

RESEARCH PROJECTS

Calibration of Active Camera Network

✍ CHUNG Chi Kit Ronald

☐ 1 January 2005

❖ Research Grants Council (Earmarked Grants)

With the increasing affordability of cameras, it has become practical to mount a number of them at various locations, constructing a camera network for sensing a large field of view of an environment. If the cameras are further equipped with individual pan/tilt mobility, not only could the cameras' respective field of view be increased (or the number of cameras needed for the same global field of view be reduced), advanced capabilities like moving-object following for tracking, and vergence and stereo vision for range sensing would also be possible.

Yet, many applications of such camera network, especially those related to metric reconstruction and image data fusion, require the inter-camera geometry of the network be known. This research addresses just that: to determine the inter-camera geometry of such camera network at arbitrary spatial configuration of the cameras.

The problem is non-trivial because, at arbitrary spatial configuration, some cameras may not have overlap in their fields of view, rendering traditional (that correspondences across cameras) inapplicable.

This research aims at deriving a solution to the stated problem that requires no cross-camera image correspondences but monocular optical flows in the cameras as the input. We also aim at having the following features in the solution:

1. *No assumption on cameras' field of view:* the cameras could be in any spatial configuration,

including the divergent one which has little or no overlap in cameras' fields of view.

2. *Direct Determination from Directly Observable Image Flows (Normal Flows):* Image flow in each camera due to camera motion is generally easy to acquire, for consecutive images in image sequence are "alike".

However, due to the aperture problem only the normal component of the flow is directly measurable. It would be desirable that the geometry parameters could be deduced from normal flows without having the full flow inferred at every image position, so as to avoid unnecessary calculations as well as error accumulation.

3. *Bypassing Camera Motion Determination:* For reasons same as the above, it would be desirable to have the inter-camera geometry determined without having to estimate the precise individual motions of the cameras.

(CU04195)

Design an Energy Efficient Controllable Mechanical Metal Forming Press

✍ DU Ruxu

☐ 1 September 2004

❖ Research Grants Council (Earmarked Grants)

The objective of the proposed research is to design a new type of metal forming press through the use of controllable mechanism. The mechanism may take various forms but its basic configuration consists of a large Constant Speed Motor (CSM) and a small Variable Speed Motor (VSM). With a large flywheel, the CSM provides a majority of the force, while the VSM tunes the motion of the punch. This design has a number of advantages. First, it is energy efficient just like the mechanical press. Second, its motion can be controlled just like the

hydraulic press. Third, it can run fast, as it is really a mechanical press. Finally, it is relatively inexpensive to build. It is expected that the new design will have a better performance than that of the existing presses, including the newly developed servo press. Currently, we have completed the first design and built a prototype. In this project, the main topics of the research include kinematics and kinematical control.

(CU04216)

A New Absorption Air-Conditioner Powered by Low Quality Renewable Energy

✍ DU Ruxu

□ 2 January 2005

❖ CLP Power Renewable Energy Fund

The proposed project is aimed at developing a new pumpless absorption air-conditioner powered by all sorts of low quality renewable heat energy, such as solar heat and waste heat. It is an absorption air-conditioner using lithium bromide (LiBr) - water solution as the working fluid. Currently, there are similar systems in the market; however, they are powered by high quality energy, such as gas and electricity. The new design is feasible because of two innovations that we are currently working on: the bubble pump and the vapor refrigeration storage. The former can be powered by low quality heat while the latter makes thermo energy accumulation possible. The system design and a preliminary computer simulation are shown in Appendix. Based on a preliminary calculation, the bubble pump can be driven by hot water of 70-80 °C. If solar panels are used to heat the water, the new air-conditioner can provide 2 kW cooling for 20 m² space by using 10 m² solar panels. In order to maximize the use of the heat and reduce the burden on the size of the solar

panels, the vapor refrigeration storage is therefore used. It allows the heat energy, in the form of vapor refrigeration, being acquired and accumulated all day long, and being used when needed. During the project, detailed theoretical investigation and experimental testing will be carried out to validate the idea leading to the design of a prototype system. In the view of large cooling demand and rich low quality energy supply in Hong Kong or similar tropic and sub tropic regions around the world, this new air-conditioner will have a great potential.

(MD04975)

Designing a Health-Conscience and Environmental-Friendly Washer

✍ DU Ruxu • YU Jimmy C. (Chemistry)

□ 21 January 2005

❖ Art Precision Industrial (H.K.) Ltd - Contracted reserach

The objective of this project is to develop the key technology for designing a health-conscience and environment-friendly mini washer.

(EE04848)

Optimizing the Design of Multi-Step Sheet Metal Stamping Dies

✍ DU Ruxu

□ 1 June 2005

❖ Feng Chuan Tooling Co. Ltd.

The objective of the project is to develop a new technology for the design of multi-step sheet metal forming, including the die design and the process design. The new technology solves the limitation of trial and error by using a combination of FEM and a state space model. It helps to improve the design

quality, shorten the design time, and reduce the die try-out cost and time.

(EE04377)

Nonlinear Internal Model and the Robust Nonlinear Servomechanism Problem

✍ HUANG Jie

□ 1 December 2004

❖ Research Grants Council (Earmarked Grants)

The nonlinear output regulation problem aims to design a control law for a nonlinear plant such that the output of the closed-loop system asymptotically tracks a class of reference inputs and rejects a class of disturbances in the presence of certain uncertain parameters, where the reference inputs and the disturbances are produced by some autonomous system called exosystem. It was made clear recently that the solvability of this problem relies on the successful address of two key issues. First, whether or not the problem can be converted into a robust stabilization problem of an augmented system, and, second, whether or not the robust stabilization problem of the augmented system is solvable? The solution of the first issue amounts to the existence of a dynamic system called internal model which can reproduce the solution of the regulator equations. The composition of the given plant and the internal model is called the augmented system whose stabilizing solution will lead to the solution of the robust output regulation problem of the original system. For over a decade, the existence of the internal model has relied on the assumption that the solution of the regulator equations is a polynomial in the exogenous signal, and this assumption is quite restrictive because it essentially limits the nonlinear systems to be polynomials. The first objective of this project is to establish a framework that can convert, without

relying on the polynomial assumption, the global robust output regulation problem of a given nonlinear system into the global robust stabilization problem of the augmented system. The second objective is to apply this framework to solve the robust output regulation problem for some exemplary nonlinear systems such as the cascaded nonlinear systems. Success of this project will render the existing robust output regulation theory the capability of handling complex nonlinear systems frequently encountered in industrial control, aircraft landing, high precision robot manipulators, and disk drive control systems.

(CU04196)

Muscle Based Character Design

✍ HUI Kin Chuen

□ 1 January 2005

❖ Research Grants Council (Earmarked Grants)

Digital character or human model is an essential tool for various design and medical applications. Popular approaches for the construction of digital characters include the skeleton subspace deformation approach, and the anatomy based approach. Both approaches require extensive user interactions in setting up the relationship between the skin surface and the skeleton or muscle. Besides, anatomy based approach generates skin surface based on a given muscle and skeleton model leaving not much freedom for the designer in creating the shape of the character. This research is to develop an intuitive technique for creating and deforming muscle based character and human models. The facial and body models are constructed with different approaches. A generic body muscle representation scheme will be developed. This allows body muscles to be generated given the skin surfaces and skeleton of a

character model. Facial muscle model and the skull bone are constructed by performing an offset of the skin surface and using a template based technique. The boundary element method will be adopted. This eliminates the computation intensive task of solid mesh generation. The facial and body muscle model will be integrated to give a complete muscle based character model. This provides an intuitive approach for designing characters and human model while a physics based muscle deformation technique is used for animating a character.

(CU04197)

Fabrication of Carbon Nanotube Sensor Arrays Using Robotic Micro-Injection and Di-Electrophoretic Manipulation

✍ LI Wen Jung • XI Ning*

□ 1 September 2004

❖ Research Grants Council (Earmarked Grants)

Research on the fundamental properties of carbon nanotubes (CNTs) has been carried out extensively in the past decade. However, one fundamental problem still exists in terms of developing CNT-based devices for tests and measurements: complexity still remains in fabricating these devices repeatably and reliably. That is, presently, unlike IC or MEMS technologies, there is not a universally accepted method to make nanotube-based devices, even for devices as simple as a nanotube connected between two electrically conductive pads. Our team aims to advance nano-fabrication technology by combining electrophoretic based manipulation and micro robotic injection to rapidly produce CNT based sensing arrays. In essence, we propose to develop a micro injection technique to dispense nano-liter volume CNT dilution onto silicon chips, and then apply di-electrophoretic force field to form sensing

elements on the chips. When the process is automated, it will enable a very rapid fabrication technology to produce CNT sensors for mechanical, thermal, and biological applications. We will specifically develop 1) a technique to dispense nano-liter CNT dilutions droplets onto silicon chips, 2) the necessary control hardware and software to automate the dilution injection process and the ensuing application of an appropriate di-electrophoretic force field to form CNT sensing elements on the chips. Potentially, this rapid CNT assembly technology can also be used to achieve automated fabrication of CNT-based nano-devices and NEMS such as integrated nano-circuits, nano-processors, and general nano sensing and actuation systems.

(CU04177)

A Ubiquitous Digital Writing System Using MEMS Motion Sensing Technology

✍ LI Wen Jung • LEONG Philip Heng Wai
(Computer Science and Engineering)

□ 1 December 2004

❖ DAKA Development Ltd • University-Industry Collaboration Prog.: Matching Grant for Joint Research, ITF, Innovation & Tech. Commission

“*Electronic Whiteboard*” and “*Digital Pen*” are new paradigms in the office automation industry that may someday completely replace the computer keyboard, which is still the preferred human-to-computer input device. These new technological devices aim to capture human hand writing or drawing motions in real-time and store the human motion strokes for character recognition or information retrieval at a later time. Products which aspire to capture this new market have begun to surface commercially in the last 2 years. However, existing technologies are still

hampered by at least two problems: 1) requirement of specialized and bulky accessories (e.g., special white boards or papers are need) that hinder the technologies for becoming highly popular; 2) relative high cost of the products which makes them inaccessible to many professional or home users.

For this project, we propose to develop a novel *Ubiquitous Digital Writing System* based on MEMS sensing and low-power wireless circuit technologies. The system will compose of a *Digital 3D Motion Pen* and a *Digital Eraser*, which, if combined with a mobile computing host, will become a completely new solution for mobile digital data input media. This novel system will provide end-users with lower cost products and allow them to have total freedom to use the new paradigm technology ubiquitously, i.e., they can use the system anywhere and on any surface, without the need for specialized papers or whiteboards. By merging DAKA's extensive electronic device manufacturing experience in the past 10 years, and CUHK's renowned Micro Input Devices System (MIDS) technology, our team intends to deliver a fully functional prototype of the Ubiquitous Digital Writing System within 2 years. Successful development of this system will enable DAKA to immediately market a very high-technology and value-added product in the increasingly demanding market for office automation technologies. DAKA will also benefit from this project by accumulating a knowledge base in developing low-power wireless sensing technologies, which will enable the company to also explore further applications to other product lines which require micro inertial-measurement technologies such as low-cost personal navigator and advanced single-user transportation systems.

(EE04484)

Precision Positioning of Hard Disk Drives Using Piezoelectric Elements

✉ LIAO Wei Hsin

☐ 1 January 2005

❖ Research Grants Council (Earmarked 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, high data density, 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, design of existing dual-stage actuators has two drawbacks: poor shock performance; limited bandwidth and position accuracy. In this research, we propose a novel dual-stage servo system using enhanced active-passive hybrid piezoelectric actuators. The proposed novel actuators will outperform the existing dual-stage actuators for two reasons. First, the proposed actuator has much higher shock resistance and reliability, due to the incorporation of passive damping in the design. Second, the proposed actuator will have a higher bandwidth and position accuracy. The objective of this research is to develop this hybrid servo system to improve the reliability and precision of track-following servos in HDDs. New piezoelectrically actuated suspensions with passive damping will be designed and fabricated. Experimental efforts will be carried out to implement the active-passive suspension structure with enhanced

piezoelectric actuators. The results of this project will not only advance the HDD technology, but also benefit the manufacturing base in Hong Kong and its vicinity.

(CU04200)

3D Stereoscopic Augmented Reality System for Nano-Assembly and Nano-Experimentation Using Atomic Force Microscopy

✉ LIU Yunhui • LI Wen Jung • FUNG Wai Keung#

☐ 1 October 2004

❖ Research Grants Council (Earmarked Grants)

In this project, we aim to develop a nanomanipulation system using atomic force microscopy (AFM), which provides real-time 3-D stereoscopic video feedback and 3-D force feedback to operators. With the 3-D stereoscopic visual feedback, the operator will have “immersive” experience, which realizes his/her virtual presence in the nano-world. The immersive feeling can greatly help the operator better understand and explore the nano-environment so that the manipulation is easier and more effective. By the 3-D force feedback, the operator is able to feel, in real-time, interactions between the AFM tip and nano-objects. The key technologies to be developed are (1) an augmented reality engine for synthesis of real-time visual and force feedbacks based on sensor information and molecular dynamic simulations so as to avoid blind exploration, (2) a 3-D immersive environment for stereoscopically visualizing the nano-world, and (3) a new hand-held haptic device that allows operator to specify 3D motion of the AFM tip and provides 3D force feedback. At the end of this project, we will demonstrate the performance of the augmented reality (AR) system by tele-operated assembly tasks of carbon nanotubes and experiments

measuring their electromechanical properties, e.g. resistance, etc. The proposed system can be widely used in nanoassembly and nano-experiments of nanometer sized objects, such as CNT, DNA, proteins, etc.

(CU04199)

Sequential Blind Source Extraction from Instantaneous and Convulsive Mixtures for Ill-conditioned Mixing Channels

✉ WANG Jun

☐ 15 August 2004

❖ Research Grants Council (Earmarked Grants)

Blind source separation and blind deconvolution are emerging techniques in adaptive signal processing with significant application potential in many fields. The objective of blind source separation and blind deconvolution is to recover unknown independent source signals from their mixtures without knowing the mixing channels. In many practical scenarios, the signal mixing channels are ill-conditioned where the channels are not invertible (e.g., there are fewer sensors than sources). In such cases, most existing blind source separation and deconvolution methods are usually not competent because they are designed for the well-conditioned invertible channels. For blind source separation and blind deconvolution in ill-conditioned channels, it is very difficult, if not impossible, to obtain separated source signals simultaneously. However, it is possible to extract signal sources sequentially one by one. In this proposed project, we will develop a sequential extraction approach to blind source separation and multichannel blind deconvolution for various ill-conditioned channels. Several neural network models will be developed for sequential blind source extraction from instantaneous mixtures in

ill-conditioned static channels and from convolutive mixtures in ill-conditioned dynamic channels. The extractability of sources will be analyzed and necessary and sufficient conditions for extractability will be obtained for both blind separation and deconvolution in various ill-conditioned channels. Effective cost functions and efficient unsupervised learning algorithms based on the extraction network models will be developed. Convergence analysis for the learning algorithms will be performed. It is conceived that the proposed neural network approach is very suitable for blind separation and blind deconvolution of sources through ill-conditioned mixing channels.

(CU04203)

Analysis and Planning of Passive Force Closures in Fixturing and Power-Grasping

✉ WANG Michael Yu

□ 1 January 2005

❖ Research Grants Council (Earmarked Grants)

In using workholding elements (i.e., locator pins, support anvils, and clamps), the fixture must hold the workpiece in an accurate, repeatable position. It must prevent undesired part motions and avoid deforming the part during the course of a manufacturing operation. This second requirement is related to so-called force closure condition, and it is achieved by relying on the reaction forces at the frictional contacts on the workpiece.

While the classical notion of force closure is well defined for actively controlled and coordinated robotic fingers, passive force closure is a more restrictive class of the problem. Within the typical rigid body framework, the passive reaction forces at the contact are indeterminate and span an unbounded linear space. The indeterminacy can cause difficulties

in the analysis, planning and implementation of reliable fixturing systems. This proposed project focuses on the force closure requirement, particularly on analysis and planning of passive force closure in fixturing and in highly-related power-grasping in robotics.

(CU04215)

Intelligent Shoes for Human Monitoring, Identification and Localization

✉ XU Yangsheng • LEE Ka Keung Caramon • Nechyba Michael*

□ 1 September 2004

❖ Research Grants Council (Earmarked Grants)

In recent years, researchers have begun to focus on wearable computers and sensor interfaces. One major benefit provided by wearable intelligent devices is that they are in close proximity to the users so that human data such as motion and physiological information can be obtained and analyzed anywhere at anytime. One niche for wearable devices useful to humans has, however, remained relatively unexplored - namely, the design and implementation of sensor and computer-equipped intelligent shoes. Therefore, we propose the development of just such a system. The on-going miniaturization revolution in electronics, sensor and battery technologies, driven largely by the cell phone and hand-held device markets, has made possible an intelligent-shoe implementation. Along with these hardware advances, progress in human data modeling and machine learning algorithms have also made possible the analysis and interpretation of complex, multi-channel sensor data. Our intelligent shoe system will leverage progress in these areas. The intelligent shoe system will consist of a microcontroller, sensor suite for

physiological, motion and force readings, and a wireless transmitter to be attached or implanted in normal shoes as a compact and light-weight attachment. Once prototyped, we will collect experimental sensor data for a variety of activities and a cross section of the population. These data will then be analyzed to meet three primary goals: (1) real-time health and gait monitoring; (2) real-time motion (activity) identification; and (3) real-time user localization. We will propose various intelligent learning algorithms, such as hidden Markov models and support vector machines, to achieve the modeling of human motion and physiological data. The proposed research opens up tremendous new human-computer interface possibilities, resulting in rich academic research contents and potential product lines in consumer electronics and multimedia industries.

(CU04202)

Development of Intelligent Lead-Free Hot Air Reflow System

✍ XU Yangsheng

☐ 1 June 2005

❖ Sun East Technology (Holdings) Limited

The research project will be based on lead-free soldering technology, to develop an intelligent lead-free hot air reflow system. The intelligent lead-free hot air reflow system is able to automatically predict temperature set curve, so as to easily control the temperature curve. The system is capable of self-adjustment, providing the control of production halt using the standard temperature recorder. The research project will be carried out by the team in ARL led by Professor XU Yangsheng.

(EE04321)

Characterization and Rendition of Human Line Drawing Techniques

✍ YAM Yeung

☐ 1 December 2004

❖ CUHK Research Committee Funding (Direct Grants)

We have developed a robot drawing platform in our laboratory comprising of a x-y-z axis translational mechanism with an attached robot pen gripper. The gripper provides an additional z-axis rotation and pitching motion, making a total of 5 axes degree of freedom for the pen motions to emulate the arm-hand-wrist movement in drawing action. The degrees of freedom are directly and independently commanded, doing away with complicated kinematics problems associated with some previous drawing machines. Industrial grade components ensure high precision and repeatability. The present proposal aims at using the platform to acquire, characterize, and emulate the line drawing skills of specific users or invited artists. There are two possible inputs to the platform. For this project the Intuos2 12" by 12" Tablet and Pen system will be used to record line drawings of the subject in concern. The recorded data include the x, y, and z-axis motion, as well as the angular orientation information of the Tablet pen. These data will be compacted by techniques such as Hidden Markov Matrix method to generate certain measures or characteristics particularly to the drawing styles of the subject. Other ways of combining various strokes to produce new strokes as would be produced by the subject will also be attempted. The goal here is not only to repeat the recorded drawings of the subject, but some sort of extrapolated drawings according to the subject's styles as well. Visual feedback will be

<p>2001-02 Integrated Micromechanical Switches for Adaptive Fractal Antenna Arrays (EE01215) ✉ LI Wen Jung • KWONG Chung Ping • LUK Kwai Man*</p>	<p>2002-03 A Multi-Robots Based Distributed Sensing System Via Mobile Communication Networks (CS02898) ✉ LIU Yunhui</p>
<p>2002-03 A Force and Impact Sensing System for Robotic Micro-Assembly (CU02381) ✉ LI Wen Jung • XI Ning*</p>	<p>2002-03 Dynamic Control of Robots Using Uncalibrated Visual Feedback (EE02504) ✉ LIU Yunhui</p>
<p>2003-04 Nanofixture-Enabled Robotic Assembly of Nanodevices (CU03225) ✉ LI Wen Jung • XI Ning*</p>	<p>2003-04 Intelligent Remote Performance Monitoring of Networked Mechatronic Systems via the Internet (EE03923) ✉ LIU Yunhui • XU Bugong*</p>
<p>2001-02 Dynamics and Control of Train Suspension Systems with Smart Dampers (MP01216) ✉ LIAO Wei Hsin • HUANG Jie</p>	<p>2003-04 Adaptive Visual Servoing of Robots in Un-Calibrated Environments (CU03167) ✉ LIU Yunhui</p>
<p>2002-03 Self-Powered Piezoelectric Sensors (CU02382) ✉ LIAO Wei Hsin • LI Wen Jung</p>	<p>2003-04 Vision-Based Measurement Technology for Railway Applications (EE03699) ✉ LIU Yunhui • WANG Defu*</p>
<p>2003-04 Hard Disk Drive Servo Systems Using Piezoelectric Elements (EE03930) ✉ LIAO Wei Hsin</p>	<p>2003-04 Analysis and Design of Recurrent Neural Networks for Dynamic Optimization Subject to Nonlinear Constraints and Their Engineering Applications (CU03165) ✉ WANG Jun</p>
<p>2001-02 3D Grasp Planning with Applications to Automated Fixture Layout Design (MP01217) ✉ LIU Yunhui • WANG Michael Yu</p>	<p>2001-02 Minimally-Invasive Techniques of Particle Vibration Damping (MP01196) ✉ WANG Michael Yu</p>
<p>2001-02 Real-Time Bilateral Teleoperation of Internet Based Robotic Systems (CS01446) ✉ LIU Yunhui • WANG Yuechao* • XI Ning*</p>	<p>2002-03 Interactive Haptic Simulations for Virtual Fixture Prototyping (CU02376) ✉ WANG Michael Yu • LIU Yunhui</p>

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|---------|---|---------|--|
| 2003-04 | Structural Shape and Topology Optimization Using Level Set Methods (CU03164)
✍ WANG Michael Yu | 2003-04 | Modelling and Analysis of Human Actions for Surveillance (CU03163)
✍ XU Yangsheng • LEE Ka Keung |
| 2001-02 | Human Informed Control of Dynamically Stable Systems (MP01228)
✍ XU Yangsheng • NECHYBA Michael* | 2003-04 | Development and Technology Transfer of Intelligent Electronics Toys (EE03359)
✍ XU Yangsheng • LEUNG Chung Ming* • TONG Hang • LEE Ka Keung Caramon |
| 2001-02 | Development of Technologies on Networked Smart Toys (EE01544)
✍ XU Yangsheng • ZHANG Ping# • LAW Kwok Ho Cedric# | 2003-04 | Synthesis of T-S Fuzzy Controller via Grid Point Designs and Closed Loop SVD Consolidation (CU03162)
✍ YAM Yeung |
| 2002-03 | Wearable Robots as Mobile Devices for Communication and Interaction (CU02317)
✍ XU Yangsheng | | |

RESEARCH PROJECTS

Semantic Analysis for AORA (Aspect-Oriented Requirements Analysis) - Graph

- ✉ BANIASSAD Elisa Ladan Anahita
- ☐ 15 January 2005
- ❖ CUHK Research Committee Funding (Direct Grants)

Aspect-orientation (AO) is a recently introduced software design and implementation paradigm in which systemic functionality is encapsulated in modules called *aspects*. AO-requirements analysis (AORA) involves identifying connections and relationships between the features described in a requirements document to determine which features are aspects.

AORA is a difficult task. The requirements that guide software development often comprise hundreds of textual pages, and may describe thousands of pieces of related functionality. AORA is generally done manually, with the developer reading the text and making notes as they see fit. Identifying all the relationships between pieces of functionality is nearly impossible, and generally left incomplete. Missed relationships become evident later in the software lifecycle, when they are costly or intractable to accommodate.

Research has shown that lexical approaches that provide graphical views of requirements text help identify relationships between pieces of functionality. However, if the set of requirements is very large, the diagrams are too complex for a developer to use within a reasonable timeframe. Developers need a way to summarize the graphs in such a way as to provide insight into the AORA process.

We assert that semantic analysis approaches could be employed to automatically glean meaningful relationships between portions of requirements documentation, and to summarize and cluster existing AORA-graphs. We propose development of semantic analysis approaches for AORA, to be integrated with existing approaches for visualization of relationships between portions of documentation. We will validate these approaches both in controlled experimental settings and in the field. (EE04821)

A Neural Network Approach for Financial Data Analysis

- ✉ CHAN Lai Wan
- ☐ 1 January 2005
- ❖ Research Grants Council (Earmarked Grants)

There has been a growing interest in the exploration of advanced technologies in the support of decision makings in financial market. Because of the powerful learning and knowledge capturing capability from historical data, neural networks have been a promising approach in this area. They have been applied to the generation of trading signals and asset allocation.

In modern portfolio management theory, more emphasis has been placed on managing and quantifying financial market risks. High expected return is not the only objective to achieve in portfolio management. The estimation of the return distribution of the portfolio is another key issue in portfolio management. It is essential for risk analysis, and hence it affects our decisions in asset allocation. Much research works have been done on the neural network research, portfolio management and risk analysis. In this project, we are planning to integrate the above areas, to design and implement a

portfolio management which determines the portfolio weights of a number of securities, based on the predicted return and distribution of the assets. A major characteristics of this system is that higher order statistics of the distribution would be involved (CU04206)

Gene Expression Data Analysis

✉ CHAN Lai Wan

☐ 1 March 2005

❖ CUHK Research Committee Funding (Direct Grants)

One of the most important developments in recent years for the understanding of gene functions is the introduction of DNA Array technologies, which levels provides us important information on the subset of genes expressed in different cell types under different conditions. Analysis of gene expression data enables us to gain more knowledge on the gene function and regulatory mechanisms. Clustering of gene expression is particular in the sense that it can be done in either comparing the expression in the gene level or in the sample level. Most current clustering algorithms perform clustering in either level, and hence they are named as one-way clustering techniques. However, gene expression can be studied in both levels at the same time. The rational behind is that it is believed that only small subsets of genes are participating in any cellular process of interest. In addition, genes can be included in more than one cluster or none at all. Two-way clustering techniques are thus useful in this application. However, current methods are very computational heavy. In this project, we will perform investigations on two-way clustering algorithms. Independent component analysis (ICA) will be used in our design of two-way clustering

method which aims at giving efficient and effective results. The proposed algorithm will be applied to the clustering of benchmark gene expression datasets and the datasets provided by the research collaborators.

(EE04669)

Issues in Outlier Detection

✉ FU Wai Chee Ada

☐ 1 November 2004

❖ Research Grants Council (Earmarked Grants)

In the research on data mining, finding patterns from apparent chaos is a major objective. For example, we may discover customer purchase patterns which can lead to appropriate marketing strategies. However, the reverse of this general goal of finding pattern from apparent chaos can also be beneficial. This is to find exceptions from patterns. The exceptions are also called outliers. The detection of outliers can be useful in applications such as fraud detection for credit-card companies of E-commerce, detecting criminal activities, intrusion detection for network security, detecting abnormal behaviour for system maintenance, and in general whenever users are interested not in the norm but in the exceptional cases.

The problems that we shall study are: (1) How to define outliers? How to efficiently detect outliers? These two problems are likely related. There are already a number of different definitions for outliers. It is observed that when an outlier definition handles more cases, it likely also requires more computations for detection outlier; (2) How to detect outliers for high-dimensional data? In real databases, there are typically many attributes, giving rise to high-dimensional data. Detecting outliers in this case becomes more difficult. The reason is that

different patterns may exist in different sub-spaces, and an outlier should deviate from all of the patterns. We hope to push forward the frontiers of this line of research and to examine possible applications which can benefit from the research.

(CU04209)

Virtual Functional and Anatomical Simulator for Orthopaedics Training

✉ HENG Pheng Ann • LEUNG Kwok Sui
(Orthopaedics & Traumatology)

□ 1 January 2005

❖ Research Grants Council (Earmarked Grants)

In this project, we propose to develop extremely high detailed virtual anatomical simulator for orthopaedics training based on ultra-high resolution digital human dataset that we acquired from the Chinese Visible Human project. The reconstructed virtual anatomical model can improve our understanding of orthopaedic anatomy and physiology. Furthermore, a haptic interface would be provided to facilitate training of basic surgical skills in surgical exposures for orthopaedic surgeries and further develop into interactive virtual reconstructive surgery for more comprehensive training. Since it is possible to simulate pathomechanics in our virtual model, the proposed simulator could also be used as research tool for investigating underlying causes and/or prediction of possible functional limitations or disabilities of certain specific orthopaedics pathologies.

(CU04223)

Enhanced Image and Video Completion

✉ JIA Jiaya

□ 1 October 2004

❖ CUHK Research Committee Funding (Direct Grants)

Some films that are 50 years old are in desperate need of restoration. With advances in digital imaging technology, digital film restoration has realized our dream to see classics like *Roman Holiday* and *Vertigo* in their originally intended color and shade when they were released nearly half a century ago.

In this proposal, we address one important area related to digital film or video restoration. Old films are damaged in various degrees due to deterioration. As for other applications like video editing and compositing, it is very common for the editor to remove a large, unwanted object from a video clip (e.g. an unwanted colossal, a mountain or large building, which is impossible to remove in real life), before a virtual object is optionally inserted into the video. Large holes are thus produced in many consecutive frames.

We propose a robust methodology, *enhanced image and video completion*, to repair the unseen or damaged static background and moving objects. Our repairing system consists of: a) *Image repairing*: given only a single 2D damaged image and under certain conditions, we are capable of repairing the previously occluded background, which is never seen in the given image. Our image repairing methodology can be generalized to repair range or 3D data, b) *Video repairing*: our repairing methodology can be extended to repair damaged videos.

We have developed prototypic systems and obtained some encouraging preliminary results.

(EE04644)

Theoretical and Experimental Research on Biased Classification Using Extensions of the Minimax Probability Machine

✉ KING Kuo Chin Irwin

□ 1 September 2004

❖ Research Grants Council (Earmarked Grants)

The Biased Classification (BC) is an important topic which arises very often in practice in classification problems. Although there are existing techniques based on either assuming a specific generative model or weighted approaches, these approaches lack generality and does not provide rigorous enough treatment for BC tasks.

The proposal consists of two main parts: the first part focuses on the theoretical exploration of the novel BC framework and the second part is to apply this novel framework extensively in medical diagnosis tasks.

1. *Extension of Minimax Probability Machine in Biased Classification*

MPM appears to be an ideal tool in handling biased classification by guaranteeing a worst-case classification accuracy without assuming specific data distribution. Our first part of work is to focus on the theoretical extension of MPM framework into BC.

2. *Application of Biased Minimax Probability Machine into Classification Tasks*

We plan to apply the biased MPM in classification tasks. For instance, we may use it for an epidemic disease system since it seems that the biased MPM is mostly suitable when diseases have undocumented cases and have no prior information but have a severe impact without timely and effective control.

The result of our research will enhance the understanding on the topic of BC with potential usage in medical applications.

(CU04235)

Study for Optimization of Operation During the Salinity Period

✉ LEE Ho Man Jimmy

□ 1 November 2004

❖ Macao Water Supply Co. Ltd.

During November of each year to March of the next year, the level of the source of water supply to Macau in Zhu Hai is low causing high salinity level in potable water. Care must then be taken to control the opening of pumps at the water source and the transfer of water between reservoirs to control the salinity level of potable water for the Macau general public. The goal of the project is to construct an optimization engine to help optimize the operations at the various pumping station and reservoirs so as to maximize the number of days that the potable salinity level is below a user acceptable level using a constraint programming approach.

This is a joint project with the International Institute of Software Technology, United Nations University (“UNU-IIST”), Macau. The responsibility of UNU-IIST is to develop a friendly user-interface on top of our optimization engine to solicit user input and present output.

(EE04733)

Utilizing Useful Redundancy Information to Increase Search Efficiency in Constraint Satisfaction

✉ LEE Ho Man Jimmy • STUCKEY Peter J.*

□ 1 January 2005

❖ Research Grants Council (Earmarked Grants)

Constraint satisfaction problems (CSPs) occur in all walks of industrial applications and computer science, such as scheduling, bin packing, transport routing, type checking, diagram layout, among others. These are all difficult applications. Rapid growth of

modern industrial sectors and higher degree of automation suggest the appearance of even more difficult constraint problems in the foreseeable future. Constraint problems are NP-complete in general. Freuder lists problem modeling among the seven most important future directions of constraint research, since the quality of the problem formulation is closely related to execution efficiency. An interesting technique in problem modeling is to introduce redundant constraints into the model, which can sometimes exhibit surprisingly good results. However, there is little systematic study on when and why a redundant constraint is useful, and how to generate useful redundant constraints in general. Successful application of this technique relies entirely upon the experience and insight of human ingenuity. The aim of the proposed project is to investigate a formal characterization of redundant constraints, ways to identify and detect useful (and useless) ones, and eventually methods to discover and generate useful redundant constraints in general to increase constraint solving efficiency. From the theoretical point of view, the proposed research will advance the understanding of how and when redundant information can affect execution efficiency of constraint-solving algorithms. From the practical point of view, this research has immense potential in giving tractable modeling of some real-life complex constraint problems.

(CU04219)

A Novel Architecture for Genetic Parallel Programming System Based on FPGA

✉ LEE Kin Hong • LEUNG Kwong Sak • CHEANG Sin Man*

□ 1 September 2004

❖ 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, Standard GP and Linear Structure GP (LGP). Standard GP evolves programs represented in tree structures. LGP evolves sequential programs directly. However, LGP suffers from inflexibility while Standard GP 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 functional-units processor (MFP). For this project, we shall build a Field Programmable Gate Arrays (FPGA) based development system to speed-up the search for GPP's. We shall also apply this GPP system to real application.

(CU04217)

Models and Applications of Bat Echolocation using FPGA Devices

✉ LEONG Philip Heng Wai

□ 1 December 2004

❖ CUHK Research Committee Funding (Direct Grants)

The field of neuromorphic engineering has the long term objective of taking architectures from our understanding of biological systems to develop novel signal processing systems. We propose to develop real-time digital hardware designs using Field Programmable Gate Array (FPGA) technology which are able to locate objects in space in a manner similar to our understanding of the echolocating bats. This work will involve the development of techniques for the efficient implementation of neuromorphic

systems using FPGA technology, a comparison of the computational efficiency of FPGA technology verses microprocessor and analog VLSI technology, and the development of improved biologically plausible models of the auditory pathways of the echolocating bat. As an application, we will apply the work to an aid for the blind based on echolocation.

(EE04769)

A New Class of Multimodal Genetic Algorithms and Its Application in Medicine

✉ LEUNG Kwong Sak • MOK Shu Kam Tony
(Clinical Oncology) • LEE Kin Hong

□ 1 September 2004

❖ Research Grants Council (Earmarked Grants)

Genetic algorithms (GAs) have been proven useful in solving a variety of search and optimization problems. Exploring multiple solutions in the multimodal optimization is very important because the optimization problems in real-world often need to locate the multiple optima in the search space. Over the years, various population diversity mechanisms have been proposed that enable GAs to maintain a diverse population of individuals throughout its search to identify multiple optima in the multimodal domain. However, none of them has demonstrated to be as efficient as we expected. In a pilot study, we have proposed a new adaptive elitist-population based genetic algorithm (AEGA) to search for all multiple optima. All the results of the experiments have demonstrated that the AEGA consistently and significantly outperforms the other multimodal evolutionary algorithms in efficiency and solution quality, particularly with efficiency speed-up of many orders. It indicates that the AEGA is very promising in real-word applications. As a case study, we have proposed a new automatic model of

drug scheduling optimization for cancer chemotherapy. The results obtained match well with the clinical treatment experience, and can provide much more realistic solutions than that of the existing models. In this project, we plan to extend and generalize the AEGA for different complex multimodal optimization problems. We will build a new dynamic model for the simulation of multi-drug chemotherapy for cancers from clinical data collected and use our new AEGA to optimize and predict efficient multi-drug administration scheduling policies for clinical treatments.

(CU04173)

Defense and Traceback of Distributed Denial-of-Service Attacks: Theory, Design, Analysis and Implementation

✉ LUI Chi Shing John

□ 31 December 2004

❖ Research Grants Council (Earmarked Grants)

The aim of this project is to devise effective mechanisms to defense against denial-of-service attacks such as distributed attacks and low rate TCP attacks.

(CU04218)

A Design Paradigm for Fault-Tolerant Wireless Distributed Software Systems

✉ LYU Rung Tsong Michael

□ 1 January 2005

❖ Research Grants Council (Earmarked Grants)

In this project, we propose to investigate a fault tolerance design paradigm for wireless distributed software systems and to analyze the resulting system performance and reliability. A six-level fault

tolerance model will be given and the fault tolerance techniques which are suitable to be applied in each level will be discussed. As components of the wireless distributed environment inherit intrinsic characteristics and provide particular functionalities, their corresponding fault tolerance techniques are different and worth exploration. To give a guideline in applying fault tolerance techniques, we will conduct the related performance and reliability analysis. Different failure scenarios will be identified and the respective failure models will be constructed. The relationships among dependent failures will be examined. We will integrate the solutions to these performance and reliability problems into the fault tolerance design paradigm for more pertinent and effective application of fault tolerance techniques. In this paradigm we will also identify the key parameters and components to improve the performance and reliability of the entire mobile systems.

(CU04205)

A Middleware Framework for Secure Mobile Grid Services

✉ NG Kam Wing

□ 1 January 2005

❖ Research Grants Council (Earmarked Grants)

A grid denotes middleware infrastructure, tools, and applications concerned with integrating geographically distributed resources to provide services to support the execution of large-scale, resource-intensive, and distributed applications [DoF03][BFH03]. The services provided by nodes in a grid are called grid services [FKN03]. Current grid technologies only enable stationary grid services provided by fixed service providers. However, if the grid services can become mobile and be able to be

securely executed on other service providers, grids can maximize their resource usages by moving the mobile grid services to suitable service providers. The challenges include enabling grid services to become mobile; enabling grid services to be run on heterogeneous environments; and ensuring security of the grid services. Mobile agent technology is to be deployed to solve the above problems. This research aims to provide solutions to the security, mobility and heterogeneity issues of grid services. The solutions consist of a mobile grid service middleware framework and security mechanisms to support secure and mobile grid services. The mobile grid service middleware framework enables grid services to be able to migrate to heterogeneous grid environments. The security mechanisms include protocols for detecting tampering against mobile grid services, and protocols to detect malicious grid nodes.

(CU04220)

Interactive Multi-Resolution Modeling Based on 2nd Generation Wavelets

✉ SUN Hanqiu

□ 1 December 2004

❖ CUHK Research Committee Funding (Direct Grants)

Multiresolution geometric modeling includes multi-resolution editing of curves and surfaces, hierarchical representations and manipulation of geometric shape, and multiresolution modeling of meshes, which are often associated with wavelets. One of classical wavelets is B-spline wavelet transform, which is widely used for multiresolution geometric modeling and editing of curves and surfaces. Endpoint-interpolating B-spline wavelets are adopted for curve fairing, smoothing, editing

while preserving the details, and approximating within given error tolerance for scan conversion. Classical constructions of B-spline wavelets, which are generated by shifting and scaling a single function over a parameter domain, are limited to simple domains such as intervals and rectangles. They, however, are not suitable for many applications, such as surfaces of arbitrary topology, virtual creatures of complicated shape and GIS products.

This project proposes to develop the interactive modeling tools for multi-resolution surfaces based on 2nd generation wavelets. In general, 2nd generation wavelet transforms require only local and fast lifting-style filtering operations, and thus make multi-resolution editing and compression of large-scale surfaces feasible. We will investigate wavelets on bounded domains or on curves and surfaces of arbitrary topology, weighted wavelets and wavelets under constraints using the lifting scheme. Lifting wavelets and subdivision surfaces with arbitrary topology have some common properties. We will work on studying various lifting wavelet transforms that can meet special orthogonality requirements, and further investigate how to build a unified framework of lifting surface wavelets and generalized subdivision surfaces. Constrained wavelets deliver new features to multi-resolution techniques yet maintain the efficiency of wavelets. We will focus on investigating multi-resolution techniques for interactive geometric modeling, with the ability to construct customized wavelets under constraints of positions, tangents and/or high order derivatives at user specified parameter values. The advanced wavelet-based tools to be developed will benefit the interactive multi-resolution modeling of arbitrary topology with efficient memory and linear computation complexity, which are important qualities in complex geometric modeling & analysis, data compression, network transmission of

large-scale datasets, data security & encryption. The outcomes of the project will help the local information industry to exploit many related applications, and further enhance the hi-tech/hi-value competitive edge of Hong Kong.

(EE04672)

Consistent Data Retrieval for Mobile Ad-hoc Sensor Network Systems

✉ WONG Man Hon

☐ 1 October 2004

❖ Research Grants Council (Earmarked Grants)

A mobile ad-hoc sensor network system is a collection of mobile processors equipped with sensors. These mobile processors can communicate through wireless channels without centralized control or static base stations for routing purposes. This technology has matured to the point that it is affordable for a large scale deployment of these devices to monitor some interesting parameters in an environment. How to get the data and the aggregates efficiently from these mobile processors has attracted the attention of many researchers in the database community. Besides efficiency, getting a set of consistent data is also important. However, due to the dynamic and widely scattered nature of mobile processors, getting a consistent snapshot of the data is difficult. The objective of this project is to derive an efficient way for retrieving data from an ad hoc sensor network system, such that the data are both topological and logical consistent.

(CU04208)

Real-Time Relighting of Compressed Image-Based Scenes Using Commodity Graphics Hardware

✉ WONG Tien Tsin

□ 1 October 2004

❖ CUHK Research Committee Funding (Direct Grants)

The ability to dynamically change the lighting (dynamic lighting) in game applications is crucial for designers to create dramatic atmosphere. However, complex geometry background is hard to be rendered in real-time. Image-based relighting offers the potential of dynamic lighting by decoupling the rendering time from the scene complexity. In order to make image-based relighting practical, the image-based scenes must be compact and relighting must be in real-time. Hence, real-time relighting directly from compressed scenes is necessary. This is challenging as its computation is very expensive. Pure software implementation is not feasible.

Current approaches to this problem are either data size too large or real-time relighting is not achieved. In this project, we propose to develop parallel relighting algorithms for compressed image-based scenes. The real-time feedback will be achieved through designing SIMD-based parallel rendering algorithms that can be run on commodity graphics hardwares such as nVidia GeForceFX or ATI 5900. Since SIMD-based parallel graphics hardwares are driven by the games market and now available at a user-affordable cost, the developed algorithms shall be directly usable for end users.

Since decompression has to be done during the relighting, the designs of codec and relighting algorithms are inseparable. We propose to compress the image-based scenes using two approaches, namely spherical harmonic and radial basis functions. Spherical harmonic provides pleasant visual quality while radial basis function may preserve high-frequency visual features such as highlights and shadows. We will propose a uniform

approach in designing real-time relighting algorithms for these two different coding methods.

We believe the set of compact representations and real-time relighting 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. The result will not just contribute to the research of image-based computer graphics and multimedia, but also be beneficial to local development of computer game industry in Hong Kong.

(EE04948)

Modeling, Analysis, and Applications for Arbitrary Shape Switching Box Designs

✉ WU Yu Liang • FAN, Hong-bing*

□ 1 December 2004

❖ CUHK Research Committee Funding (Direct Grants)

FPGA is considered one of the most important IC technology inventions in our time. The objective of this research is to develop a general methodology for building switching boxes (or networks) accommodating different terminal densities along different box sides. In the past, researches on switch box (SB) optimality were confined to regular switch boxes where all box sides possess the same number of terminals. We consider optimal design problems for arbitrary-shape (irregular) k-sided switch boxes in which terminals are located on k sides and programmable switches are joining pairs of terminals from different sides. Previous investigations on switch box designs mainly focused on regular switch boxes, where all sides have the same number of terminals. But, clearly irregular switch box models allowing arbitrary shape are more

general and flexible for potential applications such as customized FPGAs and reconfigurable interconnection networks. In this paper, we study the general arbitrary shape switch box design problems and present a simple divide and conquer (reduction) design technique for such a model. The core idea of our technique is to model a routing requirement as a nonnegative integer vector satisfying a system of linear equations. Then based on the theory of system of linear Diophantine equations, we develop a general decomposition theory for routing requirements, and as a result, we can construct a large optimal irregular switch box by combining small switch boxes of some particular sizes. Furthermore, we also show that an irregular switch box, satisfying the given channel density and routing capacity specifications, can always be designed using only a linear number of switches and yielding a linear complexity routing algorithm.

(EE04379)

A Systematic Investigation on the Acquisition-Assumption-Assessment-Adaptation-Accumulation Paradigm for Mining Multiple Structures and Detecting Multiple Objects

✉ XU Lei

□ 1 October 2004

❖ Research Grants Council (Earmarked Grants)

Finite sample acquisition, multiple candidate assumption, criterion guided assessment, local search adaptation, and global consensus accumulation are five classical problem solving strategies that have been often used in human intelligent activities. Efforts have also been made on adopting these strategies to automatic problem-solving of the above tasks by computer, which can be summarized into three major streams represented by Hough transform

and its extensions, random sample consensus, and multisets mixture learning, respectively. This proposal aims at making a systematic investigation on other combinations, from the aspects of quality, the costs of time and storage, the ability of resisting noises and outliers. Not only further studies will be made on how three streams can improved by adding in strategies that have not been considered before but also an integrated Acquisition-Assumption-Assessment-Adaptation-Accumulation paradigm will be developed for detecting multiple objects on an image and mining multiple structures from data.

(CU04225)

Retiming in Physical Planning of System-on-Chips

✉ YOUNG Fung Yu

□ 1 December 2004

❖ CUHK Research Committee Funding (Direct Grants)

As technology moves into the deep-submicron era, circuit sizes and complexities grow dramatically. In this new paradigm, signal communication time along global nets of a System-on-Chip (SOC) circuit becomes a bottle-neck. The delay from one block to another may require multiple clock periods. To remove this bottle-neck, flip-flops can be inserted to pipeline those long wires. Retiming is a well-known technique that relocates flip-flops within a circuit without destroying its functionality. The goal of this project is to study and incorporate this retiming technique in physical planning of SOCs to improve the system performance. Traditional retiming was only used on netlist of logic gates in which the delay came mainly from the gates. In order to apply retiming on global wires of macro-blocks, we need to re-formulate and solve a

new retiming problem with both gate and interconnect delay. Finally, we need to realize the retiming solution in the real circuit layout during or after the placement process by inserting flip-flops at the right places, taking into account layout constraints like blockages, routability, etc. These are all challenging problems to be solved, and the success of this project will benefit the EDA industry and the design of high performance SOCs. Some pilot studies are already underway and they show a promising potential of success in addressing the problems and accomplishing the goal.
(EE04516)

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

Edition Title/Investigators

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

2003-04 Outlier Detection among Projected Clusters (EE03476)
 ✍ FU Wai Chee Ada

2003-04 Automated Data Mining for Hot Bundle Analysis and Inventory Control (CS03972)
 ✍ FU Wai Chee Ada • YU Jeffrey Xu (Systems Engineering & Engin. Management) • WONG CHI WING
 • WONG K P Raymond*

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#

2003-04 Virtual Anatomy and Dexterous Simulators for Minimal Access Cardiothoracic and Laparoscopic Surgeries (EE03368)
 ✍ HENG Pheng Ann • CHENG Chun Yiu Jack (Orthopaedics & Traumatology) • WONG Tien Tsin
 • LEUNG Kwok Sui (Orthopaedics & Traumatology) • LAM Wai Man Wynn (Diagnostic Radiology & Organ Imaging) • LEUNG Kwong Sak • XU Yangsheng (Auto. & Computer-Aided Engin.) • YIM Ping Chuen Anthony (Surgery) • ZHANG Yuanting (Electronic Engineering)

2002-03 Target Information Estimation for Relevance Feedback Framework in

	Content-Based Image Retrieval (CU02351) ✉ KING Kuo Chin Irwin	2001-02	Integration of Constraint Satisfaction Techniques and Mixed Integer Programming (CS01211) ✉ LEUNG Ho Fung • LEE Ho Man Jimmy
2001-02	Reducing Search Space in Local Search for Constraint Satisfaction (CS01204) ✉ LEE Ho Man Jimmy • LEUNG Ho Fung • STUCKEY P. J.*	2002-03	Adaptive Strategies for Soft Bid-Determination in Agent Based Continuous Double Auctions (CU02346) ✉ LEUNG Ho Fung • LEE Ho Man Jimmy
2002-03	Efficient Local Search Methods for Soft Constraint Satisfaction Problems (CU02358) ✉ LEE Ho Man Jimmy • CODOGNET Philippe* • LEUNG Ho Fung	2003-04	Agent-Based Collaborative Workforce Management (CU03190) ✉ LEUNG Ho Fung • CHEUNG Shing Chi*
2002-03	Automated Design and Prototyping of Communication Architectures for Heterogeneous Systems-on-a-chip (EE02797) ✉ LEE Kin Hong • GLESNER Manfred*	2001-02	A Novel Fast Evolutionary Algorithm and Its Application in Unsupervised Learning (CS01212) ✉ LEUNG Kwong Sak • WONG Man Leung*
2002-03	Towards Fast Extraction of Approximate Features for Content-Based Access in Visual Informaiton Retrieval (CU02377) ✉ LEE Moon Chuen	2002-03	GPP: A Novel Framework for Genetic Parallel Programming (EE02481) ✉ LEUNG Kwong Sak
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*	2003-04	To Develop and Evaluate A Novel Genetic Parallel Programming System (CU03192) ✉ LEUNG Kwong Sak • Cheang S. M.* • LEE Kin Hong
2002-03	Floating Point Computation Using FPGA Clusters (CU02333) ✉ LEONG Philip Heng Wai • LUK Wayne*	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	2003-04	Augmented Reality Computing Arena for Digital Entertainment (ARCADE) (EE03335)
2002-03	A Proportional Delay DiffServ-Enabled Multimedia Server: Admission Control, Resource Allocation and Dynamic Adaptation (CU02368)		✍ LYU Rung Tsong Michael • KING Kuo Chin Irwin • WONG Tien Tsin
	✍ LUI Chi Shing John	2002-03	Clustering of Color Map Pixels for GPS/GIS Applications (EE02527)
2003-04	Asymmetric Parametric Sequence Approach to Provide Secure Multimedia Delivery for Wired/Wireless Peer-to-Peer Systems: Theory, Design and Implementation (CU03186)		✍ MOON Yiu Sang • LUK Tai Cheung Franklin*
	✍ LUI Chi Shing John	2002-03	Fault-Tolerant and Security Mechanisms for Mobile Agent System (EE02424)
			✍ NG Kam Wing
2003-04	OnME: Online Mobile Engine for Creating Multi-Players Online Game for Mobile Devices (EE03794)	2003-04	Fault-Tolerant and Security Mechanisms for Mobile Agent Systems (CU03187)
	✍ LUI Chi Shing John • CHIU Dah Ming (Information Engineering)		✍ NG Kam Wing
		2002-03	Interactive Deformable Registration & Simulation of Medical Volumetric Datasets (CU02356)
2001-02	Engineering Distributed Objects for Reliability and Interoperability (CS01222)		✍ SUN Hanqiu • ELAREFI Ahmed Abdalla (Surgery) • QIN Kaihuai* • ZOU Jun (Mathematics) • TO Wai Hei Edward*
	✍ LYU Rung Tsong Michael		
2002-03	Design Diversity by Component-Based Software Development (CU02360)	2003-04	Multi-Touch Haptic Sculpting with Constrained Geometries in Virtual Volume Space (CU03181)
	✍ LYU Rung Tsong Michael • STRIGINI Lorenzo*		✍ SUN Hanqiu • JIN Xiaogang* • XIN Zhouping (Mathematics)
2003-04	Reliable Automatic Multi-Layer Video Content Classification Based on Syntactic and Semantic Features (CU03182)	2001-02	Effective and Efficient Compression for Image-Based Modeling and Rendering (EE01369)
	✍ LYU Rung Tsong Michael • Howard WACTLAR*		✍ WONG Tien Tsin

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|---------|--|--|
| 2002-03 | Low-Cost Tele-Immersive Display with Multiple Live-Video Streams (EE02615)
✍ WONG Tien Tsin • HENG Pheng Ann • WONG Man Leung* | ✍ WU Yu Liang • FAN Hongbing# • HONG Xian Long* • WONG Chak Kuen |
| 2003-04 | A Spherical Wavelet Approach for Image-Based Relighting (CU03189)
✍ WONG Tien Tsin • LEUNG Chi Sing* | 2002-03 Structural Rival Penalized Competitive Learning with Automated Model Selection (CU02336)
✍ XU Lei |
| 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 | 2003-04 Extensions of BYY Independent State Space and Generalized APT Financial Models (CU03184)
✍ XU Lei |
| 2002-03 | Optimization Algorithm Based on the Less Flexibility First Principal and Its Practical Applications (CS02573)
✍ WU Yu Liang • DONG Sheqin* | 2001-02 Interconnect-Driven Multilevel Floorplan Design (EE01231)
✍ YOUNG Fung Yu • WONG Martin D F* • YANG Honghua Hannah* |
| 2003-04 | Optimal Multi-Point Switching Box Structure for FPGAs and Communication Switching Networks (CU03229) | 2003-04 Interconnect Driven Floorplanning for 3-D Chips (CU03188)
✍ YOUNG Fung Yu |

RESEARCH PROJECTS

Image-Based Modeling and Rendering from Multiple Views: A Multiple Cues Based Propagation Approach

✉ CHAM Wai Kuen

☐ 1 April 2005

❖ CUHK Research Committee Funding (Direct Grants)

We have developed a match propagation framework for image-based modeling and rendering. The framework begins by selecting a set of reliable pixel matches. It then propagates them to neighboring pixels based on the piecewise smooth assumption in the spatial domain and the clustering-based photoconsistency constraint which is applied to handle pixel occlusion, partial pixel effects and lighting effects between images. In this project, we propose to further improve the method by finding better photoconsistency and depth smoothness constraints.

(EE04521)

Adiabatic Smart Card

✉ CHAN Cheong Fat • CHOY Chiu Sing Oliver • PUN Kong Pang

☐ 1 September 2004

❖ Research Grants Council (Earmarked Grants)

There is a great demand for an increase in the processing power of the next generation of smart cards. However, power consumption, which leads to an increase in the circuitry of the smart card, is a major limiting factor. Smart cards currently used

are divided into contact and contactless types. Contactless cards generate internal DC power supplies from external RF signals. Their conversion efficiency is consequently very poor, and the power budget of the card is very tight. The power budgets of contact smart cards are higher, but they cannot supply very large amounts of DC power either, because there is only one power and ground pin on these cards. The large parasitic inductance of a single power and ground pin generates a power supply and ground bounce noise that limits the complexity of the circuit in contact smart cards. The adiabatic circuit is a new type of low-power CMOS circuit which recycles the charge to save power, and is totally compatible with conventional digital CMOS circuitry. Our test results have indicated that a significant power saving can be achieved by replacing all or part of the CMOS circuit with an adiabatic circuitry.

(CU04183)

A Novel Approach to High Efficiency RF Power Amplifier Design for Wireless Applications

✉ CHENG Kwok Keung Michael

☐ 1 September 2004

❖ Research Grants Council (Earmarked Grants)

RF power amplifiers are used in a wide variety of applications, particularly in wireless communication systems. RF power can be generated by a wide variety of techniques using a wide variety of devices. The design of a fully integrated power amplifier with reasonable output power, efficiency, and gain remains one of the major challenges in today's pursuit of a single-chip integrated transceiver. This proposal presents, the investigation of the design and implementation of an integrated, Watt-level, GHz range, low-voltage CMOS power amplifier for

wireless communication applications. This new configuration can be used to implement linear classes of amplifiers as well as the switching mode family.

(CU04239)

Silicon Realization of the PSOLA Algorithm for Tonal Language Speech

✉ CHOY Chiu Sing Oliver

□ 1 January 2005

❖ CUHK Research Committee Funding (Direct Grants)

Speech synthesizer for portable/handheld applications is very useful in our daily life. It can be implemented in PDAs, toys, mobile phone systems, etc. However, because of the size and cost constraints, speech synthesizer with low memory and low power requirements is badly needed. For a certain language, a suitable speech synthesis algorithm will lead to low memory requirement. And Silicon realization of the Speech Synthesizer can achieve low power as compared to using processors (DSPs), and will save cost in the long run.

Some previous research work has proved that Time Domain Pitch Synchronous Overlap Add (TD-PSOLA) algorithm is a suitable algorithm to realize speech synthesis for tonal languages such as Cantonese and Mandarin. And related project in our research group has developed a speech synthesizer using Field Programmable Gate Array (FPGA) technology, which partly proved the feasibility of silicon realization of this algorithm.

It is not easy to deliver high quality speech cost effectively. A good architecture is necessary to facilitate integration. At the same time, the silicon design must be readily modified to suit different cost-performance trade-offs. At circuit level, a proper balance between arithmetic complexity and

memory requirement must be reached. In short, the goal of this project is to develop a high quality and low power speech synthesizer that can be readily connected to system processor for applications like text to speech, voice generation etc.

(EE04718)

High Sensitivity Sensors for Biomedical Applications

✉ HO Ho Pui • WAYE Mary Miu Yee (Biochemistry) • TAM Hwayaw* • LIN Chinlon (Information Engineering)

□ 1 September 2004

❖ Research Grants Council (Earmarked Grants)

The detection of bio-related substances is an important and highly topical subject because of the threat of bio-terrorism and the prevalence of contagious viruses such as those responsible for SARS, Dengue Fever or West Nile disease. Accuracy and fast turn-around times are essential in the front-line detection of a range of bio-related substances, including viruses, pathogens, antibodies, DNA, pollutants etc. In this project we propose the investigation of novel methods for implementing highly sensitive biosensors. In particular we will investigate the use of optical detection of surface plasmon resonances within a resonant cavity. Photonic biosensors have been rapidly gaining acceptance because of their advantages in real time measurement, measurement simplicity, and wide dynamic range. The proposed biosensor will utilize the optical phase shift from changes in the surface-plasmon resonance (SPR) caused by the adhesion of different biomolecules to the sensor surface. A novel feature of the proposed approach is the use of self-balanced interferometric techniques to measure the changes in optical phase which arises

from a shift in SPR. This approach offers an order of magnitude improvement in sensitivity over conventional methods which rely on a measurement of the change in reflected beam angle. Our investigations will also include the use of phase-stepping for imaging the SPR phase shift and capability to sense multiple species using an array of integrated biosensors.

(CU04186)

Prosody Analysis and Modeling for Cantonese Natural Speech Synthesis

✉ LEE Tan

□ 1 January 2005

❖ Research Grants Council (Earmarked 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. Duration, fundamental frequency (F0) and signal intensity are the major acoustic correlates of prosody. We attempt to establish parametric models that can take on linguistic

specifications and accordingly predict F0 movement and duration patterns for synthetic utterances. 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 project is divided into three parts: 1) acoustical analysis of Cantonese prosody; 2) parametric modeling of prosody; and 3) TTS performance evaluation.

(CU04227)

Development of a Wireless Robotic Capsule Endoscope with External Guidance

✉ MENG Max Qing Hu • ZHANG Yuanting • MEI Tao*

□ 1 January 2005

❖ Research Grants Council (Earmarked Grants)

The cancer caseload in Hong Kong has been increasing, of which gastrointestinal (GI) tract related cancers ranked among the highest. Cancer is the leading cause of death in Hong Kong, accounting for over one third of all deaths, of which 1 In 5 are due to GI tract related cancers. Most GI related cancers can be cured if they are detected at their early stages. Wireless capsule endoscopes equipped with a micro-camera and wireless communication capability can be swallowed by a patient and then it goes through the human GI system with the natural peristaltic movement from the mouth to anus, while it transmits out images of the GI tract wirelessly. In this project, we will design a new wireless robotic capsule endoscope with external guidance and 3D capsule location and orientation determination for controlled interactive GI tract examination and GI tract 3D model construction. The developed device can be controlled to examine and stop at any

interested spots of the GI tract and can be guided to move through unimportant areas of the GI tract in a much faster pace than the passive natural human peristaltic GI movement so that it will have the advantages of both the current wired endoscopes and the wireless passive ones. It will be a better wireless capsule endoscope that is easy, safe, and comfortable to use, controllable and precise, with less examination time and with much less missing spots, suitable for controlled interactive examination and diagnosis of the human GI tract.

(CU04213)

Video Segmentation for Content-Based Encoding

✉ NGAN King Ngi • CHAM Wai Kuen

□ 1 January 2005

❖ Research Grants Council (Earmarked Grants)

MPEG-4 is the first audio-visual representation standard to model a scene as a composition of objects with specific characteristics and behavior. A major strength of this object-oriented representation is that audio and video can be independently manipulated. To take advantage of the new content-based functionalities supported by MPEG-4, a prior decomposition of video sequences into semantically meaningful objects is required. The MPEG-4 standard does not address this problem, and it is left to the content provider how this so-called video segmentation is accomplished.

Existing video segmentation techniques do not provide 100% accuracy. The difficulty inherent in segmentation stems from the fact that three-dimensional objects must be extracted from two-dimensional video frames. By combining depth information with existing segmentation techniques, higher segmentation accuracy can be potentially achieved. The goal of this research project is to

develop new and effective strategies to extract video objects from video sequences using depth information as the primary cue. We expect that a classification-based approach will be able to incorporate depth information more effectively since it allows multiple cues to be used simultaneously.

(CU04229)

Fusing of Complementary Features for Chinese Speaker Verification

✉ P.C. CHING • LEE Tan

□ 1 January 2005

❖ Research Grants Council (Earmarked Grants)

There has long been a desire to be able to recognize a person simply based on their voice. With the advances in speech processing techniques, it is now possible to automatically verify or identify a person by using speaker-specific information inside the speech waves. Recent studies show that state-of-the-art speaker recognition technologies have achieved a high degree of success for small-scale text-dependent systems under controlled environments. However, the performance of Speaker Verification (SV)/Speaker Identification (SI) systems degrades rapidly in noise and also when the model size is large rendering them less suitable for large scale deployments over landline or mobile phones. While the robustness of speaker recognition against noisy or distorted speech can be improved by applying different kinds of front-end speech enhancement processes, a major deficiency of most existing SV/SI systems lies in the fact that only Mel-frequency cepstral coefficients (MFCC) are used as feature parameters for recognition purpose, which are low-level short-term acoustic cues and are susceptible to noise. In this project, we propose to extract the linear prediction (LP) residual as an

additional feature, which is well known to be closely related to the excitation wave of individual speaker. The LP residual is then Haar transformed to reduce the vector size and to retain the spectro-temporal characteristics of the glottal excitation. In addition, we shall exploit complementary high-level prosodic features such as phone durations and pitch and energy contours to improve accuracy and to increase robustness, these are particularly useful for Chinese-speaking speaker verification. With the expanded feature set, we shall develop an efficient fusion technique as well as an effective model compression method that will allow the speaker recognition system to operate under practical constraints.

(CU04236)

Integrated Active RC Filters with Automatic Digital Frequency Tuning Based on Current Division Principle

✍ PUN Kong Pang

□ 1 January 2005

❖ CUHK Research Committee Funding (Direct Grants)

This proposal aims at studying a novel digital frequency tuning technique for integrated active RC filters and exploring its applications. Unlike the traditional tuning approach of varying the values of the capacitors or resistors, the proposed technique achieves the tuning by varying the currents that flow through the resistors or capacitors by employing a digitally programmable MOSFET-only current division network. The potential advantage of this technique is wide tuning range, compact size, high linearity and simple. We plan to design a low power filter for biomedical applications, where a cutoff frequency below 10 Hz is required. Active RC

filters are never been successfully applied in this area of application due to the very large tuning range and very large RC time constants required respectively. This project will not only provide an alternative solution to the frequency tuning of active RC filter, but also enable the applications of active RC filters in areas that have never been explored.

(EE04515)

New Approaches for Ultrafast Processing of Photonic Signals Using Fiber Kerr Non-Linearity

✍ SHU Ching Tat C. • LIN Chinlon (Information Engineering) • TSANG Hon Ki

□ 1 January 2005

❖ Research Grants Council (Earmarked Grants)

Modulation of the optical phase through fiber Kerr non-linearity offers an attractive means for ultrafast processing of photonic signals, and is important for the growth of future all-optical networks. Until recently, the focus on non-linear phase modulation has been in conjunction with the use of an optical interferometer. Hence, phase modulation can be turned into intensity changes for simple envelope detection. However, the stability of an interferometer is highly vulnerable to environmental changes such as temperature variation, vibrations, and polarization fluctuations. Other constraints are that the control pulse width should be shorter than the switching window, and an optimized phase change can only be obtained at a certain control power. Most of the above problems can be solved with the use of non-interferometric devices for photonic processing. Nevertheless, there are still unsolved issues including polarization sensitivity, requirement of intense pulses, dispersive walk-off between control and signal pulses, and degraded signal-to-noise ratio. It is the purpose of our proposal to address these

issues and to present a series of innovative solutions. In addition, we will demonstrate our novel approach for enhanced spectral broadening by phase modulation using multi-stage optical filtering in the setup. A number of applications including optical signal regeneration, high-speed demultiplexing, and wavelength multi-casting will be investigated. The experimental data will also be compared with our theoretical results to yield a complete picture of the processes and eventually will help to lay down the design rules.

(CU04184)

Addressing Key Performance Issue in Silicon on Insulator Optical Waveguides

✉ TSANG Hon Ki

□ 1 January 2005

❖ CUHK Research Committee Funding (Direct Grants)

Silicon-on-insulator (SOI) optical waveguides attracted considerable commercial development during the telecommunications bubble of 1999-2001. SOI waveguides offer an attractive platform for multi-channel optical devices because of their potential for volume manufacturing and small size for high channel count applications such as wavelength (de-)multiplexing, channel monitoring, multi-channel variable optical attenuation and multi-channel transceivers. Although remarkable advances were made in SOI waveguide devices, their performance in terms of crucial parameters such as insertion loss, polarization dependent loss or polarization dependent wavelength do not match the best available from alternative technologies such as thin film filters. What SOI waveguides can offer - a platform for compact integration of multiple functions in high channel count systems - is not needed currently

because of insufficient demand for the bandwidth provided by high channel count systems, but in the long term the continued rise in demand for bandwidth will eventually make SOI waveguides commercially attractive again. We propose a research program to work on key performance issues in SOI waveguides, particularly their polarization dependences and loss. In the revised project the main focus will be on new methods for birefringence, phase and polarization adjustment in SOI waveguides with the aim of developing integrated polarization dependent beamsplitters and mode converters.

(EE04405)

Modeling Language Endangerment among the Minority Language of China

✉ WANG William S Y

□ 7 September 2004

❖ Research Grants Council (Earmarked Grants)

As powerful languages like Chinese and English expand their spheres across the world, many minority languages lose their speakers rapidly and become extinct. We will investigate the status of some of these endangered languages, model their attentions with simulation techniques, and consider various consequences of intervention from an evolutionary perspective.

(SS04552)

Duration Analysis and Self-Adaptive Tempo Estimation in Speech Recognition for Mandarin and Cantonese

✉ WANG William S Y

□ 1 May 2005

❖ CUHK Research Committee Funding (Direct Grants)

We propose research on the durational aspects of spoken Chinese, to enhance our knowledge of the Chinese syllable, and to use the knowledge to improve automatic speech recognition.

Previous studies have demonstrated that there are several important factors, such as initial, final, tone, tempo and the syllable position in a word, a phrase or an utterance, which co-affect the syllable duration in Chinese. In this study, the powerful techniques of structural equation modeling (SEM) will be used to study the simultaneous effects of those factors on syllable duration in both Mandarin and Cantonese. One major advantage is that SEM enables the researcher to specify the relationships between the variables of interest prior to applying the technique, rather than simply allowing the statistical algorithm to atheoretically choose the model which best fits the data. Then, the contribution of each factor together with their interactions can be examined in a clearer and principled manner.

In our pilot study, tempo has been demonstrated to vary dramatically among different speakers, even within the same speaker in different time courses, and play a large role in determining the syllable duration for both Mandarin and Cantonese. However, this factor has not been taken into full consideration for duration models in automatic speech recognition, because there are no efficient methods to estimate the tempo in parallel to hidden Markov Model (HMM) speech decoding. Therefore, a self-adaptive tempo

estimation method, which can track the tempo variations according to different speakers, even at different time courses for the same speaker, will provide a parameter to model duration with higher accuracy. This kind of measurement will no doubt facilitate the full use of duration knowledge in automatic speech recognition.

(EE04658)

Ion Beam Synthesis and Modification of Metal Nanoclusters in Dielectric Substrates

✉ WONG Sai Peng Joseph • Jorg K N Lindner* • Maik Haebleren*

□ 1 January 2005

❖ Research Grants Council

Ion beam synthesis of nanostructured materials has been an area of growing research interest in recent years because of the versatility of this technique and its vast potential in fabricating novel artificial nano-structures with desired functional properties. This project aims to form metal nanoclusters in dielectric substrates by ion implantation and to study their structures and properties. One particular system of interest will be the WC/SiC system. We shall study the formation of a WC/SiC nanocomposite structure by sequential C and W implantation into Si. Our previous results showed that such a nanocomposite structure could only be formed under a certain process window. We shall perform a systematic study to find out the conditions under which such structures can be formed and to investigate the formation mechanisms. Another series of investigation will be on the formation and characterization of X-SiO₂ nanocomposites where X can be Cu, Ni, Co, Fe, Pt, Ti, Ag, or binary alloys of these elements. A substantial amount of effort will

be paid to study how the microstructures of these systems depend on the implantation parameters such as dose, energy and temperature, and thermal treatment conditions. Modification of these structures by higher energy ion irradiation will also be attempted to study how the structures change with such ion beam treatments.

(EE04978)

Dilute Magnetic Oxide Thin Films by Ion Implantation

✉ WONG Sai Peng Joseph • LI Quan (Physics)

□ 2 January 2005

❖ CUHK Research Committee Funding (Direct Grants)

In the emerging field of “spin transfer electronics” or simply “spintronics”, the spin of carriers is utilized for the processing, transmitting, and storing information. It is anticipated that spintronics devices can be faster, smaller, and less power consuming than current semiconductor devices. Potential applications of spintronics range from on-chip integration of magnetic storage with electronic processing functions to quantum computing. One key issue for the successful realization of spintronics applications is the development of semiconducting materials that are ferromagnetic at room temperature. This project aims to perform a systematic investigation on the formation of dilute magnetic oxide materials promising for spintronics applications by ion implantation techniques. Magnetic ions such as Co and Fe will be implanted into some semiconducting oxides, including TiO₂ and ZnO. The microstructures and the magnetic properties of these implanted samples will be investigated and correlated with the implantation and thermal processing

conditions. The formation mechanisms of these structures and the origin of ferromagnetism in these systems will be studied.

(EE04897)

Ion Nanostructuring of Functional Materials

✉ WONG Sai Peng Joseph • KWONG Shek Chuen Kevin* • S. T. Lee* • C.S.Lee* • W. J. Zhang* • R. Q. Zhang* • Y. Lifshitz* • N. Wang* • J. Wylie* • Q. Zhang*

□ 1 February 2005

❖ RGC Central Allocation

This group proposal aims at interdisciplinary effort to develop ion techniques for nanostructuring novel functional materials in controlled ways. The proposal is based on the previous experimental and theoretical work of the research group that already demonstrated the options of using the parameters of ion energy and substrate temperature to tailor carbon amorphous (short range), nanowires/nanotubes, and novel crystalline forms. The carbon (C) and boron nitride (BN) systems, chosen as model systems, in different phases and morphologies such as C or BN nanotubes, nano-onions, nanodiamond, nanodiamond cones, and diamond single crystal nanotips will be structured by controlled manners using energetic ions. Along their technological importance they also offer excellent models for comparative theoretical studies because C and BN complexes display striking similarities in local bonding configuration and phase structures. The proposal is expected to establish and advance the physics of ion modification of novel functional materials both experimentally and theoretically. The new data and experimental and theoretical methods will advance science, and the likelihood of utilizing some of the findings in

practical applications, particularly in hard coatings and electron field emission devices.

(PS04411)

A Systematic Approach to Deriving Physically Expressive Circuit Model of Embedded Passive RF Circuits Based on Electromagnetic Simulation

✉ WU Ke Li

□ 1 March 2005

❖ CUHK Research Committee Funding (Direct Grants)

The 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 Gigahertz 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 deliverables include a new approach to deriving physically expressive equivalent circuit model for embedded passives, a novel electromagnetic (EM) modeling scheme that will be in conjunction with network analysis, and a prototype of a broad balun in

Low Temperature Co-fired Ceramic (LTCC) substrate designed by the proposed approach.

(EE04548)

Engineering and Characterization of Low-Dimensional II-VI Nanostructures and Electrical Contacts

✉ XU Jianbin

□ 1 December 2004

❖ CUHK Research Committee Funding (Direct Grants)

One-dimensional (1D) nanostructures, such as nanowires, nanotubes, and nanoribbons, represent the smallest dimension for efficient transport of electrons and excitons. Therefore they are ideal building blocks for hierarchical assembly of functional nanoscale electronic and photonic structures and devices. We have successfully developed a generic approach for dispersion and manipulation of the nanostructures based on dielectrophoresis and tailor-made electrodes and arrays of electrodes.

In this project, we propose to engineer and characterize the aforementioned 1D nanostructures of II-VI semiconductors, and to conduct a study of electrical and optical properties of the materials either macroscopically or microscopically, by exploiting the conventional electrical measurements and scanning probe microscopy. This will ensure to have a better understanding of the fundamental issues underpinning the nanostructures and their contacts associated with metal electrodes. More specifically, we will focus on the following targets:

1. To scrutinize electronic transport in the CdS (or CdSe, ZnS) nanobelt-based devices with and without illumination by scanning probe potentiometry and conventional current-voltage characteristics.

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|--|---------|---|
| 2. To extract the field-effect mobility of the captioned devices. | 2003-04 | Methodology of Finding Optical Orthogonal Codes for Fiber Optic CDMA and Their Simulation Studies (EE03505)
✉ CHAN Kam Tai |
| 3. To study the contact barrier between CdS(or CdSe, ZnS) nanobelt and different metals (e.g., Al, Au) by applying scanning probe potentiometry and conducting AFM with or without light illumination. In this way, properties of the Schottky barrier and photovoltaic effect will be sifted. | 2003-04 | Broadband High Linearity Amplifier Design for Wireless Mobile Terminals (EE03460)
✉ CHENG Kwok Keung Michael |
| 4. To explore the possibility of fabricating sensors consisting of the newly fabricated nanostructures (EE04725) | 2001-02 | A Contactless Java Card Chip Using Asynchronous Circuit Techniques (EE01176)
✉ CHOY Chiu Sing Oliver • CHAN Cheong Fat |

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

<u>Edition</u>	<u>Title/Investigators</u>	
2001-02	Generation of 3D Wireframe Face Model from Movies and Face Animation (CS01167) ✉ CHAM Wai Kuen • TSUI Hung Tat	2002-03 A CMOS Direct Conversion Receiver for Third Generation Communication (EE02705) ✉ CHOY Chiu Sing Oliver • PUN Kong Pang
2002-03	Reconstruction of 3D Manifold Objects from 2D Images by Face Identification (EE02806) ✉ CHAM Wai Kuen	2003-04 Application Specific Instruction Set Processor with Asynchronous Methodology (EE03670) ✉ CHOY Chiu Sing Oliver
2003-04	Reconstruction of 3D Objects from 2D Images for Animation (EE03608) ✉ CHAM Wai Kuen	2003-04 Application of Surface Plasmon Enhanced Transmission to Phase-sensitive Optical Sensors (EE03521) ✉ HO Ho Pui • LIN Chinlon (Information Engineering)
2001-02	Study of Coherent and Incoherent Optical Pulse Coding Techniques for Fiber-Optic CDMA (EE01169) ✉ CHAN Kam Tai • LOU Caiyun*	2001-02 Use of Prosodic Information in Chinese Continuous Speech Recognition (EE01206) ✉ LEE Tan • XU Bo*

2003-04	Analysis and Modeling of Natural Prosody for Cantonese Text-to-Speech Synthesis (EE03821) ✉ LEE Tan	Converter for Multi-Mode Cellular Mobile Terminals (CU03202) ✉ PUN Kong Pang • CHAN Cheong Fat • CHOY Chiu Sing Oliver
2002-03	Interactive Healthcare Measuring, Monitoring, and Assisting Systems Using Wireless WAP Devices (EE02477) ✉ MENG Max Qing Hu	2002-03 Photonic Pre-processors for Ultrafast Analog-to-digital Converters (CU02369) ✉ SHU Ching Tat C. • LIU Hai Feng*
2003-04	Development of a Platform for Teleoperated Medical and Healthcare Services (CU03199) ✉ MENG Max Qing Hu	2003-04 All-Optical Wavelength Converters for Dense Wavelength-Division Multiplexing Communications (CU03196) ✉ SHU Ching Tat C. • TSANG Hon Ki
2003-04	Unsupervised Extraction of Visual Attention Objects in Color Images (EE03796) ✉ NGAN King Ngi	2001-02 Components for Next Generation All-Optical Wavelength-Division-Multiplexing Networks (EE01192) ✉ TSANG Hon Ki • SHU Ching Tat C.
2001-02	Adaptive Beamforming and Spectral Filtering for Speech Source Tracking and Recognition (EE01175) ✉ P.C. CHING • SO Hing Cheung* • WONG Kon Max	2003-04 Novel Techniques for Transient Protection in Optical Networks (CU03198) ✉ TSANG Hon Ki • SHU Ching Tat C.
2003-04	Localization Schemes for Telecommunication Applications (CU03201) ✉ P.C. CHING • Y.T. Chan#	2002-03 Modeling of Building Environments for Augmented Reality (CU02378) ✉ TSUI Hung Tat
2003-04	A New Vector Orthogonal Frequency Division Multiplexing for Broadband Communication Systems (CU03197) ✉ P.C. CHING • XIA Xianggen*	2003-04 The Position of Chinese among the Languages of Asia (AL02306) ✉ WANG William S Y • MURRAY Gell-Mann*
2003-04	Development of a Flexible IF-Sampling Sigma Delta Analogue-to-Digital	

- | | | | |
|---------|--|---------|--|
| 2001-02 | Enhancement of Electron Field Emission Properties by Surface Engineering and Ion Beam Processing (EE01200) | | ✍ XU Jianbin • KWOK H L Harry* • LAU Leo Woon Ming (Physics) |
| | ✍ WONG Sai Peng Joseph | 2001-02 | Development of Medical Devices and Nano-Biosensors to Promote Biomedical Electronic industry in Hong Kong (BL01873) |
| 2002-03 | Low Level Birefringence Detection for Study of Stresses in Ultrathin Film/Substrate Systems (CU02370) | | ✍ ZHANG Yuanting • CHAN Kam Tai • P.C. CHING • WONG Sai Peng Joseph • LEE Tan • HENG Pheng Ann (Computer Science and Engineering) • LEONG Philip Heng Wai (Computer Science and Engineering) • CHENG Chun Yiu Jack (Orthopaedics & Traumatology) • SUNG Joseph Jao Yiu (Medicine & Therapeutics) • WOO Jean (Medicine & Therapeutics) • NG Ho Keung (Anatomical & Cellular Pathology) • LI Wen Jung (Auto. & Computer-Aided Engin.) • TSUI Kwok Wing (Biochemistry) • WAYE Mary Miu Yee (Biochemistry) • FUNG Kwok Pui (Biochemistry) • CHUNG Sheung Chee Sydney (Surgery) • LEE Cheuk Yu (Biochemistry) • CHOU Chien* • DOV Jaron* • LU Z H* • ONARAL B* • POURREZAEI Kambiz* • TAMURA T* • XU Y H* |
| | ✍ WONG Sai Peng Joseph | | |
| 2003-04 | Ion Beam Synthesis of Si-Based Nanostructures for Optoelectronics Applications (CU03231) | | |
| | ✍ WONG Sai Peng Joseph | | |
| 2002-03 | A Highly Efficient Modal Analysis Methodology for Integrated RF Passive Circuits with Finite Metallization Thickness (CU02371) | | |
| | ✍ WU Ke Li | | |
| 2003-04 | Research and Development of LTCC Integrated Modules for Wireless Communication Products (EE03389) | | |
| | ✍ WU Ke Li • WANG Jie | | |
| 2003-04 | A Derived Equivalent Circuit Model for Embedded Passive RF Circuits (EE03876) | | |
| | ✍ WU Ke Li | | |
| 2001-02 | Engineering and Characterization of Low-Dimensional Group IV Materials by Scanning Probe Microscopy (EE01203) | 2003-04 | An Innovative Wireless Multifunction Stethoscope with Its Applications in Telemedicine and Home Healthcare (EE03814) |
| | ✍ XU Jianbin • HE James Zhongqing# | | ✍ ZHANG Yuanting • CHENG Chun Yiu Jack (Orthopaedics & Traumatology) • NG Ho Keung |
| 2002-03 | Engineering and Characterization of Organic Electronic Films and Devices by Scanning Probe Microscopy (CU02372) | | |

(Anatomical & Cellular Pathology) •
LEUNG Kwok Yiu (Centre for
Innovation and Technology) • TSO
S K* • YU K Y*

RESEARCH PROJECTS

All-Optical Signal Processing Techniques for High-Speed Optical Differential Phase-Shift-Keying (DPSK) Signals

✉ CHAN Chun Kit • CHEN Lian Kuan • LIN Chinlon

□ 1 January 2005

❖ Research Grants Council (Earmarked Grants)

To provide low-latency and efficient network processing at the network nodes, bit level serial processing has to be performed in all-optical domain, thus effective all-optical signal processing techniques are the enabling technologies to gear towards future ultrahigh-speed all-optical networks. This project aims at investigating various all-optical signal processing techniques for an emerging and attractive optical signal modulation format, optical differential phase-shift-keying (DPSK). It is a constant intensity modulation which can alleviate the nonlinear crosstalk as well as the patterning effect in optical signal transmission. It has found applications in long-haul optical transmission, ultrafast optical switching and all-optical logic gating. The results of this project are essentially the enabling technologies for such attractive modulation format as a feasible and practical solution for future all-optical networks.

(CU04240)

Optimization of Supercontinuum-Based Photonic Devices for Multi-Wavelength Networks

✉ CHEN Lian Kuan • CHAN Chun Kit • LIN Chinlon

□ 1 October 2004

❖ Research Grants Council (Earmarked Grants)

This project is to investigate the noise performance optimization in super-continuum (SC) based devices, such as multi-wavelength pulse sources for wavelength-division multiplexing (WDM) optical networks and all-optical data regenerators. While prior studies focused primarily on the spectrum width broadening of SC, this study concentrates on both the sliced channel quality and the number of channel. Various factors, such as the initial pulse parameters, the characteristics of the nonlinear fibers, and the subsequent filtering band selection, will influence the final sliced pulse's quality through different physical mechanisms in the nonlinear fibers. In this proposal, we will investigate these physical mechanisms that interplay in the nonlinear fiber and determine the fundamental cause of the noise performance variation with respect to different initial parameter values. Through this study, optimal designs of two SC-based optical components, namely a high quality multi-wavelength pulse source and an optical data regenerator, will be achieved.

(CU04181)

TCP and Application Friendly Congestion Control: A New Direction for a Controversial Yet Challenging Problem

✉ CHIU Dah Ming

□ 23 August 2004

❖ Research Grants Council (Earmarked Grants)

There are two types of transport protocol for the Internet: TCP and UDP. When there is congestion in the Internet, TCP flows back-off and adjust their rates so that they share the bottleneck resources fairly. UDP does not have congestion control. Among

other things, UDP is used to support multimedia applications. It has been previously recommended that UDP should include a “TCP-friendly” congestion control that adapts UDP rates smoothly to become the same as TCP rates. We argue that the current TCP-friendly requirement is not friendly to UDP applications. The goal of this research project is redefine the notion of “TCP-friendliness” and propose application-specific controls to allow better sharing of congested resources by heterogeneous network applications. Our framework is based on network utility optimization. We show theoretically as well as empirically that new control mechanisms including distributed admission control and application-aware rate adaptation can significantly improve performance for both TCP and UDP applications.

(CU04232)

Peer-to-Peer Architectures for Virtual Conferencing

✉ Jack Y. B. Lee

□ 1 November 2004

❖ CUHK Research Committee Funding (Direct Grants)

Video conferencing systems have been available for many years. However, despite the significant decrease in cost and increase in availability, video conferencing is still far from commonplace. After years of research, current video conferencing systems are well developed and international standards such as H.323 has defined the system and protocol interfaces for interoperable video conferencing systems. However, to conduct a multiparty video conference, current systems require a media control unit (MCU) for coordinating the conference and for data exchange. This centralized model, although

simplifies the front-end software, does present an obstacle for conducting video conference between users around the global Internet. This research programme proposes to investigate the transmission scheduling issues in applying peer-to-peer (P2P) architectures to implementing virtual conferences that support multi-channel audio, video, and interactive virtual meeting rooms - thus the term virtual conference instead of video conference.

(EE04940)

Mathematical Theory of Distributors and Their Recursive Construction

✉ LI Shuo-yen Robert

□ 16 August 2004

❖ Research Grants Council (Earmarked Grants)

A long-term endeavor of the PI since early 80’s has been to develop a mathematical foundation for switching fabrics and parallel processing networks. Research findings up to the year 2000 were published in the engineering book *Algebraic Switching Theory and Broadband Applications*. There has been continuation work aimed at switching topics with substantial mathematical flavor. Part of it is the present project to develop an algebraic theory for distributors and their recursive construction. Distributors are generically useful devices commonly deployed in switching networks and sometimes built into other switching components.

The theoretic work will partially build on concepts introduced in the aforementioned book, including *X2 interconnection*, *circular sorters*, and “*preservation*” of various switches under X2 interconnection, such as the *Circular-unimodal Nonblocking Theorem* and the *Circular Sorter Theorem*. While theoretic findings of the project plus sample applications are intended for academic publications, they will be timely for

industrial applications to multistage construction of high-speed distributors with totally distributed control. Algebraic principles afford deep understanding of hardware logic, which allow us to organize, design, test, debug, prove correctness, and derive flexible algorithms. Flexible constructions help coping with ad hoc engineering constraints in industrial applications.

(CU04231)

Frontiers of Photonics Research: Nanophotonics, Femtosecond Photonics and Biophotonics

✉ LIN Chinlon

□ 1 July 2004

❖ The Croucher Advanced Study Institute

This Croucher Foundation-sponsored ASI (Advanced Study Institute) will have invited overviews, short-courses, tutorials, presentations and group discussions on the frontiers of advanced research in photonics, with distinguished international speakers and regional participants, to stimulate the interest and leading to a better understanding on the frontiers of photonics research, including nanostructure photonics, photonic crystal fibers, ultra-fast femtosecond photonics and the new interdisciplinary area of biophotonics.

The goal is that collectively photonics researchers in Hong Kong and in nearby Asia Pacific regions can benefit from such a brainstorming meeting and gain a better insight on the international trends on these emerging advanced photonics research efforts and their potential long-term significance and impact on basic science and applied technology.. The international invited lecturers are:

Professor Erich Ippen, Elihu Thomson Professor of EE and Physics, MIT, Cambridge, Mass. USA

Professor Dennis Matthew, Director, NSF (National Science Foundation) Center for Biophotonics, UC Davis, USA

Professor Anders Bjarklev, Head, PCF Group, COM Center, Tech. Univ. of Denmark

Professor Roel Baets, Group Leader, Optoelectronic Comp. & Systems Research, University of Gent, Belgium

Professor Paras N. Prasad, Director, Institute for Lasers, Photonics, and Biophotonics, SUNY at Buffalo, USA

Professor Philip Russell, Chair Professor, Physics, Director, Optoelectronics Research Center, Univ. of Bath, UK.

(EE04331)

Optimal Assignment of Resources for Multiuser Communication Systems

✉ LOK Tat Ming • LEUNG Kin Kwong#

□ 1 January 2005

❖ Research Grants Council (Earmarked Grants)

Advanced wireless communication systems use different forms of diversity, e.g. frequency or spatial diversity, to combat the defects of the radio channels and to improve the overall performance of the systems. Very often, diversity gain is obtained at the expenses of extra resources, e.g. extra spectrum or extra antennas. However, there is intrinsic diversity in multiple-user wireless communication systems. Different users experience different channel characteristics. An exchange of resources between different users may, therefore, yield improved performance for all parties. Through careful assignment, we can match the right resources to the right users at the right time. The primary goal of this project is to exploit this diversity. We would try to put the available resources to the best use to

optimize the overall system performance. We would formulate a number of different optimization problems which depend on the types of communication systems being considered. We would try to seek optimal solutions to deepen our understanding of communication theory. We would also determine practical solutions that can be readily implemented by the industry.

(CU04170)

IDFace: Identification and Detection of Face in Image, Video and Sketch

✍ TANG Xiaoou • LIU Jianzhuang • MA Songde*
• JAIN Anil K*

□ 1 August 2004

❖ Funding from Industrial Sponsors • Innovation and Technology Commission

As an emerging technology, automatic face recognition has great potential in a large array of application areas, including banking and security system access authentication, video surveillance, mugshot matching for law enforcement, duplicate ID card identification, face-based video compression for video conferencing, finding long-lost relatives, multimedia information retrieval, and Casino room access control, just to name a few. Given the vast potential for face recognition technology and the only very recent beginning of market acceptance of the technology, we believe it is a great opportunity for Hong Kong to take the lead in this area. In fact, we have already built a technology lead in terms of theoretical algorithm development. Hong Kong IT industry now has a unique opportunity to turn this lead into product lead and market lead.

In this project, we will develop a core set of essential tools for face recognition system development. These include three comprehensive software suites

for Photo-based, Video-based, and Sketch-based automatic face recognition systems. In addition, several prototype application systems utilizing the developed software packages will be implemented to demonstrate the superiority of the technology. Through education, training, and technology transfer, multiple local IT industry sectors in the area of law enforcement, information security, multimedia processing and content delivery, video surveillance, and video conferencing will be able to enjoy the benefit of this project.

(EE04648)

V-China - Enhancing Teaching and Learning with Video Conferencing Activities

✍ WONG Po Choi

□ 1 July 2004

❖ Quality Education Fund, HKSAR Government

This project aims at establishing a video conferencing network between schools in Hong Kong and Mainland China. In doing so, it will develop innovative eLearning technologies and applications to facilitate teaching and learning, sharing of culture, and project learning. Each school is offered with a video phone and a network account, so that it can call up its sister school at any time for video conferencing activity. It is envisaged that the network will benefit Putonghua and English language learning, and encourage more exchange and understanding in both places. Many engineering problems in the implementation process will be studied.

(EE04945)

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

<u>Edition</u>	<u>Title/Investigators</u>		<u>Edition</u>	<u>Title/Investigators</u>
				✍ Jack Y. B. Lee • LUI Chi Shing John (Computer Science and Engineering)
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	Design, Analysis, and Implementation of a Super-Scalar Architecture for Large-Scale Video-on-Demand Services (CU02328) ✍ Jack Y. B. Lee
2003-04	A Reliable and Scalable Network Architecture for Multiwavelength Passive Optical Access Networks (CU03216) ✍ CHAN Chun Kit • CHEN Lian Kuan		2003-04	Design, Analysis, and Implementation of a Server-Less Architecture for Building Scalable, Reliable, and Cost-Effective Video Streaming Systems (CU03211) ✍ Jack Y. B. Lee
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		2001-02	Design of Large-Scale Fibre Channel Fabric for Storage Area Network (CS01208) ✍ LEE Tong Tony • CHAN Man Chi#
2003-04	Optical Sampling and Multiplexing for Distortion Reduction in an SCM Optical Network (CU03223) ✍ CHEN Lian Kuan • CHAN Chun Kit • TONG Fuk Kay Franklin		2002-03	Design of Medium Access Control Providing IP QoS for CDMA-Based Mobile Communication System (CU02380) ✍ LEE Tong Tony
2003-04	Evaluation and Enhancements of Path Monitoring and Selection Techniques in Inter-Domain Routing (EE03695) ✍ CHIU Dah Ming		2000-01	Telecommunication Network Research (EE95746) ✍ LI Shuo-yen Robert
2001-02	Improving Disk Efficiency in Continuous-Media Servers with Soft-scheduling (CS01209)		2003-04	Study of Photonic Crystal Fibers (PCF) for Nonlinear Optics and Photonic Sensor Applications (EE03538) ✍ LIN Chinlon • HO Ho Pui (Electronic Engineering) • CHEN Lian Kuan

2003-04	Broadband Optical Access Networks - Photonic Technologies and Architectural Studies (EE03509) ✍ LIN Chinlon • CHAN Chun Kit • CHEN Lian Kuan • CHU Pak Lim* • POON Wing On Andrew*	2002-03	On the Constant Weight Codes: Bounds, Constructions and Applications (CU02329) ✍ WEI Keh Wei Victor
2002-03	Novel Power Control Schemes for Multicode DS/CDMA Systems (EE02757) ✍ LOK Tat Ming • WONG Tan F*	2003-04	On Mobile and Wireless Security: Mobile Agents, Mobile Signatures, and Authenticated Key Exchange (CU03232) ✍ WEI Keh Wei Victor • WONG S Duncan*
2003-04	Code Diversity and Scheduling for Multicarrier CDMA Systems (CU03217) ✍ LOK Tat Ming • WONG Tan F*	2002-03	Code Allocation in Multi-Rate Spread Spectrum Wireless Systems (CU02366) ✍ WONG Wing Shing • SUNG Chi Wan*
2001-02	Face Image and Sketch Recognition (CS01190) ✍ TANG Xiaou • GRIMSON W Eric L* • LAM Kai Pui (Systems Engineering & Engin. Management)	2003-04	Fairness and Pricing Issues in Peer-to-Peer Networks (EE03901) ✍ WONG Wing Shing
2002-03	Video Based Character Recognition (CU02357) ✍ TANG Xiaou • PISSALOUX Edwige* • ZHANG Hong Jiang*	2000-01	Fundamental Limits in Information Storage Systems (CU00165) ✍ YEUNG Wai Ho Raymond
2003-04	Face Image and Image Sequence Recognition in a Subspace Framework (CS03446) ✍ TANG Xiaou • MA Songde* • TANG Ming*	2003-04	Network Error Correction (CU03214) ✍ YEUNG Wai Ho Raymond
2001-02	Investigation of Low-Cost Modulator for a Proposed DWDM Access Network (CS01191) ✍ TONG Fuk Kay Franklin • CHAN Chun Kit • CHEN Lian Kuan	2003-04	Extreme Mobile Device for Emergency Communications (EE03349) ✍ YUE On Ching
		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

✍ YUM Peter Tak Shing

2003-04 Fair Routing and Bandwidth Allocation
for Packet Rings (CU03220)

RESEARCH PROJECTS

Coordinated Decisions of Manufacturer/Distributor in a Fresh Product Supply Chain Involving Long Distance Transportation

✉ CAI Xiaoqiang • YU Gang*

□ 1 January 2005

❖ Research Grants Council (Earmarked Grants)

We study a supply chain where a manufacturer produces a variety of fresh products to supply a distributor in a distant export market. The manufacturer can decide the price charged to the distributor, while the distributor can decide the order quantity and the sales price in the market, based on the purchase price and the market demand. The manufacturer faces the risk that a fresh product may decay during the process of long distance transportation. The distributor faces the risk that the demand for a product is uncertain and any unsold fresh product may lose its value after the sales period. While the profit potential in supplying the products to the export market is substantial, a great challenge for both parties is how to minimize the losses involved. Our primary objective is to develop an in-depth study of the problems above. Focus will be placed on the investigation to conceptualize and model the optimal decisions in production, transportation, and pricing, and the uncoordinated/coordinated decisions between the two parties.

(CU04188)

Studies of Combined Segmental-Dynamic Pricing and Production/Replenishment Decisions

✉ CHEN Youhua • FENG Youyi

□ 1 January 2005

❖ Research Grants Council (Earmarked Grants)

Using different prices among customer segments and over time has long been recognized as a powerful tool to manage demand and supply. Such a practice is generally referred to as revenue management. In this project we plan to extend the idea of differentiating prices according to customer segment and time-period in revenue management to the production environment. The objective of the proposed research is to develop models and techniques to support concurrent decisions in pricing and production/replenishment. The new perspective in this proposal is that these models not only capture the interdependence among price, demand, and production/replenishment decisions, but also take into account the influence of customer segment-based pricing. The outcome of the research will be a set of pricing models and solution techniques that could aid various supply chain decisions.

(CU04192)

Dynamic Pricing and Production Control for a Manufacturing System

✉ FENG Youyi • OU Jihong*

□ 31 August 2004

❖ Research Grants Council (Earmarked Grants)

Many Hong Kong small and medium enterprises (SME) are adopting the practice of “making in southern China and selling in Hong Kong”. As both the production in southern China and the demand in Hong Kong face uncertainties, coordinating production and marketing in the management of the supply chains for these SMEs is a pressing issue. In this project we explore modelling and optimization

for the dynamic coordination of product pricing and production control. In particular, we study a stochastic manufacturing system in which the production rate is adjustable subject to the production capacity constraint, and the product is sold at different price levels or in different bundled packages with other products or service offerings. To maximize the long-run profit for the system, the production and sales processes must be coordinated dynamically. We build several models to analyze such problems quantitatively at the operational level and to derive qualitative insights at the management level. We intend to provide local manufacturers who “sell in Hong Kong and make in southern China” with scientific management principles and tools, and help them succeed in their supply chain management.

We focus on the easy-to-implement threshold policies: for the production control, a base stock policy is considered (i.e., the production is set at the maximum rate when the inventory holding is under certain base stock level, otherwise it is turned off); for the product pricing, the price is changed when the inventory holding crosses over certain levels. We analytically prove that in all of the models under consideration a threshold policy is optimal and provide an algorithm to effectively compute the optimal thresholds.

In situations where the demand is of low-volume, high variety, and high variability, typical for many fashionable products, there are several peculiar concerns for the management. The main among them is quick response to demand, which is a key to business success. With a service requirement as an additional target, and by assuming that the production cost is a function of the production capacity, we will be able to reap the profit-effective policies that comply with the service constraint. In addition, customer compensation is perceived as an effective incentive to raise demand for heavily loaded systems.

We will devise the appropriate customer compensation schemes for given system loading factors.

(CU04171)

Adapting Information Extraction Knowledge to New Unseen Sites of Semi-Structured Text Documents

✉ LAM Wai

□ 1 January 2005

❖ Research Grants Council (Earmarked Grants)

A tremendous amount of information sources are semi-structured text documents with a variety of formats containing a mix of short ungrammatical (or weakly grammatical) text fragments, mark-up tags, and free texts. Many intelligent applications such as shopping agents and automated travel assistants rely on automatically extracting data from semi-structured documents. These applications typically make use of *wrappers* that can extract highly precise information automatically from semi-structured documents. Recently, *wrapper induction* has become an active research area which aims at automatically constructing extraction knowledge from training examples. Training examples are simply sample text fragments corresponding to information items.

(CU04193)

Manpower Planning and Scheduling with Workforce Flexibility

✉ LEUNG May Yee Janny

□ 1 January 2005

❖ Research Grants Council (Earmarked Grants)

In the global competition of supply-chains vs. supply-chains, swiftness in each value-added process is essential. Many time-critical steps involve rapid “servicing” of transportation equipment at consolidation hubs. This project focuses on crew-scheduling for such servicing to ensure rapid turnaround-times in the supply-chain. This job-assignment/scheduling problem is highly complex because of:

- Extremely tight time-windows for servicing, and
- Variety of equipment types, making matching appropriately-skilled crews to jobs difficult.

The possibility of new operational modes — such as sharing of jobs by multiple crews to reduce service times - adds further complications.

We hope to extend our understanding of workforce flexibility in rostering/scheduling models. At the operational level, we will develop effective job-assignment and scheduling methods that allows job-sharing. At the strategic level, we explore how cross-training and broader skill-sets of the crews impacts optimal schedule costs.

In actual operations, unanticipated delays occur, so disruption recovery and redeployment of crews are necessary. This project will also investigate methods for stochastic planning and disruption recovery.

Results from this project may be relevant to many logistics businesses in Hong Kong and elsewhere, whose operations are time-critical and operational and long-term flexibility of the workforce/resource is available. We hope our findings will contribute to understanding of the value of resource flexibility.

(CU04465)

Mean-Variance Control of Discrete-Time Linear-Quadratic Gaussian Problems

✉ LI Duan

□ 1 December 2004

❖ Research Grants Council (Earmarked Grants)

Without a doubt, linear-quadratic control represents one of the most prominent successes in control theory, largely due to its wide applications and its mathematical elegance in tractability. There is a need, however, to revisit this classical problem from the view of risk management. Optimal control derived from a sole objective of minimizing the expected value of a performance index does not guarantee in every individual realization a satisfactory outcome for the randomly valued performance index. How to guarantee a satisfactory outcome in each individual realization? A mean-variance optimal control thus, in many situations, becomes necessary for discrete-time linear-quadratic Gaussian problems with a purpose to better control the dispersion of the randomly valued performance index. It is well known that an optimal policy of stochastic control be only achieved by a feedback policy. The primary goal of this project is to further study fundamental properties of the mean-variance control such that more results of this emerging research challenge can be achieved. More specifically, this research project will consider the derivation of a feedback policy for the mean-variance control of discrete-time linear-quadratic Gaussian problems, thus achieving the optimality of such problems.

(CU04245)

Exact Algorithms for Optimal Integer Solutions to Constrained Portfolio Selection

✉ LI Duan

□ 1 April 2005

- ❖ CUHK Research Committee Funding (Direct Grants)

Although the real trade practice possesses many discrete features, such as cardinality, round-lots, buy-in threshold, transaction cost and dependency purchasing constraints among risky assets, the current literature of portfolio selection has been primarily developed for the continuous solution of the portfolio policy which could be far away from the real integer optimum. Most of the few suggested solution methodologies in the literature that tackle discrete features in portfolio selection are heuristic in nature. There is an urgent call to extend the state-of-the-art of the portfolio selection theory in order to develop exact algorithms for optimal integer solutions to constrained portfolio selection.

Recent progress in convergent Lagrangian theory of nonlinear integer programming achieved by the PI and his colleagues has provided a promising platform for addressing the long-standing challenging issue of discrete features in integer programming models for portfolio selection. The overall objective of this project is to develop and testify exact algorithms for optimal integer solutions to constrained portfolio selection. The overall objective of the project will be accomplished via completing the following three research tasks:

- (i) To establish a nonlinear integer programming model that reflects discrete features in the portfolio selection practice;
- (ii) To establish a solid theoretical foundation for deriving efficient exact solution schemes for optimal integer solutions to constrained portfolio selection and to develop corresponding efficient algorithms.
- (iii) To carry out numerical experiments to testify the derived exact solution algorithms.

(EE04535)

Bimodal Modeling for Expressive Text-to-Visual-Speech Synthesis in Putonghua and Cantonese

✉ MENG Mei Ling Helen • Cai Lianhong* • Tao Lin Mi*

☐ 31 March 2005

- ❖ NSFC/RGC Joint Research Scheme

This project aims to develop a personified, *expressive text-to-visual speech synthesizer* (E-TTVS) to serve as an integral *multimodal output channel* in an interactive spoken dialog system. The virtual talking agent will be able to speak two major dialects of Chinese - Putonghua and Cantonese. Multimodality forms the core of human-centric user interfaces. Hence multimodal human-computer interaction should model after human-human communication in order to achieve efficacy and naturalness. In other words, a multimodal spoken dialog system should be able to support an interchange of user request and system response *messages* in such a way that the human and the computer are two equally active interlocutors who seek to collaboratively attain an informational goal. *Messages* carry not only *verbal, propositional information about facts*, but also *non-verbal, interactional content about the dialog/discourse*. All of these elements need to be conveyed in between interlocutors in audio-visual forms. For example, a question tends to have rising intonation accompanied by an inquisitive facial expression; important points in a statement carry emphasis in their articulation: different information genres may call for different speaking styles and an (implicit) confirmation may be expressed by a simple head nod or a non-verbal utterance like “uh-huh”. While state-of-the-art virtual talking agents can appear video-realistic and speak with high intelligibility, they predominantly

adopt neutral intonations and facial expressions. Hence their expressive capacities fall short of that needed for natural and efficient multimodal human-computer interaction. We attempt to address this problem by developing technologies to support E-TTVS. Our research agenda includes: (i) identification of the verbal and non-verbal, propositional and interactional information within the context of a domain-specific multimodal spoken dialog system; (ii) capturing the human style of presenting such prepositional/interactional content by design, collection and annotation of an expressive audio-visual corpus; (iii) extracting and tracking the acoustic and facial parameters related to the expressive audio-visual prosodic cues; (iv) modeling speech parameters for expressive speech synthesis; face parameters for expressive face animation and bi-modal audio-visual parameters for E-TTVS; (v) incorporation of the integrated E-TTVS technologies in an end-to-end spoken dialog system and evaluate the impact of expressiveness on usability. Our team's expertise achieves full coverage of the entire spectrum of technological areas in the proposed research agenda. By timely collaboration across institutions, we have a uniquely competitive position to make significant contribution in E-TTVS across dialects in Chinese.

(CS04731)

Syntactic and Semantic Parsing for Reading Comprehension of Bilingual Corpora

✉ MENG Mei Ling Helen

□ 1 June 2005

❖ CUHK Research Committee Funding (Direct Grants)

This project aims to push the technological frontiers in natural language processing (NLP), namely

syntactic and semantic parsing, to achieve reading comprehension (RC) of an English or Chinese passage. An RC system is an automatic, open-domain question answering system. It can analyze a passage or document automatically, and generate specific answers to questions that are posed by a user relating to the document. RC presents a novel mode of automatic information retrieval and complements existing search engines on the World Wide Web. RC is a relatively new problem and to the best of our knowledge, this is among the first projects that address the problem of multilingual RC. We plan to develop bilingual corpora with open-domain English and Chinese passages and questions to provide the context for our investigation as well as for empirical evaluation. We will also develop syntactic and semantic parsers for analyzing both questions and passages. The analysis includes a *dependency parsing strategy* for syntax augmented with *robust semantic inference* techniques. We will attempt to capture analysis outcome in representations like the predicate-argument structure. Answer generation will be grounded on a robust match between the predicate-argument structures derived from the user's query and the document's sentences. This processing sequence aims to achieve reading comprehension for both English and Chinese. Performance will be evaluated based on a disjoint test set and compared with baseline approaches such as the vector-space model or bag-of-words technique

(EE04637)

校園 e-報館

Campus e-Newsletter

✉ 黃錦輝 WONG Kam Fai William

□ 1 November 2004

❖ Quality Education Fund, HKSAR Government

學習源於生活，親力親為去辦一份校園報刊或刊物，過程必然讓學生有所體會。只要老師從旁引導，加以啓發，教與學的效果，必定相得益彰。在校園內辦一份刊物，包括資料搜集、訪問、撰文、影音處理、排稿、編審、網上發布、印刷等繁複程式，看來似乎複雜，非一般學校師生所能負荷。可幸隨著資訊科技的發展，在網上採編、印刷、發佈一份刊物，可以輕而易舉。加上種種多媒體效果，資料庫，檢索等功能，學生必可在一個趣味盎然的環境中學習。中文大學創新科技中心（CINTEC）有意把相關技術引入校園。從而達致以下目標：1）鼓勵學生從體驗寫作中學習，認識報刊製作及出版過程；2）推行電子流程，減少紙張，增加環保意識，亦大大減低製作各類刊物的開支；3）加強學生文字表達、組織合作、運用多媒體資訊科技等能力；4）鼓勵師生一同參與，提高教與學成效；5）鼓勵學校間聯合制作校園刊物，著重群策群力的重要性；6）推廣校園文化；7）培養學生以活動型式增加學習興趣；8）傳遞學生正確運用傳媒的意識，使成為具備傳媒素養的公民；9）啓發學生創作能力 / 創新意念，配合香港政府發展“創意工業”。(ED04840)

Foreign Name Forward and Backward Transliteration for Cross Language Information Retrieval

- ✉ WONG Kam Fai William • Robert Luk* • Chuanfa Yuan*
- ☐ 1 November 2004
- ❖ CUHK Research Committee Funding (Direct Grants)

Cross Language Information Retrieval (CLIR) involves the use of a query expressed in one language to retrieve information represented in another language. It is an important area as foreign information can now be easily accessed through the Internet. One problem seriously affecting retrieval

performance in CLIR is processing of queries with embedded foreign names. In addition to large number of different popular foreign names, one frequently comes across unfamiliar ones, e.g. new names. Thus, a proper noun dictionary is never complete rendering machine translation ineffective. One way to solve this problem is not to rely on a dictionary alone but to adopt heuristic rule-based translation. Unlike translation of general words, name translation from English to Chinese is based on pronunciation similarities. The idea is to map phonemes comprising an English name to sound units (e.g. pin-yin) of the corresponding Chinese name. This process is called transliteration, which is dialect dependant. However, existing transliteration rule-bases are subjective and non-scalable as their rules are produced manually. Furthermore, they cannot cater for backward transliteration, which is often ambiguous due to distortions introduced by forward transliteration. To overcome these predicaments, we propose a statistical phoneme-based transliteration method and demonstrate its effectiveness in CLIR using a standard corpus.

(EE04615)

Multi-Period Risk-Averse Inventory Models

- ✉ YAN Houmin
- ☐ 1 September 2004
- ❖ Research Grants Council (Earmarked Grants)

In supply chain and inventory management literature, the majority work is aimed at optimize an expected objective function, meanwhile the issue of risk management is not adequately addressed. In this project, we propose to develop a risk management model for the problem of multi-period inventory management. In our model, the objective is to

optimize; the profit (to minimize the cost); the risk is measured by the probability of a below target profit (the probability of an above target cost). The goal is to characterize the optimal policy and its structural properties, and to develop insights into better supply chain and inventory management.

We expect that this research will generate new analytical models and interesting insights into supply-chain management. We also expect that our research will lead to effective methods which provide strategic and operational benefits to the manufacturing companies. This is particularly important for manufacturers in the Pearl River Delta Region, where a large number of OEM/ODM companies are located, for whom miscalculation in demand forecasting can be catastrophic, and failure in managing its supply inventory can be devastating. A scientific risk management approach for supply and inventory management provides companies a critical competitive edge.

(CU04167)

Continuous Linear Programming - Computational and Control Perspectives

✉ ZHANG Shuzhong • YAO David Da Wei • ZHOU Xunyu

□ 1 January 2005

❖ Research Grants Council (Earmarked Grants)

The subject of this research project is the so-called *separated continuous linear programming* (SCLP), in which linear optimization decisions are made over a given planning horizon. The SCLP lies at the interface of optimization and control, and in recent years has become an effective model to capture the interplay between stochastic networks and their deterministic counterpart known as fluid networks. Because of its many appealing features, SCLP has

been applied to areas as diverse as modeling input-output economics and scheduling semiconductor fabrications. The focus of this project is two-fold: (a) to develop an efficient and scalable algorithm to solve the SCLP with guaranteed accuracy, exploiting the problem structure known as symmetric duality; and (b) to extend the SCLP to the stochastic setting, pursuing the connection between the maximum principle and the symmetric duality. It is also our plan to apply the solution algorithm to dynamic scheduling problems that arise in large networks of supply chains and logistics systems.

(CU04242)

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

<u>Edition</u>	<u>Title/Investigators</u>
2001-02	Scheduling with Negotiable Third-Party Machines (MP01166) ✉ CAI Xiaoqiang • LEE Chung Yee*
2003-04	Scheduling of Perishable Jobs under Uncertain Deadlines (CU03170) ✉ CAI Xiaoqiang
2003-04	On Inventory Control, Dynamic Pricing, and Goods/Service Bundling (EE03526) ✉ CHEN Youhua
2002-03	Grouping Models in Ready-to-Assembly Products (EE02945) ✉ CHENG Chun Hung
2002-03	Optimal Booking Control on Multi-Leg Flights (CU02320)

	✍ FENG Youyi		✍ LI Duan
2003-04	Operational and Strategic Models for Hotel Revenue Management (CU03235) ✍ FENG Youyi	2001-02	"The Author Once, Present Anywhere (AOPA)" Software Platform (EE01512) ✍ MENG Mei Ling Helen • P.C. CHING (Electronic Engineering)
2001-02	Hierarchical Information Extraction Learning Framework and Its Applications to Event Tracking and Filtering (CS01187) ✍ LAM Wai	2002-03	The Use of Belief Networks for Mixed-Initiative Dialog Modeling (CU02326) ✍ MENG Mei Ling Helen
2003-04	Dynamic News Topic Taxonomy Discovery from Texts Using Bayesian Model-Based Unsupervised Learning (CU03179) ✍ LAM Wai	2002-03	Towards Multi-Modal Human-Computer Dialog Interactions with Minimally Intrusive Biometric Security Functions (EE02512) ✍ MENG Mei Ling Helen • P.C. CHING (Electronic Engineering) • LEE Tan (Electronic Engineering) • MOON Yiu Sang (Computer Science and Engineering) • TANG Xiaoou (Information Engineering) • MAK Man Wai* • MAK Brian* • SIU Man Hung*
2001-02	Logistics Support for Mobile Commerce (MP01213) ✍ LEUNG May Yee Janny • CHENG Chun Hung		
2003-04	A Traffic Inference Engine for Travel-Time Estimation (CU03171) ✍ LEUNG May Yee Janny • CHENG Chun Hung	2003-04	Natural Language Generation of Cooperative Responses in Mixed-Initiative Dialog Systems Using a Corpus-Based Approach (CU03237) ✍ MENG Mei Ling Helen
2001-02	Efficient Solution Schemes for Solving Multidimensional Nonlinear Knapsack Problems (MP01214) ✍ LI Duan	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	A Theoretical Framework of Nonlinear Lagrangian Theory (EE02531) ✍ LI Duan		
2003-04	Dual Control in Linear-Quadratic Gaussian Problems (CU03180)		

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| <p>2002-03 XML Database: Technology and Applications (EE02536)
 ✎ WONG Kam Fai William • LAM Wai • YANG Christopher Chuen Chi • YU Jeffrey Xu</p> | <p>2002-03 Large Bio-Sequence Analyzing and Mining from a Database Perspective (EE02868)
 ✎ YU Jeffrey Xu</p> |
| <p>2003-04 A Support Program to Increase the Competitiveness of Hong Kong Software SMEs in Mainland China (EE03567)
 ✎ WONG Kam Fai William • CHAN Kei Fu*</p> | <p>2001-02 Primal-Dual Interior Point Approach to Multi-Stage Stochastic Programming (MP01233)
 ✎ ZHANG Shuzhong</p> |
| <p>2003-04 Supply Chain Coordination with Risk-Averse Agents (CU03239)
 ✎ YAN Houmin</p> | <p>2003-04 Primal-Dual Interior Point Approach to Multiple-Stage Stochastic (EE01461)
 ✎ ZHANG Shuzhong</p> |
| <p>2002-03 Automatic Generation of Chinese/English Cross-Lingual Concept Space by Associate Constraint Network (CU02335)
 ✎ YANG Christopher Chuen Chi</p> | <p>2003-04 Nonnegative Mappings and Their Applications in Robust Optimization (CU03174)
 ✎ ZHANG Shuzhong</p> |
| <p>2003-04 Studies on Dynamic Pricing Models (CU03173)
 ✎ YAO David Da Wei</p> | <p>1999-00 Optimal Controls of Forward-Backward Stochastic Systems with Financial Applications (CU99435)
 ✎ ZHOU Xunyu</p> |
| <p>2003-04 Improving Efficiency and Transparency of Public Disclosure (EE03832)
 ✎ YEN Jerome • FENG Youyi</p> | <p>2001-02 Risk-Sensitive Control (MP01234)
 ✎ ZHOU Xunyu • YAO David Da Wei</p> |
| <p>2001-02 Concurrent and Personalized Data Mining with a Large Number of Users (CS01229)
 ✎ YU Jeffrey Xu • LU Hongjun*</p> | <p>2003-04 Indefinite Stochastic LQ Control with Partial Information (CU03175)
 ✎ ZHOU Xunyu</p> |