view of the cameras, rendering image correspondences across the cameras impossible to obtain and traditional estimation techniques inapplicable. This research seeks to come up with a new method that could estimate the binocular geometry at arbitrary time in the middle of the camera head's operation, which *requires no feature correspondence* but only monocular optical flows in the two cameras as the input. Due to the so-called aperture problem, only the normal flow (i.e. the flow component normal to the iso-brightness' contour in the image) not the full optical flow is directly observable from image data. Thus this work also aims to use *monocular normal flow only* as the input of the estimation. Besides, this work aims to estimate the binocular geometry without estimating the *two camera motions explicitly*, so as to let the estimations of binocular geometry and the cameras motion be decoupled.
(EE03360)

Develop a New Air-Conditioning System Based on Ultrasonic Actuation and RMZ Heating

- ✍ DU Ruxu ● XU Yangsheng
- ❑ 1 November 2003
- ❖ Aoyagi Hong Kong Ltd. ● University-Industry Collaboration Prog.: Matching Grant for Joint Research, ITF, Innovation & Tech. Commission

Air-conditioning (AC) system is a common commodity in modern living. Every year millions of AC systems are made and sold, and hence, even a small technology gain may add up to significant corporate profit. Currently, nearly all domestic AC systems are built based on the vapor compression refrigeration technology developed some 100 years ago. Although this technology is very mature, it also has a number of drawbacks, such as environment unfriendly (the leaking refrigerant could damage the ozone layer of the earth), noisy, and fragile (component wear and fatigue often limit the system life in less than 10 years). This proposal presents a plan to develop a new kind of AC system based on ultrasonic actuation and RMZ heating. This new AC system is based on the same working principle of refrigerant changing phases. However, instead of using a compressor, it uses a combination of ultrasonic actuation and effective heating to make the refrigerant changing phases. The new system has a number of advantages including environment friendly, quiet, and long life. Our preliminary tests indicated that the new AC system is effective and has a great commercial potential.
(EE03833)

Global Asymptotic Tracking of Nonlinear Systems with Unknown Exosystem

- ✍ HUANG Jie
- ❑ 1 July 2003
- ❖ Research Grants Council (Earmarked Grants)

Output regulation aims to achieve, in addition to closed-loop system stability, asymptotic tracking and disturbance rejection for a class of reference inputs and disturbances where both reference inputs and disturbances are generated by an autonomous system called exosystem. For over three decades, the output regulation problem has been studied assuming that the exosystem is exactly known. Recently, some attempts have been made on studying the output regulation problem with an uncertain exosystem. In particular, an adaptive output feedback control technique has been developed to solve the semiglobal robust output regulation for the class of cascaded nonlinear systems coupled with a neutrally stable linear exosystem with an uncertain parameter. In this project, we will develop a paradigm that can convert the problem of the global output regulation problem for nonlinear systems with unknown exosystem into an adaptive control problem, thus enhancing the capability of the existing output regulation theory to a new dimension. The framework will be applied to solve the adaptive output regulation problem for some exemplary nonlinear systems such as the cascaded nonlinear systems. Success of this project will enable the controller to handle such reference input or disturbance as the sinusoidal function with unknown amplitude, initial phase, and natural frequency, a scenario frequently encountered in ship control, aircraft landing, high precision robot manipulators, and disk drive control systems.
(CU03168)

Enabling Tools for the Design and Development of Chinese Style Game Characters, Sceneries and Effects

- ✍ HUI Kin Chuen ● YEUNG Sau Nang*
- ❑ 1 May 2004
- ❖ Funding from Industrial Sponsors ● Innovation and Technology Support Programme, ITF, Innovation & Technology Commission

According to the report "Baseline Study on Hong Kong Creative Industries" by the University of Hong Kong in 2003, the sales of online game in China amount to RMB$910 million in 2002, and is estimated to reach RMB$8.34 billion by 2006. In order to enable local game developers to explore this blooming market, technologies tailored for the China and Asia market is essential to increase the competitiveness of the local game industry. Existing tools for computer game design and development are mainly designed for the development of games in a general sense (e.g. racing, shooting games).

There is no tool for the design of games with Chinese favor. In this project, a new technique, the Curve-Pair Based Axial Representation, developed at The Chinese University of Hong Kong will be adopted for manipulating game characters. This provides an intuitive interface for designing Chinese style characters (e.g. Martial art hero) with waving hair and cloths. Moreover, it is envisaged that the next generation games will be enriched with realistic facial expressions. In order to prepare the industry to face this challenge, a facial expression editor will be implemented by incorporating a Boundary Element Based Facial Deformation technique developed at The Chinese University of Hong Kong. Together with a set of tools for streamlining the design and development of Chinese style characters, sceneries, and effects, the proposed system will constitute a unique Chinese style game design and development system, which can be licensed to all

game developers intending to explore the China market. Besides, the system will form a basic platform for incorporating new game design techniques, and hence, continuously enhances the technical know-how of the local game industry.
(EE03681)

Nanofixture-Enabled Robotic Assembly of Nanodevices

- ✍ LI Wen Jung ● XI Ning*
- ❑ 1 September 2003
- ❖ Research Grants Council (Earmarked Grants)

Our proposed project aims to advance nanomanipulation technology by utilizing *nanofixtures* to fix and hold manipulated nanotubes unto bulk substrates, which will then allow post-fabrication using micro/nano lithography processes on the bulk substrates to create reliable nanodevices using nanotubes. At the conclusion of this project, we will demonstrate an AFM-based nanomanipulation system for assembly of CNT-based nanodevices. Using this developed system, we will also create prototype circuits of nanotubes connected in a complexity not possible with current technology to prototype novel nano sensors and circuit elements. Potentially, this nanoassembly technology can be used to achieve automated fabrication of CNT-based nanodevices and NEMS such as integrated nanocircuits, nanoprocessors, nanosensor arrays, and general nano sensing and actuation systems. The contribution of this project will be very significant in that it will provide a feasible solution for *automated nanoassembling* of nanotube-based devices. Results of our research will advance the scientific and engineering knowledge of researchers worldwide, and possibly allow Hong Kong industries to participate in the nano-manufacturing and nano-assembly market sector in the future.
(CU03225)

Hard Disk Drive Servo Systems Using Piezoelectric Elements

- ✍ LIAO Wei Hsin
- ❑ 1 November 2003
- ❖ CUHK Research Committee Funding (Direct Grants)

Hard disk drives (HDDs) are the most important information storage devices for computers. Positioning precision is crucial to today's increasingly high-speed, high-capacity, and miniaturized HDDs. The demand for higher bandwidth servo systems that can quickly and precisely position the read/write head on a high track density becomes more pressing. In recent years, the idea of applying dual-stage actuators to track servo systems has been studied. In particular, push-pull piezoelectric actuated devices have been developed as a fine actuator for the servo system, while the voice coil motor functions as a coarse actuator. However, existing dual-stage actuators have piezoelectric patches only, which are lack of passive damping. In this research, a novel dual-stage servo system using enhanced active-passive hybrid piezoelectric actuators is proposed. The reliability of the servo system will be improved because the shock resistance is much higher in the presence of passive damping. Considering suspension and spindle vibrations into the servo design, the new active-passive hybrid dual-stage actuators would achieve higher bandwidth and positioning precision of the servo system. The objective of this research is to develop this hybrid servo system to improve the capability of track-following servos in HDDs.

Characteristics of HDDs will be studied. New piezoelectrically actuated suspensions with passive damping will be designed and fabricated. Models and controllers will be developed for the dual-stage track servo systems. We will evaluate actuating and damping abilities individually, and then their positioning precision. Experimental efforts will be carried out to implement the active-passive suspension structure with enhanced piezoelectric actuators.

(EE03930)

Intelligent Remote Performance Monitoring of Networked Mechatronic Systems via the Internet

- ✍ LIU Yunhui ● XU Bugong*
- ❑ 1 October 2003
- ❖ South China University of Technology

The Internet, also known as the information super highway, has been playing an increasingly important role in both economical development and people's daily life. Recent efforts have been made to control and diagnose complex mechatronic system remotely via the Internet. The success of these endeavors will make the Internet not only an information super highway, but also a means to transfer actions to remote locations, which will make the Internet an action super highway as well. Health care professionals will be able to provide services through a robot at home-based facilities via the Internet; a special manufacturing process can be performed using the equipment at a remote location with the assistance of robots communicating via the Internet, which will provide an infrastructure to enhance the human reachability and power. It, no doubt, will have a significant impact on the world economy as well as people's daily life. In this project, we will investigate perform monitoring and real-time motion control of Internet-based mechatronic systems. One of the most critical issues in Internet-based monitoring and control is how to cope with various problems such as disorder of information, instability, etc. caused by random delay of Internet communication. The technical issues to be investigated include modeling of the communication delay, stability analysis of the system, information fusion of networked sensors, design of controller, haptic inteface, and performance diagnosis. To verify the theoretical results developed, we will develop a prototype remote monitoring system between The Chinese University of Hong Kong (CUHK) and South China University of Technology (SCUT) and on it conduct Internet-based control and performance monitoring experiments. The CUHK side is responsible for coordinating the research efforts, designing the control system, setting up the experiment platform, and developing a mobile monitoring system for SCUT, and the SCUST side will focus on modeling of time-delay, system analysis, and experiments.

(EE03923)

Adaptive Visual Servoing of Robots in Un-Calibrated Environments

- ✍ LIU Yunhui
- ❑ 1 November 2003
- ❖ Research Grants Council (Earmarked Grants)

Visual servoing is an approach of using visual information to control motion of a robot, and it has been proven effective for sensor-based task execution of robots. To implement a visual servo controller, it is necessary to calibrate the relation between the vision space and the robot space. The accuracy of such a calibration directly determines the control

performance. In this project, we will investigate the problem of designing robot controllers with un-calibrated visual feedback under a full consideration of robot dynamics. Existing un-calibrated visual feedback controllers are based on kinematics only, and thus they are suitable for slow motion of robots and cannot guarantee the stability of the entire system. By including dynamics in its controller design, a robot would be able to perform fast visual tracking tasks and achieve dynamic stability. We will formulate the problem of un-calibrated visual servoing as output adaptive regulation and tracking problems in nonlinear control theory. Based on this formulation and properties of robot dynamics, we will develop and adaptive algorithm to estimate on-line the unknown transformation from the vision space to the robot space. Furthermore, we will implement the controller developed to a 3 degrees of freedom (DOF) robot to verify the performance by experiments.
(CU03167)

Vision-Based Measurement Technology for Railway Applications

- ✍ LIU Yunhui ● WANG Defu*
- ❑ 9 January 2004
- ❖ Shenzhen Dilin High Technology Co., Ltd.

For safety of railway operations, it is necessary to regularly inspect defects/failures of facilities such as cracks of tunnel surfaces, water leakage, and etc. It is also important for operation planning and safety to measure distances (geometric information) from tracks to surrounding objects such as platforms, tunnels, bridges, signaling facilities, etc. Obviously, such measurement or inspection cannot be efficiently done by manual approaches as they may request suspension of operations. In order to automatically measure the distances and detect the defects/failures, in this project we propose to develop a vision-based system, which will be trailed by a train to dynamically acquire 360 images along tracks by a group of cameras. From the sequence of images captured, the distances will be calculated and a 3-D virtual railway environment will be constructed for defect detection. Compared with manual methods, the technology to be developed has the advantages of being accurate and fast, having images recorded, being able to visualize the 3-D environment from arbitrary viewing points and angles, and having one system for multiple purposes (automatic geometric measurement, defect inspection, and visualization). The key technologies to be developed are a dynamic image acquisition unit (hardware), an efficient algorithm for constructing the 3-D model from a sequence of images, and the visualization method. Upon the completion of this project, a prototype system will be built and its performance will be examined by experiments with the collaboration with the Shenyang Institute of Railway Technology.
(EE03699)

Analysis and Design of Recurrent Neural Networks for Dynamic Optimization Subject to Nonlinear Constraints and Their Engineering Applications

- ✍ WANG Jun
- ❑ 1 October 2003
- ❖ Research Grants Council (Earmarked Grants)

Numerous engineering applications such as robot control and signal processing require real-time solutions to dynamic optimization problems subject to linear or nonlinear constraints. Recurrent neural networks have demonstrated to be promising for solving dynamic optimization problems subject to

linear constraints in real time. However, existing neural networks cannot be effectively applied for solving optimization problems with nonlinear constraints. In this proposed project, a new class of recurrent neural networks is to be developed for solving nonlinearly constrained dynamic optimization problems. Based on equivalent optimality conditions of optimal solutions, the proposed research will focus on the analysis and design of recurrent neural networks using a new design method never used before. The proposed neural networks are believed to be capable of solving nonlinearly constrained dynamic optimization problems. Moreover, the proposed new recurrent neural network would have many desirable properties such as global convergence, asymptotic optimality, and low structural complexity. It is conceived that the proposed neural network approach is more suitable for robot motion control and adaptive signal processing in real-time applications.

(CU03165)

Structural Shape and Topology Optimization Using Level Set Methods

- ✍ WANG Michael Yu
- ❑ 1 October 2003
- ❖ Research Grants Council (Earmarked Grants)

Structural optimization plays an important role in engineering design for cost-efficient use of materials. It has a great potential to bring significant performance improvement especially to the systems in a multi-material and multi-physics domain (e.g. micro and MEMS structures). Optimizing shape and topology of a mechanical structure is a challenging task as it has to automatically define an optimal connectivity of the material domain of the structure (i.e. the number and location of "holes") in conjunction with an optimal boundary shape.

This proposed project focuses on a new method of shape and topology optimization with a level-set based implicit boundary model. The research effort of the project will focus on a comprehensive development of the new approach. The specific research tasks include: (1) developing the level-set based representation of linearly elastic structures, (2) deriving necessary optimality conditions and exploiting level-set computing techniques to construct efficient and robust numerical algorithms for optimization, and (3) performing performance evaluation of the new approach with benchmark problems of topology optimization and developing new applications in compliant mechanisms design.

(CU03164)

Modelling and Analysis of Human Actions for Surveillance

- ✍ XU Yangsheng ● LEE Ka Keung
- ❑ 1 September 2003
- ❖ Research Grants Council (Earmarked Grants)

Anti-Terrorism has been a global issue and video surveillance has become more and more popular in public places such as elevators, banks, airports and casinos. The fundamental problem in visual surveillance systems is the understanding of human actions intelligently in real-time. In this proposal, we provide a feasible way to model and analyze human real-time actions based on learning by demonstration. By teaching the systems the difference between normal and abnormal human actions, the computational action models built inside the trained machines can automatically identify whether the

newly observed behaviors require security interference. In this research, our expected contribution will be in four major areas, namely 1) the modelling of human actions, 2) tracking of human actions, 3) analysis of human actions, and 4) network architecture for distributed human action learning modules. This work has potential for applications in different areas of our everyday life. Firstly, it can be applied in intelligent surveillance systems for security purposes in places where the behaviors of the people are expected to be closely monitored for the detection of any abnormality. Secondly, this research will lead to system interfaces that enable computers and robots to learn the individual and collective behaviors of humans, as well as the interactive behaviors between humans and other objects. Thirdly, the content-based video database system developed in this research has the potential to help the media industry to handle their vast amount of human-motion-related materials more effectively, particularly in applications of data indexing, retrieval and storage. Apart from the above applications, the developed technology can also be beneficial to other professional areas such as sport analysis, dance choreography and sign translation.
(CU03163)

Development and Technology Transfer of Intelligent Electronics Toys

- ✍ XU Yangsheng ● LEUNG Chung Ming* ● TONG Hang ● LEE Ka Keung Caramon
- ❑ 1 May 2004
- ❖ Innovation and Technology Commission ● Lung Cheong Toys Limited

Hong Kong, being the largest toy exporter in the world, had a total export amount of HK$53,711 million dollars in the year 2000. In the past few years, our research group in the Chinese University of Hong Kong has been working closely with the regional toy industry in the development of smart toy technology based on the support of ITF. Some of the developed prototypes have been successfully converted into a series of commercial products. With the support from Lung Cheong International Holdings Ltd., we propose to develop a series of technologies for intelligent electronic toys, including hardware design, autonomous navigation, obstacle avoidance, human-computer shared control, user intention recognition, and networking communication. These technologies will be implemented on a number of toy prototypes: the Dicycle toy, and the Roly-Poly transporter.
(EE03359)

Synthesis of T-S Fuzzy Controller via Grid Point Designs and Closed Loop SVD Consolidation

- ✍ YAM Yeung
- ❑ 1 October 2003
- ❖ Research Grants Council (Earmarked Grants)

Control of nonliner dynamical systems provides a platform for more general applications than its linear counterpart, as most plants and systems in real life are nonlinear by nature. However, the mathematical problems involved are also much more challenging. The present project aims to formulate a general, systematic, computational-based methodology to synthesize Takagi-Sugeno (T-S) fuzzy controller for a certain class of nonlinear plants. The approach calls for sampling and interpolating the nonlinear plant by a set of localized linear models, and then designing linear control law for each of the localized models. To resolve the ensuing dimensionality problem, the model and controller sets are subjected to a high dimensional SVD consolidation process. The end result is that the consolidated models and controllers

shares a common fuzzy structure with drastically reduced numbers of items, and existing tests on the relevant performance of the consolidated closed loop system can be applied. Essentially, this project attempts to equip the grid point modeling and design technique with high computational power in a quest to overcome some mathematical complexities of nonlinear control. The computational approach here does not require an inherent T-S fuzzy model in the nonlinear plant, and allows for more flexible designs than some existing methods. The present study will look into stabilizing controllers, robust controllers, and fuzzy observers. Implications to other topics will also be discussed.
(CU03162)

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

Edition	Title/Investigators
2001-02	A 2D Reference Image of a 3D Object: How Much Can It Do toward Vision Problems? (CS01177) ✍ CHUNG Chi Kit Ronald
2002-03	Development of An Advanced Wafer-level 2D and 3D Inspection Platform (EE02899) ✍ CHUNG Chi Kit Ronald ● XU Yangsheng ● LAM Edmond* ● FUNG Kenneth*
2001-02	Intelligent e-Diagnosis of Plastic Injection Molding Machines (EE01404) ✍ DU Ruxu ● XU Yangsheng
2002-03	Developing the Technology on Diagnosis of Sheet Metal Stamping Processes Based on Thermal Imaging and Finite Element Analysis (EE02346) ✍ DU Ruxu ● XU Yangsheng
2002-03	Design the Next Generation Metal Forming Machine Using Controllable Mechanism (EE02528) ✍ DU Ruxu
2000-01	Approximation Methods for the Discrete Nonlinear Servomechanism Problem (CU00209) ✍ HUANG Jie
2001-02	Output Regulation in Uncertain Nonlinear Systems (MP01181) ✍ HUANG Jie
2002-03	A General Framework for Global Robust Nonlinear Output Regulation Problem (CU02316) ✍ HUANG Jie
2001-02	Representation and Deformation of 3D Shapes for Design Applications (MP01182) ✍ HUI Kin Chuen
2002-03	Intuitive Freeform Modelling for Character Design (CU02375) ✍ HUI Kin Chuen
2001-02	Computational Algebraic Geometry in Control System Analysis and Design (MP01185) ✍ KWONG Chung Ping

2002-03 Curve Shortening, Heat Flow, and Global Optimization (EE02593)
✍ KWONG Chung Ping

2000-01 Micromachined Nafion Actuators for Tactile-display Systems (CU00206)
✍ LI Wen Jung ● GUO Shuxiang* ● LIU Yunhui

2001-02 Integrated Micromechanical Switches for Adaptive Fractal Antenna Arrays (EE01215)
✍ LI Wen Jung ● KWONG Chung Ping ● LUK Kwai Man*

2001-02 Eco-safe Human-motion-powered MEMS Energy Generator for Mobile Electronic Devices (EE01757)
✍ LI Wen Jung ● LEONG Philip Heng Wai (Dept of Computer Science and Engineering) ● YAM Yeung ● XU Yangsheng ● WONG Sai Peng Joseph (Dept of Electronic Engineering)

2002-03 A Force and Impact Sensing System for Robotic Micro-assembly (CU02381)
✍ LI Wen Jung ● XI Ning*

2002-03 Polymer-based Micro Electromechanical System Devices for Cellular Manipulation and Sensing (CS02337)
✍ LI Wen Jung

2000-01 Active-Passive Hybrid Vibration Control Using Enhanced Self-sensing Piezoelectric Actuators (CU00205)
✍ LIAO Wei Hsin

2001-02 Dynamics and Control of Train Suspension Systems with Smart Dampers (MP01216)
✍ LIAO Wei Hsin ● HUANG Jie

2002-03 Self-Powered Piezoelectric Sensors (CU02382)
✍ LIAO Wei Hsin ● LI Wen Jung

2002-03 Croucher Chinese Visitorship 2002-2003 (MP02904)
✍ LIAO Wei Hsin

2000-01 Real-time Control of Cooperative Robots via the Internet with Force Reflection (CU00173)
✍ LIU Yunhui ● NING Xi* ● WANG Yuechao*

2001-02 3D Grasp Planning with Applications to Automated Fixture Layout Design (MP01217)
✍ LIU Yunhui ● WANG Michael Yu

2001-02 Real-Time Bilateral Teleoperation of Internet Based Robotic Systems (CS01446)
✍ LIU Yunhui ● WANG Yuechao* ● XI Ning*

2002-03 3D Model Construction of Railway Environments (CS02891)
✍ LIU Yunhui

2002-03 Development of a Service Robot with Lift Interface (EE02577)
✍ LIU Yunhui ● YI Jianqiang*

2002-03 A Multi-Robots Based Distributed Sensing System Via Mobile Communication Networks (CS02898)
✍ LIU Yunhui

2002-03 Dynamic Control of Robots Using Uncalibrated Visual Feedback (EE02504)
✍ LIU Yunhui

2000-01 Recurrent Neural Networks for Real-time Grasping Force Optimization of Dexterous Manipulations Using Multi-fingered Robotic Hands (CU00174)
✍ WANG Jun ● LIU Yunhui

2001-02 Minimally-Invasive Techniques of Particle Vibration Damping (MP01196)
✍ WANG Michael Yu

2002-03 Interactive Haptic Simulations for Virtual Fixture Prototyping (CU02376)
✍ WANG Michael Yu ● LIU Yunhui

2000-01 Smart Wheelchair (CU00197)
✍ XU Yangsheng ● NECHYBA Michael*

2001-02 Human Informed Control of Dynamically Stable Systems (MP01228)
✍ XU Yangsheng ● NECHYBA Michael*

2001-02 Development of Technologies on Networked Smart Toys (EE01544)
✍ XU Yangsheng ● ZHANG Ping# ● LAW Kwok Ho Cedric#

2002-03 Wearable Robots as Mobile Devices for Communication and Interaction (CU02317)
✍ XU Yangsheng

2002-03 Finite Element Software to Investigating Formation Flying of Autonomously Controlled Units (EE02511)
✍ YAM Yeung

RESEARCH PROJECTS

Outlier Detection among Projected Clusters

- ✍ FU Wai Chee Ada
- ❑ 1 November 2003
- ❖ CUHK Research Committee Funding (Direct Grants)

The detection of outliers or exceptions can be very useful in applications such as fraud detection, network intrusion detection, system maintenance for detecting abnormal behavior, detecting criminal behaviors, and in general whenever users are interested not in the norm but in the exceptional cases.

Clustering is a related data mining problem which conceptually is complementary to outlier detection. In many real databases, it is found that the number of attributes is large, and when dealing with high-dimensionality, it is not suitable to consider clusters over the entire subspace, instead we should consider clusters in subspaces. Similarly when the number of attributes is large, outliers should be measured against patterns in different subspaces. It is also important to consider efficient computation and scalability of the algorithms since the data is typically of large volume. Another aspect that is not well-understand is the combination of both numerical data and categorical data. For network security, intrusion detection is very important, and there are two different cases: (1) cases with known intrusion patterns (2) cases with no prior knowledge. So far outlier detection has not assumed any outlier patterns, we would like to consider the case where known patterns is given. However, the pattern of outliers is different from normal patterns since the occurrence is typically very infrequent. We shall examine how to detect outliers under such assumptions.

(EE03476)

Automated Data Mining for Hot Bundle Analysis and Inventory Control

- ✍ FU Wai Chee Ada ● YU Jeffrey Xu (Dept of Systems Engineering & Engin. Management) ● WONG CHI WING ● WONG K P Raymond*
- ❑ 1 April 2004
- ❖ Funding from Industrial Sponsors ● Innovation and Technology Support Programme, ITF, Innovation & Technology Commission

Industry players agree that data mining technology, as one of the strong pillars in CRM (Customer Relationship Management), plays an important role in discovering customer behavior. However, applying the technology in business applications requires mining experts. Without expertise in adjusting more than 20 parameters in the mining process, data mining means nothing valuable to enterprises. We introduce this R&D project to propose a fundamental change to traditional data mining tools to minimize the involvement of technical expertise in adjusting parameters.

The first problem we tackle is the mining of association rule which has found applications in many different business arenas. We propose to consider a more practical problem, roughly speaking, it is to mine the top N most frequent itemsets, new algorithms are introduced for mining N-most interesting itemsets. Another application of association rule is in the inventory control problem, where the products carried by a retailer or a service provider are varied from time to time to optimize the profits. For such a problem the effect of cross-selling should be considered. We strongly

believe the research output would benefit the Hong Kong–based enterprises by the way of understanding their customer behavior through automated and manageable data mining platform.
(CS03972)

Virtual Anatomy and Dexterous Simulators for Minimal Access Cardiothoracic and Laparscopic Surgeries

- ✍ HENG Pheng Ann ● CHENG Chun Yiu Jack (Dept of Orthopaedics & Traumatology) ● WONG Tien Tsin ● LEUNG Kwok Sui (Dept of Orthopaedics & Traumatology) ● LAM Wai Man Wynnie (Dept of Diagnostic Radiology & Organ Imaging) ● LEUNG Kwong Sak ● XU Yangsheng (Dept of Auto. & Computer-Aided Engin.) ● YIM Ping Chuen Anthony (Dept of Surgery) ● ZHANG Yuanting (Dept of Electronic Engineering)
- ❑ 1 June 2004
- ❖ Supplementary Funding for RGC Central Allocation

Virtual reality (VR) based learning of human anatomy is feasible when a database of 3D organ models is available for the learner to interactively explore, visualize and dissect in virtual space. Highly accurate virtual and functional organ models are also essential for enhancing *realistic look* and *dexterous touch* in advanced surgical simulators. One of the main objectives in this project is to develop state–of–the–art virtual environments that feature interactive photo-realistic visualization of virtual and functional anatomy constructed from ultra-high resolution digital human datasets. The latest Chinese Visible Male dataset is about 1143 GB in size. There are in total 18,200 cross-section color digital images (4064×2704 resolution, 24 bits per pixel) at 0.1 mm intervals. These newly available gigantic visible human datasets provide almost an inexhaustible source of medical information. We would like to explore new possibilities for using such data in multiple directions for medical research, education, surgical training and simulation.

To further extend and strengthen our current development in VR based training systems, we propose to develop dexterous simulators for minimal access cardiothoracic and laparoscopic surgeries. Due to dynamic activities such as breathing and heart beating, as well as all the flexibility of those cardiothoracic and abdomen organs, it is still a great challenge to build a VR based training system that provide real-time dexterous feedbacks coupled with realistic rendering and physically based deformation. These simulators are also excellent testing platforms for evaluating the functional and flexible virtual human organs that we aim to construct on this project.
(EE03368)

Agent-Based Collaborative Workforce Management

- ✍ LEUNG Ho Fung ● CHEUNG Shing Chi*
- ❑ 1 October 2003
- ❖ Research Grants Council (Earmarked Grants)

There have been increasing demands for the support of mobile workforce management across multiple platforms. Examples include supply-chain logistics, dynamic human resources planning, etc. Workforce management typically involves tight collaboration, negotiation and sophisticated business domain knowledge. These can be facilitated by the use of intelligent software agents. As mobile devices become more powerful, intelligent software agents can now be deployed on these devices and hence

subject to mobility. However, existing researches in agent technology rarely addresses the integration of mobile agents into business processes as well as their interactions with human. We propose a flexible architecture of mobile workflow management system framework based on three tiers of views. *User interface views* provide alternative presentations of inputs and outputs, supporting both users and agents. *Data views* summarize data over limited bandwidth and display them in different forms. Furthermore, we introduce a novel approach of applying *process views* to mobile applications, where the business process for each user may dynamically adapt to his/her mobile environments and devices, which also serve as the centric mechanism for integrating user interface views and data views.
(CU03190)

To Develop and Evaluate A Novel Genetic Parallel Programming System

- ✍ LEUNG Kwong Sak ● Cheang S. M.* ● LEE Kin Hong
- ❑ 1 September 2003
- ❖ Research Grants Council (Earmarked Grants)

Genetic Programming (GP) is one of the four common approaches in Evolutionary Computation. There are two main streams in GP, namely, Tree-based GP (TGP) and Linear GP (LGP). TGP evolves programs represented in tree structures. LGP evolves sequential programs directly. However, LGP suffers from inflexibility while TGP suffers from inefficiency. We have done a pilot study on a novel idea of Genetic Parallel Programming (GPP) based on LGP with very promising and interesting initial results. In GPP, evolved optimal parallel programs with multiple instructions are to be executed in parallel on an optimally designed multiple-ALU processor (MAP). For all the problems solved, GPP not only can evolve parallel programs directly for any specified architecture, but more effectively and efficiently than its sequential counterpart. We therefore propose to design and implement an integrated GPP system consisting of a Multiple Instruction Multiple Data (MIMD) register machine, an evolution engine and control strategies to solve real-life problems, e.g. symbolic regression, algorithm learning and data mining. Due to the accelerated evolution phenomenon of GPP over sequential program evolution, we could also increase the normal GP's evolution efficiency by first evolving a parallel program by GPP and then translate the evolved MAP parallel program into a sequential program.
(CU03192)

Asymmetric Parametric Sequence Approach to Provide Secure Multimedia Delivery for Wired/Wireless Peer-to-Peer Systems: Theory, Design and Implementation

- ✍ LUI Chi Shing John
- ❑ 31 December 2003
- ❖ Research Grants Council (Earmarked Grants)

The goal of this research is to help computer system designers and engineers to understand various design issues and different tradeoff in designing a secure multimedia distribution system for wired/wireless peer-to-peer systems. We propose to build a prototype of a secure multimedia distribution system for a peer-to-peer network under the wired/wireless environment. Users in the peer group can distribute different forms of multimedia contents, e.g. MPEG1, MPEG2, MPEG4, MP3, AVI, Quicktime…etc.
This secure multimedia distribution can have many important applications, such as delivery of

educational video material to students and provide a collaborative work environment for engineers and scientists who are working in different parts of the Internet. This prototype system will allow us to take various measurement and fine tune different algorithms so that the system can operate at an optimal operating point. Lastly, we 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 systems, secure computer / communication systems, high performance networks and proxy systems.
(CU03186)

OnME: Online Mobile Engine for Creating Multi-players Online Game for Mobile Devices

- ✍ LUI Chi Shing John ● CHIU Dah Ming (Dept of Information Engineering)
- ❑ 1 March 2004
- ❖ Funding from Industrial Sponsors ● Innovation and Technology Support Programme, ITF, Innovation & Technology Commission

The objective of this project is to create a new platform for designing multi-players mobile online game for different mobile devices using the J2ME and Symbian. This project has a far reaching benefit to many industries, spanning from the movie/TV entertainment industries, to the comics/animation industries as well as mobile operators and mobile devices manufacturers.
There are some major technological challenges in realize this platform. First, we need a compact and efficient game engine to facilitate the rapid development of general multi-player mobile online game. The current PC/console game engines are not appropriate for mobile devices. The OnMe platform consists (1) Scene/Story-line editing tool; (2) Animation/Video Streaming library; (3) Networking module; (4) Memory management library for the compact memory requirement; (5) Version update engine to support on-the-fly download of new data/maps/story-text. Developers can use these components to quickly create multi-players mobile online games optimized for the wireless network and mobile devices. The proposed platform will help local designers to cope with the tight production schedule and maintain high quality game creation by re-using the well-structured components. This platform will create a new market and new revenues for entertainment and mobile industries.
(EE03794)

Reliable Automatic Multi-layer Video Content Classification Based on Syntactic and Semantic Features

- ✍ LYU Rung Tsong Michael ● Howard WACTLAR*
- ❑ 1 September 2003
- ❖ Research Grants Council (Earmarked Grants)

This project proposes to classify a video story by both syntactic features and semantic features. We first tackle the definition of these features and the means to extract them. Besides the textual information, aural and visual information is also considered in generating the Video Content Feature (VCF). Then, we investigate a number of classification models, including the Bayesian classifier, the neural networks, the Support Vector Machine (SVM), the Hidden Markov Model (HMM), and the decision trees, to construct an appropriate VCF classifier. The classifier will be trained to generate a multi-layer class hierarchy, which is

extendable to include new story classes. After the classification, the video story is organized into a tree structure to support a category-based query mechanism. We also build intra- and/or inter-class relationship among video stories, enabling rich representations of the video material.
(CU03182)

Augmented Reality Computing Arena for Digital Entertainment (ARCADE)

- ✍ LYU Rung Tsong Michael ● KING Kuo Chin Irwin ● WONG Tien Tsin
- ❑ 1 April 2004
- ❖ Funding from Industrial Sponsors ● Innovation and Technology Support Programme, ITF, Innovation & Technology Commission

We propose to apply Augmented Reality technology for digital entertainment by building an enabling environment called "Augmented Reality Computing Arena for Digital Entertainment (ARCADE)" to support the development of Augmented Reality entertainment applications. The objectives of ARCADE are to ease the hurdle of applying the Augmented Reality technology for digital entertainment, to enable new entertainment experience for end-users, and to provide new tools for helping the production of digital composition of virtual images with real scenes.
Video object tracking engine (VOTE) is the core component in ARCADE. Two video object tracking algorithms will be developed: 3D surface markers tracking and human head and face tracking. The former tracking technology will provide new technology tools for TV production and digital animation house. The latter tracking technology will bring new entertainment experience to theme park or amusement park visitors, kiosk-based entertainment viewers, and mobile entertainment application users.
(EE03335)

Fault-tolerant and Security Mechanisms for Mobile Agent Systems

- ✍ NG Kam Wing
- ❑ 31 December 2003
- ❖ Research Grants Council (Earmarked Grants)

Mobile agents are autonomous software processes that 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 and securely, independent of communication and node failure. This research aims to provide solutions for the fault-tolerant execution of mobile agents and the protection of mobile agents against malicious hosts. The solutions consist of a framework of fault-tolerant and security mechanisms that could be deployed in real-world applications. The fault-tolerant mechanisms include a lightweight fault-tolerant protocol for the exactly-once execution of mobile agents, and recovery algorithms based on the partial rollback of mobile agent execution. The security mechanisms include protocols for detecting tampering against a mobile agent's data and execution states, and protocols to detect malicious hosts.
(CU03187)

Multi-touch Haptic Sculpting with Constrained Geometries in Virtual Volume Space

✍ SUN Hanqiu ● JIN Xiaogang* ● XIN Zhouping (Dept of Mathematics)

❑ 1 September 2003

❖ Research Grants Council (Earmarked Grants)

Recently, the benefits of haptic rendering of volumetric data have been recognized, but this area of research has not yet fully explored. We will develop innovative algorithms for montage object fusion using harmonic mapping and constrained spatial deformation based on generalized meatballs, and carry out research in real-time dynamic volume rendering and haptic manipulation of the complex deforming geometries. We will study the dynamic deforming behavior of voluminous and complex structures under the simulated stress distribution and dynamic boundary conditions. The hybrid virtual environment that consists of both volumetric and geometric models will be haptically simulated. We hope that such and information-enhanced virtual simulator can offer long-term benefits of high quality, lower costs, and optimal efficiency in VR applications in Hong Kong.

(CU03181)

A Spherical Wavelet Approach for Image-based Relighting

✍ WONG Tien Tsin ● LEUNG Chi Sing*

❑ 1 August 2003

❖ Research Grants Council (Earmarked Grants)

In traditional computer graphics, accurate surface reflection is computed by sophisticated illumination model which requires expensive computation. In contrast, image-based relighting computes the reflected radiance simply by interpolation and superposition. Moreover, real-time rendering of arbitrarily complex scene is possible and resultant images are realistic. The trade-off is the enormous data acquired from images.

As the reflected radiance values through a pixel window form a spherical function, we propose an image-based representation for relighting based on spherical wavelet in this project. Spherical wavelet is compact to represent the spherical function. Its property of local support facilitates the representation of specular highlight and shadow. Its multiresolution nature allows the compressed data to be transferred and displayed progressively. We shall also investigate the possibility of developing a coding method for spherical wavelet which conforms to the latest wavelet-based JPEG2000 standard. This compatibility will allow the proposed image-based representation to be supported by both commercial software and hardware. Since we need to represent multiple spherical functions (one for each pixel), we shall also investigate the coding method that exploits the redundancy among pixels.

We believe the image-based representation and the set of coding algorithms developed in this project can improve the efficiency and practicability of current image-based modeling and rendering technology, which have a strong potential in computer games and Internet applications due to its real-time rendering nature. The result will contribute to both the research of image-based computer graphics and the development of computer game industry in Hong Kong.

(CU03189)

Optimal Multi-point Switching Box Structure for FPGAs and Communication Switching Networks

✍ WU Yu Liang ● FAN Hongbing# ● HONG Xian Long* ● WONG Chak Kuen

- 1 October 2003
- Research Grants Council (Earmarked Grants)

In this project, we propose to further explore our recently developed optimal switching structures targeting for simultaneous multi-point connections for re-configurable systems such as Field Programmable Gate Arrays (FPGAs) and communication switching networks. We have successfully built a formal mathematical model for analyzing the generalized optimum multi-point connection structure problems, and proposed a simple constructive design scheme for building such a structure under very low hardware cost. This switch network will be able to realize connections for any grouping of the *kxW* terminals (with terminals of the same group connected) under lowest hardware cost, which is useful for applications like multi-client phone connection, tele-conference, etc. We will further extend our theory for *irregular* switching box designs and study optimal FPGA architecture designs considering merging of C/S boxes.
(CU03229)

Extensions of BYY Independent State Space and Generalized APT Financial Models

- XU Lei
- 1 July 2003
- Research Grants Council (Earmarked Grants)

An efficient computational model for financial market will not only provide a theory for understanding market but also an effective information processing technique for financial analysis, investment management and portfolio optimization, especially in the rapid developing intend supporting environment. The arbitrage pricing theory (APT) is a well known theory for financial market modeling. However, implementing APT relies on the well known factor analysis as a tool. While being widely applied to various tasks of data analyses and information process factor analysis not only suffers an intrinsic rotation indeterminacy but also has no consideration on temporal dependence. The Bayesian Ying-Yang (BYY) independent state space approach extends factor analyses by considering temporal structure via introducing an auto-regressive state space for inner factors, with both the disadvantages removed. This proposal targets on further generalizing the BYY independent state space to a wider scope of state space models that includes a mixture of multiple stable and identifiable state spaces, with their state behaviors driven by both Gaussian and nonGaussian factors. Moreover, not only parameter learning can be effectively implement by an EM-like algorithm via the nature of Gaussian mixtures, but also model selection can be made automatically during learning via the nature of BYY harmony learning. Basing on these studies, generalizations of the APT will be explored on financial data from the Hong Kong markets. Focuses will be given on finding appropriate factors, testing whether the factors are independent, as well as how to including macro-economic factors to further improve the APT model.
(CU03184)

Interconnect Driven Floorplanning for 3-D Chips

- YOUNG Fung Yu
- 1 October 2003
- Research Grants Council (Earmarked Grants)

One negative by-product of the rapidly increasing chip size of modern ICs is the growing number of excessively long on-chip wires and the increase in critical path length. Three-dimensional ICs (3-D

ICs) can alleviate this interconnect delay problem by offering higher flexibility in design routing. Some previous works have studied the benefits of such 3-D integration system and shown that 3-D integration scheme can offer substantial advantages over traditional 2-D approach in total wire length, system timing and chip area. However no circuit fabrication technology is commercially viable without the tools that allow designers to develop circuits using the technology. Our goal is to develop a floorplanning tool for 3-D chips. The objective of this project is *to study and develop the methodology and tools for performance driven floorplanning in 3-D ICs*. The floorplanning process will be divided into three phases: (1) device layer assignment, (2) performance-driven floorplanning, and (3) module sizing and replication. In the major part of performance-driven floorplanning, issues like chip area, buffer insertion, usage of 3-D vias (for vertical connections), congestion, critical path length, circuit retiming and chip temperature will be considered. This is a pioneering attempt in devising such a performance-driven floorplanning tool for 3-D chips, the success of which will benefit the EDA industry, and the development of Hong Kong as a high technology center.
(CU03188)

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

Edition Title/Investigators

1999-00 Intersection Graphs and Their Recognition Algorithms (CU99410)
✍ CAI Leizhen

2001-02 Efficient Algorithms for a Contamination Control Problem on Graphs (CS01165)
✍ CAI Leizhen

2001-02 Financial Application of Neuro-Dynamic Programming (CS01170)
✍ CHAN Lai Wan

2001-02 Where is the Beef? Data Mining in High Dimensional Space (EE01179)
✍ FU Wai Chee Ada ● KING Kuo Chin Irwin

2001-02 High Performance Computing for Centers, Distinguisher and Clusters in Projected Subspace (and Applications to Intelligent Information Retrieval on the Web) (EE01492)
✍ FU Wai Chee Ada ● DENG Xiaotie* ● ZHENG Weimin* ● WANG Dongshen* ● WANG Lusheng*

2002-03 Outlier Detection in Large Databases (EE02741)
✍ FU Wai Chee Ada

2000-01 Augmented Reality System for Endoscopic Surgery Simulation and Operations (CU00012N)
✍ HENG Pheng Ann ● LEUNG Kwong Sak ● WONG Tien Tsin ● SUNG Joseph Jao Yiu (Dept of Medicine & Therapeutics) ● CHUNG Sheung Chee Sydney (Dept of Surgery) ● TANG Zesheng* ● CHAI Jianyun*

2001-02 Comprehensive Analysis and Interactive Visualization of Cardiac MR Data (CS01180)
✍ HENG Pheng Ann ● WANG Yongmei* ● SHI Peng Cheng*

2002-03 Visualization and Virtual Reality Research in Chinese Visible Human Project (EE02941)
✍ HENG Pheng Ann ● WONG Tien Tsin ● FUNG Ping Fu ● CHUI Yim Pan ● XIE Yongming

2002-03 Virtual Anatomy (EE02595)
✍ HENG Pheng Ann ● CHUI Yim Pan ● WONG Tien Tsin ● XIE Yongming

2002-03 Target Information Estimation for Relevance Feedback Framework in Content-Based Image Retrieval (CU02351)
✍ KING Kuo Chin Irwin

2000-01 Collaborating Redundant Models in Constraint Satisfaction (CU00183)
✍ LEE Ho Man Jimmy ● LEUNG Ho Fung ● STUCKEY P. J.*

2001-02 Reducing Search Space in Local Search for Constraint Satisfaction (CS01204)
✍ LEE Ho Man Jimmy ● LEUNG Ho Fung ● STUCKEY P. J.*

2002-03 Efficient Local Search Methods for Soft Constraint Satisfaction Problems (CU02358)
✍ LEE Ho Man Jimmy ● CODOGNET Philippe* ● LEUNG Ho Fung

2002-03 Efficient Local Search Methods for Soft Constraint Satisfaction Problems (EE02934)
✍ LEE Ho Man Jimmy ● CODOGNET Philippe*

2002-03 Automated Design and Prototyping of Communication Architectures for Heterogeneous Systems-on-a-chip (EE02797)
✍ LEE Kin Hong ● GLESNER Manfred*

2001-02 Fast Approximate Feature Extraction for Content-based Visual Databases (EE01903)
✍ LEE Moon Chuen

2002-03 Towards Fast Extraction of Approximate Features for Content-based Access in Visual Informaiton Retrieval (CU02377)
✍ LEE Moon Chuen

2001-02 Interface Software for Cluster Computing: Providing Cost Effective Computational Turn-key Solutions to Local Industries (MD01951)
✍ LEONG Philip Heng Wai ● LEUNG Kwong Sak ● SUEN Wai Mo* ● CHOW Kenneth*

2002-03 Floating Point Computation Using FPGA Clusters (CU02333)
✍ LEONG Philip Heng Wai ● LUK Wayne*

2001-02 Integration of Constraint Satisfaction Techniques and Mixed Integer Programming (CS01211)
✍ LEUNG Ho Fung ● LEE Ho Man Jimmy

2002-03 Adaptive Strategies for Soft Bid-Determination in Agent Based Continuous Double Auctions (CU02346)
✍ LEUNG Ho Fung ● LEE Ho Man Jimmy

2000-01 A New Class of Genetic Algorithms with Applications on Data Mining (EE20009)
✍ LEUNG Kwong Sak

2001-02 A Novel Fast Evolutionary Algorithm and Its Application in Unsupervised Learning (CS01212)
✍ LEUNG Kwong Sak ● WONG Man Leung*

2002-03 GPP: A Novel Framework for Genetic Parallel Programming (EE02481)
✍ LEUNG Kwong Sak

2001-02 Object Synchronization, Dynamic Resource Allocations and Admission Control Policies for Distributed Streaming Multimedia Systems: Design, Analysis and Implementation (CS01220)
✍ LUI Chi Shing John

2002-03 A Proportional Delay DiffServ-Enabled Multimedia Server: Admission Control, Resource Allocation and Dynamic Adaptation (CU02368)
✍ LUI Chi Shing John

2000-01 Dependability and Security Paradigms for Mobile Agent Systems (CU00193)
✍ LYU Rung Tsong Michael

2001-02 Engineering Distributed Objects for Reliability and Interoperability (CS01222)
✍ LYU Rung Tsong Michael

2002-03 Design Diversity by Component-Based Software Development (CU02360)
✍ LYU Rung Tsong Michael ● STRIGINI Lorenzo*

2001-02 Fixed-Point Algorithms for In-Card Fingerprint Recognition (CS01224)
✍ MOON Yiu Sang ● LUK Franklin Tai Cheung#

2002-03 Clustering of Color Map Pixels for GPS/GIS Applications (EE02527)
✍ MOON Yiu Sang ● LUK Tai Cheung Franklin*

2001-02 Synthesizing Multidimensional Applications on Reconfigurable Computing Systems (EE01437)
✍ NG Kam Wing

2002-03 Fault-tolerant and Security Mechanisms for Mobile Agent System (EE02424)
✍ NG Kam Wing

2000-01 Advanced Knowledge Discovery & Spatial-temporal Visualization for Georeferenced Information (CU00016N)
✍ SUN Hanqiu ● LEUNG Yee (Dept of Geography & Resource Management) ● LEUNG Kwong Sak

● LIN Hui (Dept of Geography & Resource Management) ● PENG Qunsheng* ● BAO Hujun*

2001-02 A Multisensory Virtual Environment for Dental Surgical Simulation & Training (CS01189)

✍ SUN Hanqiu ● LEONG Philip Heng Wai ● QIN Kaihuai* ● TSANG Wai Kit Ricky (University Health Service) ● TO Wai Hei Edward*

2001-02 Image-based Synthesized Techniques for Augmented Reality (EE01459)

✍ SUN Hanqiu

2002-03 Interactive Deformable Registration & Simulation of Medical Volumetric Datasets (CU02356)

✍ SUN Hanqiu ● ARIFI Ahmed A (Dept of Surgery)* ● QIN Kaihuai* ● ZOU Jun (Dept of Mathematics) ● TO Wai Hei Edward*

2000-01 Accelerating High-quality Volume Visualization with Image-based Computer Graphics (CU00186)

✍ WONG Tien Tsin ● HENG Pheng Ann

2001-02 Effective and Efficient Compression for Image-based Modeling and Rendering (EE01369)

✍ WONG Tien Tsin

2002-03 Low-cost Tele-immersive Display with Multiple Live-video Streams (EE02615)

✍ WONG Tien Tsin ● HENG Pheng Ann ● WONG Man Leung*

2001-02 A Graph-based Rewiring Scheme for Boolean Networks and Its Applications for New FPGA Design Automations (EE01236)

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

2002-03 Optimization Algorithm Based on the Less Flexibility First Principal and Its Practical Applications (CS02573)

✍ WU Yu Liang ● DONG Sheqin*

2000-01 Extending APT Financial Modeling by State Space Approach, Kalman Filtering and Temporal BYY Learning (CU00169)

✍ XU Lei

2002-03 Structural Rival Penalized Competitive Learning with Automated Model Selection (CU02336)

✍ XU Lei

2001-02 Interconnect-Driven Multilevel Floorplan Design (EE01231)

✍ YOUNG Fung Yu ● WONG Martin D F* ● YANG Honghua Hannah*

RESEARCH PROJECTS

Reconstruction of 3D Objects from 2D Images for Animation

- ✍ CHAM Wai Kuen
- ❑ 1 November 2003
- ❖ CUHK Research Committee Funding (Direct Grants)

We propose to develop a convenient and fast method to convey human perception of 3D shape into a computer. A simple and direct way to show the 3D structure of an object is a 2D line drawing. Given an object in a 2D intensity image, we can expose its 3D structure easily by drawing lines with a mouse along edges of the object in the image such that the line drawing looks like the 2D projection of the 3D object. Whilst a human brain can readily perceive the shape of the object from the line drawing, we must develop a method for a computer to do the job. Hence, the problem of 3D shape reconstruction now becomes the problem of 2D line drawing interpretation.

Objects consist of faces. If the face configuration of an object is known before reconstructing its 3D geometry, the complexity of the reconstruction will be reduced significantly. Therefore, we propose to divide the problem into two parts: face identification and 3D geometry reconstruction. Our target is that the total computation time should be within one second for objects having twenty faces or less on a typical PC. The results of the research will have applications in CAD, virtual design, model-based vision and computer animation and adds a new dimension to image processing.

(EE03608)

Methodology of Finding Optical Orthogonal Codes for Fiber Optic CDMA and Their Simulation Studies

- ✍ CHAN Kam Tai
- ❑ 1 November 2003
- ❖ CUHK Research Committee Funding (Direct Grants)

Fiber-optic code division multiple access (FO-CDMA) is a novel attractive broadband fiber-optic access technology. It is especially suitable for local area network (LAN) applications owing to its unique attributes of all optical processing, asynchronous transmission, soft capacity, low delay access by a large number of users. The aim of this proposal is to investigate the methodology of searching for the appropriate optical codes suitable for FO-CDMA and the implementation of such codes by fiber Bragg gratings. First, the appropriate codes should be found that have as large auto-correlation and as small cross-correlation as possible. In calculating the auto-correlation, there is no need to cater to multipaths because it is assumed that the signals will all arrive from the fiber which does not allow multipaths to exist. On the other hand, cross-correlation requirements are more stringent because the other users may send their signals at arbitrary times simultaneously. Hence it is conceivable that these codes can differ significantly from the codes for wireless communications. After the codes have been found, the performance of the codes by encoding and decoding them via super-structured fiber Bragg gratings will be simulated to determine if the super-structured fiber Bragg gratings can really implement the correlation features intrinsic to the codes. This step must be done because up to now there has been no

appropriate encoder or decoder that can truly perform phase encoding and decoding of optical signals as good as what the codes can predict mathematically. With such results available, then one can decide whether the technique is feasible in a real access network environment.
(EE03505)

Broadband High Linearity Amplifier Design for Wireless Mobile Terminals

- ✍ CHENG Kwok Keung Michael
- ❑ 1 November 2003
- ❖ CUHK Research Committee Funding (Direct Grants)

Modern digital communication systems require highly linear power amplifier (PA) to minimize undesirable out-of-band emission that may violate the FCC specification. Several techniques have been developed to achieve linear amplification such as the feed-forward and pre-distortion schemes. Due to the increased demand in high data-rate applications, the capability of power amplifier to handle broadband signal has become a major consideration in wireless communication systems. In this project, advanced bandwidth enhancement techniques will be investigated for high linearity broadband power amplifier design. The proposed work is essential to emerging 3G and wireless LAN markets and will have a significant impact on design and performance of future mobile terminals.
(EE03460)

Application Specific Instruction Set Processor with Asynchronous Methodology

- ✍ CHOY Chiu Sing Oliver
- ❑ 1 November 2003
- ❖ CUHK Research Committee Funding (Direct Grants)

The main task of this project is to design an ASIP (Application Specific Instruction set Processor) by asynchronous methodology for a specified range of similar applications, implemented with VLSI.
The objective of the ASIP design is to design electronic system efficiently with the optimum performance that is cost effective. The creation of this new processor is a balance between two extremes: custom designs and general programmable processors. Similar to a general-purpose processor, ASIP will have a specified instruction set and architecture that we customized for a targeted set of similar applications to greatly enhance performance. In general, ASIP will extend the instruction set and datapath of a general programmable processor. New instructions may be either subroutine or a sequence of instructions that are common in the applications and the extension of datapath may include specific function units, memory, register file and interconnection. Flexibility is clearly the accent of an ASIP. That is also assured because it is very easy to change instructions to modify the control of the datapath.
In order that an ASIP can be put together readily and efficiently, the processor will be running asynchronously. Without a global clock acting as a sequence control signal as in a synchronous system, many clock timing problems are avoided. As long as each asynchronous module is functionally correct, timing and function correctness of the whole system are guaranteed by handshake communication between these modules. Designing an ASIP becomes a simple stitching together of the necessary modules. Use of the asynchronous methodology

will also result in some other good characteristics, such as low power and ease of modular composition.
(EE03670)

Application of Surface Plasmon Enhanced Transmission to Phase-sensitive Optical Sensors

- ✍ HO Ho Pui ● LIN Chinlon (Dept of Information Engineering)
- ❑ 1 January 2004
- ❖ CUHK Research Committee Funding (Direct Grants)

This project aims to use a recently discovered effect called "surface-plasmon-enhanced transmission" (SPET) for optical sensor applications. SEPT refers to an extraordinarily large optical transmission through sub-wavelength perforations fabricated in an optically opaque metal film. Despite that conventional theory has been unable to account for this intriguing observation, it has been shown that SPET is caused by "couple surface plasmons" excited by the incident optical beam. The involvement of surface plasmons leads to the idea of using SPET for improving the design of surface plasmon resonance sensors. The proposed scheme offers several advantages over the conventional design, including faster sample throughput because of a more straight-forward optical set-up, better spatial resolution because of the inherent optical confinement associated with SPET, and higher measurement sensitivity because of the measurement of differential optical phase. Two-dimensional imaging, thus offering parallel sensing of a large number of sensor sites, can be achieved by using perforation arrays and an imaging detector. The widespread interest from the health market in developing low-cost sensor devices, including those using the surface plasmon resonance effect, means that our project theme is of much commercial relevance.
(EE03521)

Analysis and Modeling of Natural Prosody for Cantonese Text-to-Speech Synthesis

- ✍ LEE Tan
- ❑ 1 December 2003
- ❖ CUHK Research Committee Funding (Direct Grants)

The technology of speech synthesis enables computers to speak like human. The ultimate goal is to automatically convert any text or concept input into acoustic signals that sound as natural as human speech. The applications include automated information delivery, multi-modal human-computer interface and reading aids for the visually impaired. Although most of the existing speech synthesis systems can generate speech with high intelligibility, the naturalness of synthetic speech is generally considered inadequate. The lack of naturalness is perceived particularly in the aspects of intonation and tempo. The proposed research aims at improving the naturalness of Cantonese synthetic speech via the incorporation of properly designed prosody models. Prosody refers to the temporal and rhythmic structure of human speech. It covers the phenomena of intonation, segmental duration, pauses, breaks, stress, and many others. Cantonese is the most commonly spoken Chinese dialect in Hong Kong and Southern China. It possesses many special linguistic features, which present great challenges to the proposed investigation.

The primary objective of this research is to establish a descriptive understanding about the acoustic realization of natural prosody in continuous Cantonese speech. This will be achieved via

statistical analysis of the fundamental frequency, duration and intensity features extracted from a large amount of natural Cantonese utterances. Accordingly we will attempt to derive a set of simple rules that cover the major considerations in prosody generation for Cantonese text-to-speech. Finally, the rule-based prosody model will be integrated with our existing TTS system and performance evaluation will be carried out via subjective listening test. We will investigate on the relationship between perceived prosody and acoustically measured prosodic parameters and try to identify what kind of prosodic alternation would most affect the speech naturalness.
(EE03821)

Development of a Platform for Teleoperated Medical and Healthcare Services

- ✍ MENG Max Qing Hu
- ❑ 16 August 2003
- ❖ Research Grants Council (Earmarked Grants)

The proposed research will investigate and develop the fundamental theory, core technologies and critical applications in next generation teleoperated medical and healthcare services using smart robotic devices, potable medical equipment and devices, real-time network transport protocols, and intelligent sensor technologies. Examples of teleoperated medical and healthcare services include monitoring and assisting of elderly people in home care environments, telemedicine based examination and diagnosis of patients at small community clinics in rural areas by experts from distant medical centers over a communication link. The anticipated outcomes from the proposed research will provide new technologies to expand medical and healthcare service capabilities, breaking the limit of space and time in delivering large medical center expert services to smaller hospitals and clinics in rural areas over a communication link. The success of the proposed project will provide Hong Kong medical and communications industries the opportunities to lead in innovative tele-healthcare technologies and to provide tele-healthcare services in Hong Kong, China, and even around the globe to improve the quality of life of human beings in general and the people in need of the services in specific.
(CU03199)

Unsupervised Extraction of Visual Attention Objects in Color Images

- ✍ NGAN King Ngi
- ❑ 1 April 2004
- ❖ CUHK Research Committee Funding (Direct Grants)

Content-related functionalities of multimedia applications call for efficient tools that can automatically extract meaningful objects in images. However, traditional methods generally fail to capture objects of user interest because they totally neglect human visual attention perception. Aiming to address this problem, this project proposes a generic model for unsupervised extraction of viewer's attention objects from color images. Without the full semantic understanding of image content, the model formulated the attention objects as a Markov random field (MRF) by integrating computational visual attention mechanisms with seeded region growing techniques. Furthermore, we express the MRF in the form of a Gibbs random field with an energy function. The minimization of the energy function provides a practical way to obtain attention objects. The proposed model extracts attention objects from images in a manner analogous to human visual perception and has great promise to

become a basic tool for second-generation multimedia services such as content-based image/video coding, indexing, and retrieval. Subjective evaluation of the experimental results will be performed to determine the effectiveness and robustness of the proposed approach.
(EE03796)

Localization Schemes for Telecommunication Applications

- ✍ P.C. CHING ● CHAN Yiu Tong
- ❑ 1 August 2003
- ❖ Research Grants Council (Earmarked Grants)

In telecommunications, there are many applications where it is necessary to know the position of a signal source. Examples are in the localization of a mobile phone for surveillance or emergency assistance, and of a speaker in a teleconference for proper camera pointing. Receivers, base stations in the case of the mobile phone and microphones for speakers, intercept the source signals and then through triangulation, locate the phone or speaker positions. This project aims to develop accurate methods to accomplish localization.
(CU03201)

A New Vector Orthogonal Frequency Division Multiplexing for Broadband Communication Systems

- ✍ P.C. CHING ● XIA Xianggen*
- ❑ 1 October 2003
- ❖ Research Grants Council (Earmarked Grants)

While the 2G cellular systems are widely used everywhere and the 3G systems, although technically viable, have not yet been fully deployed due to their performance limitations, the 4th generation mobile communication systems have begun to attract a lot of attention from the research community. The 4G system under investigation is expected to have significantly higher performance goals than most existing systems. For instance, it is aimed to provide 20MHz bandwidth in transmission that should be adequate for most, if not all, applications. However, it is still in the research stage and some of the technical challenges such as severe frequency-selective fading still need to be overcome. In this particular regard, the orthogonal frequency division multiplexing (OFDM) system is well recognized as an effective solution and has been successfully applied in digital video broadcasting (the DVB in European systems) and wireless LAN (the IEEE 802. 11a and g standards).
In this project, we attempt to explore a new vector OFDM scheme for broadband wireless systems with applications to the 4th generation cellular communication and digital video broadcasting. The proposed VOFDM framework can be applied to both single and multiple antenna systems with better power and bandwidth efficiencies over the conventional OFDM systems. These are critical attri9butes for cellular applications and are also important in enlarging the coverage area of DVB systems. Furthermore, the new VOFDM should be able to combine naturally with matrix modulations for combating multi-path fading. The outcomes of this project could result in potential new standards for the 4G cellular and DVB systems.
(CU03197)

Development of a Flexible IF-Sampling Sigma Delta Analogue-to-Digital Converter for Multi-Mode Cellular Mobile Terminals

- ✍ PUN Kong Pang ● CHAN Cheong Fat ● CHOY Chiu Sing Oliver
- ❑ 8 September 2003
- ❖ Research Grants Council (Earmarked Grants)

This project focuses on a novel IF-sampling analogue-to-digital (A/D) converter for the application in cellular mobile receivers. The IF A/D conversion will allow more signal processing, for example, gain, filtering and demodulation, to be performed in digital domain, thereby allow more programmability of the receiver. The project aims at achieving a high and tunable IF (in the range of 50-250MHz) to enable a flexible receiver architecture, and make the converter immediately applicable to most exiting receivers. Besides, the proposed A/D converter will be compatible with both GSM-like second generation standards and WCDMA standard of third generation systems. It will exhibit different bandwidth and dynamic range performance when operates in different modes. In this project, the continuous-time sigma-delta modulation approach, which allows high linearity and signal-to-noise ratio by means of oversampling and spectral shaping of the quantization noise, will be adopted. The proposed IF ADC will be fully integrated using a deep sub-micron CMOS technology.
(CU03202)

All-optical Wavelength Converters for Dense Wavelength-division Multiplexing Communications

- ✍ SHU Ching Tat C. ● TSANG Hon Ki
- ❑ 1 September 2003
- ❖ Research Grants Council (Earmarked Grants)

All-optical wavelength conversion is a key enabling technology in future optical networks to avoid the block of traffic and to allow dynamic routing of signals. The conversion also offers simplicity and flexibility in network management. In this proposal, we focus on the use of four-wave-mixing in a semiconductor optical amplifier to perform the conversion. The integrated optical approach offers a solution for strict transparency to convert wavelength at a rate upto hundreds of Gb/s. However, there are drawbacks of the approach including a narrow wavelength conversion range and polarization dependence of the conversion efficiency and optical signal to noise ratio. To overcome the problems, we propose an innovative conversion scheme based on polarization-diversified SOA fiber rings for broadband orthogonal pumps four wave mixing. We also explore additional functional features of our converter, including simultaneous data format conversion and time-division-demultiplexing. The dynamics of wavelength tuning in the converter will be probed by constructing a switching a switching-wavelength pump source. The study is important for network control on the routing of optical packets. To conclude the project, we will address packaging issues of the converter and propose solutions to some of the major problems.
(CU03196)

Novel Techniques for Transient Protection in Optical Networks

- ✍ TSANG Hon Ki ● SHU Ching Tat C.
- ❑ 1 October 2003
- ❖ Research Grants Council (Earmarked Grants)

Erbium doped fiber amplifiers (EDFAs) have enabled the rapid widespread deployment of wavelength division multiplexed (WDM) optical networks. However the adding or dropping of channels, either from network reconfiguration or faults, will lead to

transient power fluctuations in the surviving channels because of cross saturation in EDFAs. In mesh optical networks the unplanned dropping of a set of channels can cause transients which ripple through the network and potentially cause network outages. A related problem is the onset of spectral tilt in nominally gain-flattened EDFAs when the total input signal power changes or the EDFA pump power is adjusted to compensate for the planned add or drop of a subset of channels. In general the static gain-flattening filters (GFF) employed in EDFAs only achieve gain flatness for a constant signal gain. Uncompensated gain tilt can rapidly accumulate in a cascade of amplifiers to produce excessive power at one end of the spectrum and too low a power at the other end, making the received signal unacceptable for the limited dynamic rage of receivers. Spectral tilt across WDM channels may also accumulate from stimulated Raman scattering. The proposed research aims to address the problems of optical transients and spectral gain tilt in optical networks by investigating novel devices for detecting and compensation transients and spectral tilt.
(CU03198)

The Position of Chinese among the Languages of Asia

- ✍ WANG William S Y ● MURRAY Gell-Mann*
- ❑ 1 September 2002
- ❖ Research Grants Council (Earmarked Grants)

Chinese is surrounded by diverse languages. Whereas its relationship to languages of the Tibetan group and Burman group is largely secure, its relationship to Austria Asiatic and Austronesian languages remains controversial. We aim to determine the position of Chinese among these languages by research within a multidisciplinary framework.
(AL02306)

Ion Beam Synthesis of Si-based Nanostructures for Optoelectronics Applications

- ✍ WONG Sai Peng Joseph
- ❑ 1 September 2003
- ❖ Research Grants Council (Earmarked Grants)

In this project, we shall synthesize nanometer-sized $FeSi_2$ in Si by implantation using a metal vapor vacuum art ion source. The dependence of the micro structures and light emission properties of the implanted samples on the processing conditions. The formation mechanisms of these structures and light emission mechanisms will be studied. The fabrication of possible device structures from this material system will also be explored.
(CU03231)

Research and Development of LTCC Integrated Modules for Wireless Communication Products

- ✍ WU Ke Li ● WANG Jie
- ❑ 1 October 2003
- ❖ Funding from Industrial Sponsors ● Innovation and Technology Support Programme, ITF, Innovation & Technology Commission

The industry has shown a clear trend towards greater functionality, denser integration and lower cost. Great attention has been paid to the integration of passive components and circuits. One of the most prevailing technologies for passive integration is Low-Temperature Cofired-Ceramic (LTCC).
This project aims at uplifting the multi-chip and multi-functional high module design capability in

Hong Kong and promoting the business partnership with high volume LTCC manufacturing industry in Shenzhen, China. By combing the design strength in Hong Kong and manufacturing and market advantage in China, Hong Kong electronic industry will position himself in a new competitive edge in the high frequency module industry. The objectives of the project will be achieved through

Developing the core design technology for Multi-Chip Module (MCM) with embedded passives. The design technology will provide timely support of fast product development;

Developing 5 key and widely used high-end LTCC modules for local wireless industry. The modules include a compact Bluetooth Front End Module (FEM), a 5.8 GHz multichip transceiver module for cordless phones, an integrated diplexer/switch module for GSM phones, a high performance Voltage Controlled Oscillator (VCO) module and a balanced amplifier module for wireless repearters; and

Providing a complete measurement procedure for characterization of LTCC material and modules.

(EE03389)

A Derived Equivalent Circuit Model for Embedded Passive RF Circuits

- ✍ WU Ke Li
- ❑ 1 January 2004
- ❖ CUHK Research Committee Funding (Direct Grants)

The recent development of wireless industry has shown a clear trend that more and more passive elements and circuits are either monolithically integrated with active circuits on an RFIC die, or embedded in the packaging substrate that RFIC dies are directly attached to. When the working frequency is in Gig hertz range, the parasitic effects existed among conducting traces become apparent and have to be incorporated in system design stage. The most effective way to incorporate the effects in the design is to use an equivalent circuit model.

The proposed research aims at developing a systematic approach, based on a mixed electromagnetic and network analysis, to deriving a physically expressive circuit model for passive elements embedded in RFICs and packaging substrates. The equivalent circuit model will reflect all the major parasitics by a frequency independent network for a given accuracy requirement in the frequency band of interest. The developed model will be extensively verified in a wide range of LTCC embedded components.

(EE03876)

An Innovative Wireless Multifunction Stethoscope with Its Applications in Telemedicine and Home Healthcare

- ✍ ZHANG Yuanting ● CHENG Chun Yiu Jack (Dept of Orthopaedics & Traumatology) ● NG Ho Keung (Dept of Anatomical & Cellular Pathology) ● LEUNG Kwok Yiu (Centre for Innovation and Technology) ● TSO S K* ● YU K Y*
- ❑ 1 July 2003
- ❖ Funding from Industrial Sponsors ● Innovation and Technology Support Programme, ITF, Innovation & Technology Commission

Rapid economic developments and political stability in recent decades have resulted in greater prosperity, increased life expectancy and better working conditions in developed regions like Hong Kong. These improvements have, however, been accompanied by the challenges of escalating health-care costs, which are mainly caused by the

ageing population. New strategies and methods are needed to control these costs. The proposed project is aiming to improve the efficiency of the traditional healthcare service provision by applying the state-of-the-art communication, wireless, machine intelligence and service automation technologies to develop a new user-friendly telemetry system for medical applications. The realization of this project will allow the patients and the elderly people to stay at home and send vital personal states such as pulse rate, blood pressure, blood oxygen saturation level, heart sounds, hung sounds and temperature to their doctors. Based on the provided data, the doctors can monitor a large class of patients at their own home, thereby obviating the need for either party traveling and reducing the occupation of valuable beds in hospitals. In addition to the above benefit, the new technology can also meet the life-style of modern society, where individuals tend to travel more often for work and for pleasure, and are more concerned about their own well being. In the project, various previously developed non-invasive biosensors for measuring vital signs will be enhanced for home use and also a new multifunction stethoscope will be developed to diagnose cardiovascular and pulmonary disorders. In order to make the system more user-friendly for non-expert users, a new Medical Plug and Play system will be developed. The proposed system will also provide a pre-diagnosis facility in order to speed up the diagnosis process. Besides the above benefits, the deliverables of the project could be readily converted into a design-intensive high-value-added commercial product in a relatively short duration. This will certainly form a living proof on how the telemedicine and service automation technology can be used in creating innovative products and open up a new profitable sector for Hong Kong industry.

(EE03814)

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

Edition	Title/Investigators
2001-02	Generation of 3D Wireframe Face Model from Movies and Face Animation (CS01167) ✍ CHAM Wai Kuen ● TSUI Hung Tat
2002-03	Reconstruction of 3D Manifold Objects from 2D Images by Face Identification (EE02806) ✍ CHAM Wai Kuen
2000-01	900 and 1800 MHz Digital Controlled Oscillators for Wireless Communication (CU00218) ✍ CHAN Cheong Fat ● CHOY Chiu Sing Oliver
2000-01	High-energy and High-repetition Rate Mode-locked Fiber Laser (EE20013) ✍ CHAN Kam Tai
2001-02	Study of Coherent and Incoherent Optical Pulse Coding Techniques for Fiber-Optic CDMA (EE01169) ✍ CHAN Kam Tai ● LOU Caiyun*
2001-02	Novel RF Power Amplifier Linearization Techniques for Next Generation Wireless Communication Systems (EE01174) ✍ CHENG Kwok Keung Michael

2001-02 A Contactless Java Card Chip Using Asynchronous Circuit Techniques (EE01176)

✍ CHOY Chiu Sing Oliver ● CHAN Cheong Fat

2002-03 A CMOS Direct Conversion Receiver for Third Generation Communication (EE02705)

✍ CHOY Chiu Sing Oliver ● PUN Kong Pang

2002-03 MOVPE Synthesis of InGa(N)As Quantum Dots for Enhanced Luminescence at 1.3μm (EE02317)

✍ HO Ho Pui

2000-01 Development of a Cantonese Text-to-Speech System with High Naturalness (CU00219)

✍ LEE Tan ● MENG Mei Ling Helen (Dept of Systems Engineering & Engin. Management) ● ZEE Yun Yang Eric*

2001-02 Use of Prosodic Information in Chinese Continuous Speech Recognition (EE01206)

✍ LEE Tan ● XU Bo*

2002-03 Interactive Healthcare Measuring, Monitoring, and Assisting Systems Using Wireless WAP Devices (EE02477)

✍ MENG Max Qing Hu

2001-02 Adaptive Beamforming and Spectral Filtering for Speech Source Tracking and Recognition (EE01175)

✍ P.C. CHING ● SO Hing Cheung* ● WONG Kon Max

2001-02 A CMOS RF Front-end Chip for 3G WCDMA Applications (EE01690)

✍ PUN Kong Pang

2000-01 A New Family of Electrically Wavelength-tunable Semiconductor and Fiber Lasers (CU00220)

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

2001-02 Ultrafast Photonic Analog-to-digital Converters (EE01680)

✍ SHU Ching Tat C. ● LIU Hai Feng* ● CHIANG Kin Seng*

2002-03 Photonic Pre-processors for Ultrafast Analog-to-digital Converters (CU02369)

✍ SHU Ching Tat C. ● LIU Hai Feng*

2000-01 Measurement of All-optical Nonlinearities in Ion-Implanted Materials (CU00221)

✍ TSANG Hon Ki ● WONG Sai Peng Joseph

2001-02 Components for Next Generation All-Optical Wavelength-Division-Multiplexing Networks (EE01192)

✍ TSANG Hon Ki ● SHU Ching Tat C.

2002-03 Modeling of Building Environments for Augmented Reality (CU02378)

✍ TSUI Hung Tat

2000-01 Nano-granular Metal-carbon Thin Films by Pulsed Filtered Vacuum Arc Deposition (CU00216)

✍ WONG Sai Peng Joseph

2001-02 Enhancement of Electron Field Emission Properties by Surface Engineering and Ion Beam Processing (EE01200)

✍ WONG Sai Peng Joseph

2001-02 A Multi-institutional Effort to Establish an Advanced Surface Technology Development Centre (EE01769)

✍ WONG Sai Peng Joseph ● LAU Leo Woon Ming (Dept of Physics) ● WONG Hong Kuen (Dept of Physics) ● TSUI Yun Cheong Ricky* ● YEUNG Lee Kin Kinny* ● ONG Chung Wo*

2002-03 Low Level Birefringence Detection for Study of Stresses in Ultrathin Film/Substrate Systems (CU02370)

✍ WONG Sai Peng Joseph

2001-02 Integrated LTCC Antenna Array and Front-end Passive Modules for Millimeter Wave Wireless Communication Systems (EE01202)

✍ WU Ke Li

2002-03 A Highly Efficient Modal Analysis Methodology for Integrated RF Passive Circuits with Finite Metallization Thickness (CU02371)

✍ WU Ke Li

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*

2000-01 Size Effects of SrBi2Ta2O9 (SBT) Ferroelectric Thin Films (CU00214)

✍ XU Jianbin ● WILSON Ian Howard ● WONG Sai Peng Joseph

2001-02 Engineering and Characterization of Low-Dimensional Group IV Materials by Scanning Probe Microscopy (EE01203)

✍ XU Jianbin ● HE James Zhongqing#

2002-03 Engineering and Characterization of Organic Electronic Films and Devices by Scanning Probe Microscopy (CU02372)

✍ XU Jianbin ● KWOK H L Harry* ● LAU Leo Woon Ming (Dept of Physics)

2001-02 Development of Medical Devices and Nano-biosensors to Promote Biomedical Electronic industry in Hong Kong (BL01873)

✍ ZHANG Yuanting ● CHAN Kam Tai ● P.C. CHING ● WONG Sai Peng Joseph ● LEE Tan ● HENG Pheng Ann (Dept of Computer Science and Engineering) ● LEONG Philip Heng Wai (Dept of Computer Science and Engineering) ● CHENG Chun Yiu Jack (Dept of Orthopaedics & Traumatology) ● SUNG Joseph Jao Yiu (Dept of

Medicine & Therapeutics) ● WOO Jean (Dept of Medicine & Therapeutics) ● NG Ho Keung (Dept of Anatomical & Cellular Pathology) ● LI Wen Jung (Dept of Auto. & Computer-Aided Engin.) ● TSUI Kwok Wing (Biochemistry) ● WAYE Mary Miu Yee (Biochemistry) ● FUNG Kwok Pui (Biochemistry) ● CHUNG Sheung Chee Sydney (Dept of Surgery) ● LEE Cheuk Yu (Biochemistry) ● CHOU Chien* ● DOV Jaron* ● LU Z H* ● ONARAL B* ● POURREZAEI Kambiz* ● TAMURA T* ● XU Y H*

RESEARCH PROJECTS

A Reliable and Scalable Network Architecture for Multiwavelength Passive Optical Access Networks

- ✍ CHAN Chun Kit ● CHEN Lian Kuan
- ❑ 1 September 2003
- ❖ Research Grants Council (Earmarked Grants)

Passive optical networks (PONs) have recently emerged to be a promising approach to enhance the penetration of fiber towards the subscriber side, thus further enables delivery of higher data-rate services to the subscribers. They feature easy network maintenance, as there is no active component at the remote node (RN). By applying wavelength division multiplexing (WDM) technique to PONs, the total system capacity can be further largely enhanced. Each optical network unit (ONU) enjoys a dedicated bandwidth and resolves the ranging problem in time-shared PONs.

In both conventional time-shared PON and multiwavelength PON, network reliability or survivability is an important issue in network management. Whenever there is any fiber cut between an ONU and the RN, all data traffic on that fiber branch will be lost and the affected ONU will be isolated fro the central office or the optical line terminal (OLT). In this project, we investigate and propose a feasible and reliable network architecture for a multiwavelength PON in which any fiber cut between RN and an ONU will be transparent to the OLT as the network traffic will be automatically re-routed and restored. Thus both network protection and traffic restoration can be achieved in the optical layer. The network architecture is also scalable to support a large number of ONUs and subscribers.

(CU03216)

Optical Sampling and Multiplexing for Distortion Reduction in an SCM Optical Network

- ✍ CHEN Lian Kuan ● CHAN Chun Kit ● TONG Fuk Kay Franklin
- ❑ 1 September 2003
- ❖ Research Grants Council (Earmarked Grants)

In this project, we propose a new inter-modulation distortion (IMD) reduction technique based on optical time-division multiplexing (OTDM) and optical sampling. By splitting the composite SCM carriers into two or more orthogonal TDM channels, IMD can be reduced substantially. The proposed scheme possesses several attractive features, including distortion reduction, negligible additional distortion, no additional wavelength or fiber is required for transmission, no frequency conversion is necessary, and service differentiation can be applied to different TDM channel. The proposed project is important for the development of future high channel-count, versatile optical networks.

(CU03223)

Evaluation and Enhancements of Path Monitoring and Selection Techniques in Inter-domain Routing

- ✍ CHIU Dah Ming
- ❑ 1 December 2003
- ❖ CUHK Research Committee Funding (Direct Grants)

In this proposal, we describe the important research problem of how to make Internet's inter-domain routing more *available, stable* and *scalable*.

Today's Internet inter-domain routing is based on a decentralized path-vector protocol, BGP. As the network grows, it takes increasingly more time to react to topological changes. We discuss a new approach to routing based on path monitoring near the source. We review how this approach is used (a) in overlay networks and (b) in some commercial products for access networks today, and (c) as part of a new inter-domain routing protocol proposal. We pose a number of research problems related to this new approach to routing.
(EE03695)

Design, Analysis, and Implementation of a Server-less Architecture for Building Scalable, Reliable, and Cost-effective Video Streaming Systems

- ✍ Jack Y. B. Lee
- ❑ 1 September 2003
- ❖ Research Grants Council (Earmarked Grants)

Video streaming systems have traditionally been built around the client-server architecture where a video server stores compressed video for delivery to clients connected by a network. With increasing demand for large-scale video streaming services, researchers have spent considerable effort in designing high-capacity video servers. Nevertheless, a video server can only have finite capacity and the continuous server upgrade can become increasingly more expensive as the system scales up. In this research programme, we investigate a radically different architecture where the bottleneck - video server, is eliminated altogether. This server-less architecture exploits resources in the end-user machines for distributed data storage and video delivery. Thus when new hosts are added to the system they add resources in addition to workload to the system. This research programme will systematically explore and investigate architectural alternatives for building a scalable, reliable, and cost-effective server-less video streaming system. Research topics include: (a) distributed data storage policy; (b) distributed video streaming protocol; (c) fault tolerance mechanism to support non-stop video streaming despite machine failures; (d) dynamic system reconfiguration to cope with additions and deletions of hosts; (e) load balancing mechanism to cope with host heterogeneity; and (f) dynamic scheduling mechanism to cope with changing host resource availability. Academically, this research programme will contribute to the fundamental understandings of and solutions to challenges in distributed multimedia streaming systems. Practically, this research programme will open up a new way to building next-generation multimedia systems for the future broadband Internet.
(CU03211)

Study of Photonic Crystal Fibers (PCF) for Nonlinear Optics and Photonic Sensor Applications

- ✍ LIN Chinlon ● HO Ho Pui (Dept of Electronic Engineering) ● CHEN Lian Kuan
- ❑ 1 October 2003
- ❖ CUHK Research Committee Funding (Direct Grants)

The development of photonic crystal fibers (PCF) are receiving more and more worldwide attention from the photonic communications research community over the last few years. This is because these specialty fibers using microstructures containing air holes (for this reason sometimes the PCFs is also called "holey fibers") have interesting optical light-guiding properties not found in the conventional

silica glass fibers used in today photonic communications. PCFs have been shown to exhibit interesting dispersion and nonlinear properties, which are desirable for nonlinear photonic signal processing device applications. In this project we propose to explore the feasibility of special microstructure PCFs for nonlinear optical frequency conversion as well as for potential applications as photonic sensors. High-nonlinearity PCFs are well suited for nonlinear optical frequency conversions. In addition, due to PCF special guiding properties, it is possible that the refractive index change of PCF light-guides in the presence of various materials under test (for example, biological fluids) in or around the light-guide region can impact the PCF guiding properties significantly that these phenomena can be used in some unique photonic sensor applications (including biomedical sensors). We intend to examine the various PCF fibers available and evaluate their properties from the view of potential photonic sensor applications.
(EE03538)

Broadband Optical Access Networks -- Photonic Technologies and Architectural Studies

- ✍ LIN Chinlon ● CHAN Chun Kit ● CHEN Lian Kuan ● CHU Pak Lim* ● POON Wing On Andrew*
- ❑ 1 June 2004
- ❖ Supplementary Funding for RGC Central Allocation

The project is a collaborative research on the photonic technologies and architectural studies related to future high-capacity broadband optical access networks. The topics include:
Studies of architectures for future high-speed broadband optical access networks;
Techniques for protection and performance monitoring in optical access networks;
Research on novel optical devices for optical filtering and wavelength add-drops with the aim to have mass-production and low-cost technologies.
(EE03509)

Code Diversity and Scheduling for Multicarrier CDMA Systems

- ✍ LOK Tat Ming ● WONG Tan F*
- ❑ 1 September 2003
- ❖ Research Grants Council (Earmarked Grants)

The challenge for future generations of wireless communication systems is to support multimedia communication, allowing smooth transmission of voice, data, video, and etc., in different wireless channels, which suffer different impairments. Multicarrier modulation allows relatively easy compensation to the channel impairments. Code division multiple access (CDMA) technology using multicarrier modulation has been considered as a good candidate for future wireless communication systems.
However, ordinary multicarrier CDMA systems do not exploit the full potentials of the technology. In this project, we propose a novel design for multicarrier CDMA systems by allowing a choice of codes for each user. The design allows easy implementation while provides major improvements in system performance. We would focus on packet switched systems, where continuous transmission is usually not required, and scheduling can be used to exploit diversity among different users. By allowing code selection and scheduling for the packets, we exploit selection diversity of the systems. Channel variations, due to fading, can actually enhance the performance of the systems.

In this project, we would formulate different optimization problems based on different system design philosophies, which suit different applications, such as voice communication, web browsing, and video conferencing. We would focus on the development of different practical algorithms that can be easily implemented in future systems.
(CU03217)

Video Based Face Recognition

- ✍ TANG Xiaoou
- ❑ 1 December 2003
- ❖ Research Grants Council (Earmarked Grants)

Automatic face recognition has great potential in a wide range of commercial and law enforcement applications. However, the relatively low accuracy and easy to be forged nature put the image-based face recognition technology at a disadvantage comparing to other high accuracy biometric technologies such as iris and fingerprint. In this project, we propose a video-based face recognition approach using several innovative algorithms. The method not only can help to prevent fraudulent system penetrations but also significantly improve the face recognition accuracy by taking advantage of the large amount of information in a video sequence. To overcome the processing speed and data size problems we propose several new concepts including spatial-temporal video synchronization and 3D video cube subspace analysis. A large face image and video database will also be constructed to evaluate the new algorithms.
(CU03224)

Face Image and Image Sequence Recognition in a Subspace Framework

- ✍ TANG Xiaoou ● MA Songde* ● TANG Ming*
- ❑ 1 January 2004
- ❖ NSFC/RGC Joint Research Scheme

The use of biometric measurements in security applications is becoming increasingly common due to recent incidents of terrorist attack. Of all the available biometric techniques, face recognition is perhaps the best suited for surveillance of busy public places like airports and the customs, since it does not require those being watched to cooperate by looking into an iris scanner or putting a hand on a fingerprint reader. However, as a biometric technology, image-based face recognition still has to solve some important problems before it becomes widely used in many practical applications. The fundamental problem is still that the face recognition accuracy is too low for many applications comparing to other high accuracy biometric technologies. In this project, we propose to use a unified framework of linear and nonlinear subspace methods on both image-to-image and sequence-to–sequence face recognition. Through a new framework, we combine the advantage of the linear and nonlinear sequence methods and extract the complete spatial temporal information contained in an image sequence to achieve significant improvement of face recognition accuracy over existing methods.
(CS03446)

On Mobile and Wireless Security: Mobile Agents, Mobile Signatures, and Authenticated Key Exchange

- ✍ WEI Keh Wei Victor ● WONG S Duncan*
- ❑ 1 December 2003
- ❖ Research Grants Council (Earmarked Grants)

Wireless and mobile networks are expected to be extremely fast growing in the next few years. One of the critical concerns is the further exposure of wireless components to security risks. We will deal with several crucial areas in this arena. These areas include the security of mobile agents (or mobile code) in protecting computation results and in protecting itinerary privacy; the design of digital signature schemes with various features specially suited to wireless and mobile applications such as thresholding, delegation, and non-repudiation; and the design of authenticated key exchange systems for the security of mobile e-commerce applications. We aim to make advancements in these areas.
(CU03232)

Fairness and Pricing Issues in Peer-to-Peer Networks

- ✍ WONG Wing Shing
- ❑ 1 December 2003
- ❖ CUHK Research Committee Funding (Direct Grants)

In this project, we regard a peer-to-peer network is as a decentralized communication network in which all nodes serve simultaneously as client, server, and traffic router. One example of such a network is an ad-hoc wireless data network consisting of mobile nodes. In such a network, nodes help each other in routing traffic. To measure fairness, it is desirable to have an index that quantifies the contribution made by each node in the routing process. The PI of this proposal has proposed one such index, the *fairness index*. Roughly speaking, the fairness index is a ratio obtained by dividing the traffic related to a node by the total amount of traffic that passes through it, and is determined by the traffic data rate at each node. There is a dual concept to the fairness index that is related to a pricing scheme on the network. The combined pricing-rate model is closely related to the von Neumann economic model. As a result, the von Neumann theorem guarantees the existence of an equilibrium solution for it. In this project, we aim to investigate fundamental properties of the von Neumann equilibrium solution and try to understand its implication on peer-to-peer network rate control and pricing. If resources permit, we also hope to investigate simple, distributed, feedback algorithms for controlling such a model.
(EE03901)

Network Error Correction

- ✍ YEUNG Wai Ho Raymond
- ❑ 1 September 2003
- ❖ Research Grants Council (Earmarked Grants)

In existing communication networks, error control is done on a link-by-link basis. Specifically, the message to be sent on a link is protected by an error-correcting code, and a decoder at the receiving end makes the best estimate of the message sent. Inspired by network coding recently introduced by Ahlswede et al., we propose a more general approach called network error correction, where error control is done on an end-to-end basis. In this approach, redundancy for protecting the information to be multicast is distributed over the network. The problem is to construct network error-correcting codes with desired properties and to study fundamental properties of such codes.
(CU03214)

Extreme Mobile Device for Emergency Communications

- ✍ YUE On Ching

- 1 October 2003
- CUHK Research Committee Funding (Direct Grants)

Current technologies in 2G and 3G standards allow priority access in the sense that **AFTER** a mobile has established a control connection, the base station can assign traffic channel to the mobile with different priority. However, in heavily loaded networks, which will be the case for cells affected by the national emergency, mobile users will have difficulty in establishing control channels. In this project we address the issue of providing priority access **BEFORE** the control channel is established.

We have identified tentatively 3 methods for improving Priority Control Access. These methods have been evaluated analytically in terms of Access Success Rate and the time to acquire the control channel. Preliminary results indicate that our combined methods can improve **Access success Rate from 10% to almost 100%**. With the combined methods for *Priority Control Access* implemented in the new **Extreme Mobile Devices**, emergency workers will be able to complete voice or data calls even in the most congested networks.

In this project, we propose to investigate these 3 methods (and others) through simulations and study the implementation issues for the Extreme Mobile Device. The RF environment for different disaster scenarios will be modeled. Based on the functionalities specified in 2Gand 3G standards, we will simulate the overloaded condition and evaluate the performance of our combined methods. Then we will specify the design of the new algorithms in a terminal and modify the reference design for implementation. One of the project deliverables will be an ITF proposal for prototype implementation.

(EE03349)

Fair Routing and Bandwidth Allocation for Packet Rings

- YUM Peter Tak Shing
- 31 December 2003
- Research Grants Council (Earmarked Grants)

As the bandwidth demand for IP services grows, traditional circuit based SONET/SDH metro networking infrastructure becomes inefficient. As a result, Resilient Packet Ping, a packet ring architecture being developed into an IEEE standard (IEEE 802.17), is generally regarded as a promising technology for the next generation metro network.

Resilient Packet Ring has a bidirectional dual ring topology. By default, shortest path based routing scheme is used. In a preliminary study we have shown that for dynamically changing traffic load, the simple shortest path routing is inefficient and unfair. This is a consequence of the conventional wisdom that the routing cannot be separately designed from flow and congestion controls. We propose to solve a joint routing and flow control optimization problem in this research. We understand that the metro network is a backbone shared by many parties and therefore fairness in bandwidth allocation is essential. The fairness measure is embedded in the objective of the optimization. Under the same framework, a separate link capacity dimensioning problem can be formulated. The solution of this problem can provide guidelines for network facility planning. Aside from publications, we will also make the network design and analysis software developed available on the Web for use by the research community.

(CU03220)

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

Edition — Title/Investigators

2002-03 Novel Schemes to Alleviate the Intrinsic Detrimental Effects of In-line Semiconductor Optical Amplifiers in Optical Transmission Systems (CU02386)
✍ CHAN Chun Kit ● CHEN Lian Kuan

2002-03 Optical Networking Techniques Using High-speed Constant Intensity Modulation (EE02749)
✍ CHAN Chun Kit

2001-02 A Generic Optical Switch Fabric for Photonic Code-based Multi-protocol Label Switching (MPLS) Networks (CS01172)
✍ CHEN Lian Kuan ● TONG Fuk Kay Franklin

2002-03 Investigation of a Novel Polarization Mode Dispersion (PMD) Compensator (EE02751)
✍ CHEN Lian Kuan ● CHAN Chun Kit

1999-00 Scalable and Fault-Tolerant Video-on-Demand Systems – Design, Analysis, Prototyping, and Performance Evaluation (CU99095)
✍ Jack Y. B. Lee

2000-01 Hong Kong IP Multicast Initiative (EE20005)
✍ Jack Y. B. Lee ● CHEN Lian Kuan ● LUI Chi Shing John (Dept of Computer Science and Engineering)

2001-02 Improving Disk Efficiency in Continuous-Media Servers with Soft-scheduling (CS01209)
✍ Jack Y. B. Lee ● LUI Chi Shing John (Dept of Computer Science and Engineering)

2001-02 Study of a Peer-to-Peer Architecture for Building Scalable, Reliable, and Cost-Effective Video-on-Demand Services (EE01594)
✍ Jack Y. B. Lee

2002-03 Design, Analysis, and Implementation of a Super-Scalar Architecture for Large-Scale Video-on-Demand Services (CU02328)
✍ Jack Y. B. Lee

2001-02 Design of Large-Scale Fibre Channel Fabric for Storage Area Network (CS01208)
✍ LEE Tong Tony ● CHAN Man Chi#

2002-03 Design of Medium Access Control Providing IP QoS for CDMA-based Mobile Communication System (CU02380)
✍ LEE Tong Tony

2000-01 Telecommunication Network Research (EE95746)
✍ LI Shuo-yen Robert

2000-01 Integrated Retransmission and Adaptation Scheme for Video Streaming over Legacy and Advanced Internet with QoS Guarantee (CU00229)

✍ LIEW Soung Chang ● Jack Y. B. Lee

2002-03 Novel Power Control Schemes for Multicode DS/CDMA Systems (EE02757)

✍ LOK Tat Ming ● WONG Tan F*

2001-02 Face Image and Sketch Recognition (CS01190)

✍ TANG Xiaoou ● GRIMSON W Eric L* ● LAM Kai Pui (Dept of Systems Engineering & Engin. Management)

2002-03 Video Based Character Recognition (CU02357)

✍ TANG Xiaoou ● PISSALOUX Edwige* ● ZHANG Hong Jiang*

2000-01 Homodyne Crosstalk Reduction using FP Laser Diode (CU00228)

✍ TONG Fuk Kay Franklin ● HO Keang Po Ricky# ● TSANG Hon Ki (Dept of Electronic Engineering)

2000-01 Photonic Packaging Laboratory (EE00750)

✍ 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.)

2001-02 Investigation of Low-Cost Modulator for a Proposed DWDM Access Network (CS01191)

✍ TONG Fuk Kay Franklin ● CHAN Chun Kit ● CHEN Lian Kuan

2002-03 On the Constant Weight Codes: Bounds, Constructions and Applications (CU02329)

✍ WEI Keh Wei Victor

2000-01 Power Control for Wireless Multimedia System in a Fading Environment (CU00222)

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

2002-03 Code Allocation in Multi-Rate Spread Spectrum Wireless Systems (CU02366)

✍ WONG Wing Shing ● SUNG Chi Wan*

2000-01 Fundamental Limits in Information Storage Systems (CU00165)

✍ YEUNG Wai Ho Raymond

2002-03 Quantum Information Theory (EE02836)

✍ YEUNG Wai Ho Raymond

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

✍ YUM Peter Tak Shing

2000-01 Architecture for IP Operating on WDM (CU00223)

✍ YUM Peter Tak Shing ● TONG Fuk Kay Franklin

2002-03 OVSF Code Assignment Strategies (CU02325)

✍ YUM Peter Tak Shing

RESEARCH PROJECTS

Scheduling of Perishable Jobs under Uncertain Deadlines

- ✍ CAI Xiaoqiang
- ❑ 1 December 2003
- ❖ Research Grants Council (Earmarked Grants)

We plan to study a new class of scheduling problems involving perishable jobs with post-completion deterioration, where each finished product will be picked up by a transporter that arrives with uncertainty. The processing time to complete a job, as well as its fresh time, are random variables. If a job is finished too early, it may decay and thus incur a decaying cost; on the other hand, if it misses the pickup, it will suffer a loss due to such causes as having to be transported to its original destination by a much more expensive means, or be put to a local market at a discounted price. The problem is to determine an optimal policy to process and handle all the jobs, so as to minimize the total expected loss. The objective of this project is to develop an in-depth study of scheduling problems with features as described above. Topics to be addressed include those on modelling, propositions of optimal policies, and algorithms.

(CU03170)

On Inventory Control, Dynamic Pricing, and Goods/Service Bundling

- ✍ CHEN Youhua
- ❑ 1 December 2003
- ❖ CUHK Research Committee Funding (Direct Grants)

The advent of the Internet and e-commerce has significantly affected the way that many businesses price and present their products and services, and has allowed for dynamic pricing and more product/service bundling. The goal of this project is twofold: (1) to integrate the joint decision of dynamic pricing with stock replenishment, and (2) to provide a framework for the simultaneous determination of product/service bundling with stock replenishment.

More specifically, there are two sets of research issues to be addressed in this project.

To better coordinate purchasing and marketing decisions in inventory-based businesses, a major concern is the coordination of inventory control and pricing decisions. We will develop a stylized model to address this issue, in which a general cost structure is assumed, and the average demand of each period is a general function of price. The objective is to identify the optimal decision rules that jointly maximize the average profit. Efficient computational procedures will also be developed.

An inventory-based business may sell goods with value-added service packages. Different combinations of packages with the goods have varying effect on revenue. We ask the following question: is it an effective approach to make all packages available all the time? That is, how do we coordinate decisions on what packages to offer over time and what inventory control strategies to use to maximize the long-run average profit?

The two sets of issues can be connected through the concept of maximum increasing concave envelope, and they are of theoretical significance both inside and outside of e-commerce.

(EE03526)

Operational and Strategic Models for Hotel Revenue Management

- ✍ FENG Youyi
- ❑ 1 September 2003
- ❖ Research Grants Council (Earmarked Grants)

This project concerns with the effectiveness and efficiency of hotel revenue management in Hong Kong which consists of an industrial backbone for local economy. It proposes a new dynamic optimal reservation model with aim of long-run average to maximize daily revenue for hotels. The characteristics of the hotel reservation management differ from those of airlines since hotel customers may rent rooms for subsequent and random days. This additional dimension of uncertainty sources increase difficulties of hotel revenue management problem and makes it awkward to apply airline revenue management model. It will be practicable to assess revenue performance for relatively long seasons during which demand remains stable. However, this is only a part of the project. The proposed model will be widely used for evaluating various strategic perspectives offered to hotels to which opportunities and risks coexist. One example is about alliances of the hotel with airlines or credit card issuers. The good thing for alliances is the demand expansion whereas the bad thing is the demand from the alliance channels may cannibalizes the continues our effort in exploring optimal booking control rules in airline reservation systems with multi-leg flights. The objective is to develop effective and efficient algorithms to replace existing ones based on single-leg models for network booking control. The output of the project is twofold: to identify the structural properties of the optimal control on the multi-leg flights and to develop algorithmic decision supports for booking control. It is believed that the structural properties identified from simple models will help develop heuristics to be implemented in real systems. The direct beneficiaries of the second output are the airlines in the Asia-Pacific region, which have many multiple leg flights internationally and domestically. The project is expected to develop (1) a prototype that consists of an interface interacting friendly with airline reservation managers and identifying the customer requests; (2) a logic system which contains optimization functions for recommending decisions; (3) a database design accommodating historical and to-date pricing and reservation information.
(CU03235)

Dynamic News Topic Taxonomy Discovery from Texts Using Bayesian Model-Based Unsupervised Learning

- ✍ LAM Wai
- ❑ 1 December 2003
- ❖ Research Grants Council (Earmarked Grants)

News data is generated around the clock. The amount of electronically available news text is massive. New or unseen topics or events arise everyday and they are often reported simultaneously in different news sources. It would be useful to have an intelligent system that can detect new and unseen topics from streams of news based on the content. This is the goal of topic is regarded as a seminal event or activity, along with all directly related events and activities. Once a new topic arises, it is often to have news or reports directly related to it in subsequent days or months. We propose to develop a topic discovery system that can identify related articles belonging to topics not known in advance from a stream of incoming news.
(CU03179)

A Traffic Inference Engine for Travel-time Estimation

✍ LEUNG May Yee Janny ● CHENG Chun Hung

❑ 15 December 2003

❖ Research Grants Council (Earmarked Grants)

Transportation logistics in Hong Kong is very complex. The highly unpredictable transit times due to traffic congestion and/or accidents, the tight time-windows and high reliability demanded by the customers make delivery planning a nightmare for the hundreds of logistics service-providers in Hong Kong.

In this project, we will develop a **Traffic Inference Engine** for transit-time estimation for *all* road segments in a network, based on information on the durations of a collection of trips between various origins and destinations points. The core of the engine is a mathematical-programming model which can be adapted to various forms and frequencies of data input, and for which computations for estimation-updating can be done rapidly. The technology is also scalable, adaptable for use over the entire road network in Hong Kong or applied to a more focused region of interest to a particular organisation.

The methodology for the **Traffic Inference Engine** will be easily implementable. Logistics service providers and public transportation services will be able to use this tool directly and/or incorporate it into their current planning/database systems. The improved transit-time estimates will facilitate up-to-the-minute tracking and planning of goods movement, to enable the entire supply chain to plan and respond efficiently and just-in-time.

(CU03171)

Dual Control in Linear-Quadratic Gaussian Problems

✍ LI Duan

❑ 1 September 2003

❖ Research Grants Council (Earmarked Grants)

Except for a few ideal situations, an optimal control usually pursues two often conflicting objectives: to drive the system towards a desired state and to perform active learning to reduce the systems reducible uncertainty. Due to great analytical difficulties, previous efforts in dual control have mainly been devoting to developing certain suboptimal solution schemes. Using a variance minimization approach, the principal investigator has recently derived an analytical active dual control law for a class of dual control for the linear-quadratic Gaussian problem where there exists a parameter uncertainty in the observation equation. The issue of how to determine an optimal degree of active learning is then addressed, thus achieving optimality for this class of dual control problems.

The primary goal of this project is to further study fundamental properties of dual control such that more results of this long-time research challenge can be achieved. More specifically, this research project will consider linear-quadratic stochastic optimal control problems where parameter uncertainties exist in both the state and the observation equations. The overall research goal will be achieved by carrying out the following three research tasks: 1) To investigate the primary reasons in causing solution difficulties for optimal closed-loop policies in dual control; 2) To explore the best possible (partial) closed-loop feedback policy; and 3) To investigate an application of dual control in dynamic portfolio selection.

(CU03180)

Natural Language Generation of Cooperative Responses in Mixed-Initiative Dialog Systems Using a Corpus-based Approach

✍ MENG Mei Ling Helen

❑ 1 December 2003

❖ Research Grants Council (Earmarked Grants)

State-of-the-art spoken dialog systems (SDS) can support convenient information access via goal-oriented human-computer dialogs, e.g. in restaurant recommendations, travel planning, etc. Mixed-initiative (MI) dialog models (DM) in SDS facilitate highly interactive, two-way communication. Speech recognition (SR) and natural language understanding (NLU) technologies are continually advancing to handle user input of growing complexities. SDS need to match up with system outputs of increasing sophistication by natural language generation (NLG) technologies. NLG transforms the semantic input from the DM into a *cooperative system response* that tailor to the user's information needs and linguistic preferences. The predominant approach uses handcrafted response templates with variables instantiated according to semantics from the DM. However, handcrafting templates is a tedious process with limited scalability and portability across languages and domains. We propose to develop a *corpus-based approach* to NLG that models after cooperative responses in a domain-specific human-human dialogs. We address two sub-problems for both English and Chinese - (1) *Message planning* uses Belief Networks to infer the communicative goal of the response message based on the goal(s) and concepts in the user's input. Corpus-derived heuristics are used to filter the discourse for pertinent semantics to form a well-posed *message plan* (MP). (2) *Message realization* (MR) uses the MP to guide the top-down, recursive invocation of context-free grammar rules. The grammar is induced semi-automatically from the dialog corpus. MR aims to generate a well-formed message in terms of syntax, lexical choice and user-centered phrasing. A corpus-based approach can incorporate statistical techniques and alleviate the tedium of handcrafting templates.

(CU03237)

A Support Program to Increase the Competitiveness of Hong Kong Software SMEs in Mainland China

✍ WONG Kam Fai William ● CHAN Kei Fu*

❑ 1 February 2004

❖ SME Development Fund (Coll. w/ Hong Kong & Mainland Software Industry Cooperation Association)

Hong Kong software Industry is experiencing a very difficult time due to the recent economic downturn and shrinking domestic demand. To expand business into Mainland China, many software SMEs encounter difficulties in establishing their presence there. These difficulties can be classified into two major areas: (1) business development and (2) project management.

Business development: In the Mainland, HK software SMEs are often unfamiliar with the local government organization structure, e.g. which departments to deal with, what are the legal regulations and operation procedures for setting up their offices, etc. As a result, they do not know the market opportunities available in the Mainland.

Project management: In cases where HK software SMEs manage to find an engineering partner, which is very common in outsourcing in China. The differences in software project management cultures of the two places cause serious quality control problem. This, in turn, often leads to software products of poor quality, serious delayed schedule, etc.

We propose a support program to mediate the above predicaments. Through this program, we plan to:

(1) Provide market information regarding business opportunities, industry trends, preferential policies and company set-up procedures in mainland China;
(2) Assist Hong Kong software SMEs to establish their offices and expand their businesses in China;
(3) Compile a China software project management handbook based on the know-how of experienced professionals and widely disseminate it to HK software SMEs.

The Centre for innovation and Technology of Faculty of Engineering of The Chinese University of Hong Kong will be responsible for the implementation of the Project Management Part of the project.

(EE03567)

Supply Chain Coordination with Risk-Averse Agents

✍ YAN Houmin

❑ 1 September 2003

❖ Research Grants Council (Earmarked Grants)

The proposed research will develop analytical models to study the channel coordination issues for risk-averse players; design contracts which ensures a satisfactory level of profit while satisfying a risk constraint; explore the structural properties and managerial insights of the proposed supply contracts; and analyze incentives of supply-chain coordination for risk-averse players.

(CU03239)

Studies on Dynamic Pricing Models

✍ YAO David Da Wei

❑ 1 October 2003

❖ Research Grants Council (Earmarked Grants)

Using pricing as a tool to regulate demand and manage supply has in recent years become a standard practice among diverse industry sectors such as airline, hotel, retail, and others. This business model is generally referred to as revenue management. Internet commerce has further facilitated the applications of revenue management, and promoted its popularity among both business and consumers.

The objective of this project is to extend some of the basic ideas and models in revenue management to supply chains, in particular, to support dynamic pricing decisions in a production environment. The plan is to develop models that not only capture the interplay between dynamics relate to and interact with production or replenishment decisions. Output from the research will contribute to the field of supply chain management by way of a set of dynamic pricing models and solution techniques, which can effectively support various supply chain decisions that aim at enhancing revenue, increasing resource utilization, and improving customer service.

(CU03173)

Improving Efficiency and Transparency of Public Disclosure

✍ YEN Jerome ● FENG Youyi

❑ 15 October 2003

❖ CUHK Research Committee Funding (Direct Grants)

Transparency and efficiency are two key factors in determining the stability and development of any financial market. The collapse of the Enron and WorldCom indicated that the transparency in US financial markets was not adequate. Similarly, the

same situation can be found in Hong Kong and other Asian countries, for example, Taiwan and China. Currently, there are many systems and applications that aim at improving transparency and the utilization of financial information. For example, SMART system, which was developed in Australia, is currently used in several countries to monitor the transactions and to identify illegal transactions. To improve transparency of listed companies, public disclosure is extremely important. Which include policy making, design of disclosure rules, and implementation of the mechanism to support submission of disclosure documents. Two sample electronic filing systems to support public disclosure are EDGAR and SEDAR that used in the U.S. and Canada respectively.

However, we felt that such systems may not be sufficient to reach the goal of improving the transparency. Market transparency is not a pure technical or managerial question. It is very complicated and covers many activities and issues. We have to identify all the parties involved in Hong Kong and to capture their relationships by surveys and interviews. We will also develop instruments to measure the transparency of a listed company or of a market. Then we will review what other countries have done in improving their transparency and compare their performance by the instruments we will develop. Then, based on the results, to develop a set of framework and model to guide the development of solution. We feel that we need to use a total new framework to guide the development of systems or solutions that can help users who need better transparency, for example, surveillance officers from government organizations, such as, Security Exchange Commission (SEC) in US and Securities and Futures Commission (SFC) of Hong Kong. Such framework, at this moment, we call it Financial Knowledge Management. Based on the Informedia project at Carnegie Mellon University, we will develop a new version of Informedia and a new public disclosure system based on the Financial Knowledge Management framework to be developed. Then, we will conduct experiments and case studies to measure the impacts or performance of our efforts. (EE03832)

Primal-Dual Interior Point Approach To Multiple-stage Stochastic

- ✍ ZHANG Shuzhong
- ❑ 1 October 2001
- ❖ Research Grants Council

This research project aims at developing new and high performance solution methods for multiple stage stochastic (convex) programming. We, as human being, too often are compelled to make decisions while the consequences of the decisions depend largely upon the unknown future. There is no other way for us, but to live with the uncertainty of this nature. However, we can learn to improve our ability to reduce the chance of getting trapped into some undesirable situations by means of, e.g. quantitative techniques. Stochastic programming is exactly such a tool developed in the field of optimization to cope with the problem of decision-making under uncertainty. Among others, stochastic programming has found many applications in finance, such as asset-liability and bond-portfolio management. The conceptual model being extremely useful beyond any debate, many stochastic programming applications still remain computationally intractable because of their overwhelming dimensionality. Much research effort has been devoted to the numerical aspects of stochastic programming. The success, however, has been only moderate so far. In particular, only

two-stage stochastic programming with a linear objective is studied extensively in the literature. In this project we propose to study a new decomposition approach for multiple-stage stochastic programming with a convex objective, based on the path-following interior point method combined with the homogeneous self-dual embedding technique. A pilot study has been conducted along this direction. Our preliminary numerical experiments show that this approach is very promising in many ways for solving generic multi-stage stochastic programming, including its superiority in terms of numerical efficiency, as well as the flexibility in testing and analyzing the model.
(EE01461)

Nonnegative Mappings and Their Applications in Robust Optimization

- ✍ ZHANG Shuzhong
- ❑ 1 October 2003
- ❖ Research Grants Council (Earmarked Grants)

In this research project we propose to study the robust optimization models arising from convex conic programming. Large size convex programming problems can now be routinely solved thanks to the recent high performance methods. However, the result of a simple-minded convex program can sometimes be disappointing. A common cause for this is that the problem data are not accurate. The optimal solution can depend critically on the data of the model. Therefore, due to the 'polluted' data source, the corresponding optimal solution may not solve the actual problem. In many practical applications, the data estimation can involve human judgments or other imprecise processes, and so decision-making under data imprecision is a structural challenge. Robust optimization suggests a viable approach to meet the challenge. In robust optimization, the data uncertainty is taken into consideration while solving the original model. The difficulty associated with robust optimization is that, often the resulting robust counter-part of a nice convex program becomes hopelessly intractable. This difficulty is what we shall strive to resolve through this research project. Our preliminary investigation shows that there exists a very rich structure in the formulation of roust convex conic programming. We believe that this structure can be used: (1) to identify tractable robust optimization models; (2) to find approximation methods for hard robust optimization models; and (3) to enhance the performance of the solution methods. The theoretical results will then be applied to solve practical convex conic programs from financial and logistics applications where the robust consideration plays a crucial role for the success of the models.
(CU03174)

Indefinite Stochastic LQ Control with Partial Information

- ✍ ZHOU Xunyu
- ❑ 1 December 2003
- ❖ Research Grants Council (Earmarked Grants)

Stochastic optimal control is concerned with optimization of dynamic stochastic systems and has wide applications in many real-world problems, such as communication, manufacturing, and finance. In most practical situations the information regarding the systems under control is not completely available to the decision-makers (controllers). This gives rise to the partially observable stochastic control problems. In this project we plan to investigate stochastic linear-quadratic (LQ) control with partial information where the cost weighting matrices are

allowed to be indefinite. The problem, which is termed the *partially observed indefinite LQ control*, has not been studied in literature and contains many interesting and challenging sub-problems. It is the objective of this project to study three such key problems: 1) validity of the separation principle, 2) optimality conditions, and 3) optimal control of the related information state.
(CU03175)

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

Edition	Title/Investigators
1999-00	Earliness/Tardiness Scheduling Subject to Known Due Dates and an Unknown Deadline (CU99418) ✍ CAI Xiaoqiang ● ZHOU Xian*
2001-02	Scheduling with Negotiable Third-Party Machines (MP01166) ✍ CAI Xiaoqiang ● LEE Chung Yee*
2001-02	Incentives for Advance Ordering in a Supply Chain (EE01684) ✍ CHEN Youhua
2002-03	Grouping Models in Ready-to-Assembly Products (EE02945) ✍ CHENG Chun Hung
2001-02	Optimization of Reservation Process on Two-Leg Flights with Cancellations and No-Shows (EE01306) ✍ FENG Youyi
2002-03	Optimal Booking Control on Multi-Leg Flights (CU02320) ✍ FENG Youyi
2001-02	Hierarchical Information Extraction Learning Framework and Its Applications to Event Tracking and Filtering (CS01187) ✍ LAM Wai
2002-03	A Knowledge Management System Based on Chinese Text Clustering and Classification Algorithm (CS02112) ✍ LAM Wai ● LAM Ringo*
2001-02	Logistics Support for Mobile Commerce (MP01213) ✍ LEUNG May Yee Janny ● CHENG Chun Hung
2001-02	Efficient Solution Schemes for Solving Multidimensional Nonlinear Knapsack Problems (MP01214) ✍ LI Duan
2002-03	A Theoretical Framework of Nonlinear Lagrangian Theory (EE02531) ✍ LI Duan
2001-02	Mandarin-English Information (MEI): Investigating Multi-Scale Query and Document Expansion for Translingual Spoken Document Retrieval (CS01223) ✍ MENG Mei Ling Helen ● KWOK Kui Lam* ● WANG Hsin Min*
2001-02	"The Author Once, Present Anywhere (AOPA)" Software Platform (EE01512)

✍ MENG Mei Ling Helen ● P.C. CHING (Dept of Electronic Engineering)

2002-03 The Use of Belief Networks for Mixed-Initiative Dialog Modeling (CU02326)
✍ MENG Mei Ling Helen

2002-03 Towards Multi-modal Human-computer Dialog Interactions with Minimally Intrusive Biometric Security Functions (EE02512)
✍ MENG Mei Ling Helen ● P.C. CHING (Dept of Electronic Engineering) ● LEE Tan (Dept of Electronic Engineering) ● MOON Yiu Sang (Dept of Computer Science and Engineering) ● TANG Xiaoou (Dept of Information Engineering) ● MAK Man Wai* ● MAK Brian* ● SIU Man Hung*

2001-02 Towards Cost-Effective E-business in the News Media & Publishing Industry Using NewsML (EE01966)
✍ WONG Kam Fai William ● YANG Christopher Chuen Chi ● LAM Wai ● CHEUNG David* ● LU Qin*

2002-03 XML Database: Technology and Applications (EE02536)
✍ WONG Kam Fai William ● LAM Wai ● YANG Christopher Chuen Chi ● YU Jeffrey Xu

2002-03 Digital Asset Management System - NewsML CIDAX Gateway (EE02653)
✍ WONG Kam Fai William ● FUNG Ivan*

2001-02 Concept-based Chinese/English Cross-lingual Information Retrieval (EE01564)
✍ YANG Christopher Chuen Chi

2002-03 Automatic Generation of Chinese/English Cross-lingual Concept Space by Associate Constraint Network (CU02335)
✍ YANG Christopher Chuen Chi

2000-01 Linear Quadratic Control via Semidefinite Programming with Applications (CU00175)
✍ YAO David Da Wei ● ZHANG Shuzhong ● ZHOU Xunyu

2000-01 Dynamic Aggregate View Selection and Maintenance for Large Financial Data Warehouses (CU00198)
✍ YU Jeffrey Xu ● LU Hongjun*

2001-02 Concurrent and Personalized Data Mining with a Large Number of Users (CS01229)
✍ YU Jeffrey Xu ● LU Hongjun*

2002-03 Large Bio-sequence Analyzing and Mining from a Database Perspective (EE02868)
✍ YU Jeffrey Xu

2000-01 Conic Optimization: Theory and Methods (CU00181)
✍ ZHANG Shuzhong

2001-02 Primal-Dual Interior Point Approach to Multi-Stage Stochastic Programming (MP01233)

✍ ZHANG Shuzhong

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

✍ ZHOU Xunyu

2001-02 Risk-Sensitive Control (MP01234)

✍ ZHOU Xunyu ● YAO David Da Wei