

## RESEARCH PROJECTS

### Development of An Advanced Wafer-level 2D and 3D Inspection Platform

✉ CHUNG Chi Kit Ronald • XU Yangsheng • LAM Edmond\* • FUNG Kenneth\*

☐ 16 June 2003

❖ UICP: Matching Grant for Joint Research, Innovation & Tech. Commission (Coll. w/ HKU)

This project aims at developing inspection technology in defect detection and metrology for wafers. Because of the complexity in manufacturing, visual inspection is needed in many steps for semiconductor yield management. We focus on wafer bump inspection, which involves both 2D and 3D inspections in bump size and location. An advanced inspection platform with supporting vision algorithms will be developed, with particular emphasis on their throughput, accuracy, and expandability for future markets. Multiple algorithms will address different inspection requirements for different applications. This is achievable by leveraging on the innovative capability and expertise of the local universities in inspection, computer vision, and automation to complement the technological capability of the company. At the same time, the experience gained in the systems design with lighting, optics, and image processing capability in 3D processing is not limited to packaging but can be applied to other semiconductor processes. This therefore makes the technological challenges of much academic interest, while also helps to solidify Hong Kong competitive position in playing a key role in China boom in the semiconductor industry.

(EE02899)

### Developing the Technology on Diagnosis of Sheet Metal Stamping Processes Based on Thermal Imaging and Finite Element Analysis

✉ DU Ruxu • XU Yangsheng

☐ 1 July 2002

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

Sheet metal stamping process is a complicated process involving many factors, such as the dies, the machine, the workpiece, and the stamping conditions (shot per minute, lubrication, and etc.). Today, owing to the ever-increasing demand for reduced production cost, sheet metal stamping operations are often pushed to the extreme (in terms of geometry shape, production speed, stamping press power usage etc.). This causes various problems such as excessive dimension variation, poor surface finishing and etc., especially in progressive stamping. When malfunction occurs, currently there has been no scientific way to find what causes the problem. This proposal describes the idea of using thermal imaging technology and finite element modeling to diagnose the stamping process and proposes a plan to develop the new technology. The project can be completed in two years. The deliverables include a prototype system, scientifically approved and tested in shop floor, which can diagnose various problems in sheet metal stamping operations. The total budget of the project is \$2,989,240 including \$1,495,500 from Mansfield Manufacturing Co. Ltd.

(EE02346)

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## Design the Next Generation Metal Forming Machine Using Controllable Mechanism

✍ DU Ruxu

□ 1 November 2002

❖ CUHK Research Committee Funding (Direct Grants)

Metal forming is one of the oldest and yet most commonly used manufacturing processes. Everyday, millions of parts are produced by metal forming ranging from battery caps to automotive body panels. Therefore, even a small improvement may add to significant corporative gain. It is well known that there are two types of metal forming presses: mechanical presses and hydraulic presses. The former is fast (high speed presses may reach up to several thousand shots per minute) and is inexpensive to build and operate, but is inflexible. The later is flexible (their motions, including the travel and the velocity, can all be programmed), but is expensive to build and operate. The objective of the proposed research is to design a new type of metal forming presses through the use of controllable mechanisms. The mechanism may take various forms but its basic configuration is made of a large Constant Speed Motor (CSM) and a Variable Speed Motor (VSM). With a large flywheel, the former provides the majority of the energy, while the later tunes the motion of the punch. This design has a number of unique features. First, it is relatively inexpensive to build since only a small servomotor and a mechanical mechanism are needed. Second, it is energy efficient as the large flywheel will help to reduce the instantaneous peak force. Finally, its motion can be regulated just like a hydraulic press. It is expected that the new design will have a significant impact to the metal forming industry for years to come. Currently, we have developed a first prototype and

are applying for a patent. Nevertheless, much research and development is still required. The main topics of the research include: the configuration of the mechanism, the sensitivity of the major design parameters, the dynamics of the press, the kinematical control of the press, and dynamical control of the press. Eventually, we wanted to build a 200 ton press to demonstrate our new design. It should be mentioned that we applied a RGC grant last year, which was ranked as fundable but not funded. We will continue to work until success.

(EE02528)

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## A General Framework for Global Robust Nonlinear Output Regulation Problem

✍ HUANG Jie

□ 1 December 2002

❖ Research Grants Council (Earmarked Grants)

Stabilization is the most fundamental problem in nonlinear control. Output regulation aims to achieve, in addition to closed-loop stability, asymptotic tracking and disturbance rejection for a class of reference inputs and disturbances. Therefore output regulation poses a more challenging thus more interesting problem. For over a decade, the nonlinear output regulation problem has been one of the focuses in nonlinear control community, and active research on this problem has generated many salient results. Nevertheless, progress on robust output regulation with global stability has been slow. This is because the existing framework for handling nonlinear output regulation problem has a fundamental limitation, inherited from its linear ancestor, in that it inherently utilizes the Lyapunov's Linearization method to achieve stabilization, and therefore is handicapped in dealing with output regulation with global stability. The objective of this

project is to establish a general framework that aims to convert the robust output regulation problem for nonlinear systems into a robust stabilization problem. This new framework will offer greatest flexibility to incorporate recent new stabilization techniques, thus setting a stage for systematically tackling output regulation with global stability. The framework will be applied to solve the global robust output regulation problem for some exemplary nonlinear systems.

(CU02316)

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### **Intuitive Freeform Modelling for Character Design**

✍ HUI Kin Chuen

□ 1 September 2002

❖ Research Grants Council (Earmarked Grants)

Existing works on character modeling mainly focuses on the development of techniques for the animation of characters. Tools for the design of characters relies on contemporary geometric modeling functions available in existing graphics or CAD systems. For instance, character models are usually constructed with either parametric surfaces, or as polyhedral models. In the former case, the types, sizes, and shapes of the surfaces have to be carefully selected in order to allow for the necessary deformation that may arise in an animation of the completed model. In addition, the continuities between the surfaces have to be carefully monitored so as to retain the characteristics of the model while being deformed in an animation. In the latter case, special equipment (e.g. 3D laser scanner) may be required for the construction of a character model. In both cases, extensive user interactions are required for manipulating and associating the character model with a skeleton model for the subsequent animation design.

The objective of this project is to develop a technique for the intuitive design of character models. By extracting a set of common characteristic of character models, a feature based design technique will be developed. For example, characters are usually humanized so that most basic features of a human may be included in a character. By mapping the features on a standard template to an intended design (or a sketch), a character model can be constructed intuitively. A sketch of a character is constructed with a set of skeletal curves. This will form a basis for mapping the necessary features of a character template to the intended design. By using the set of skeletal curves as the basic component for animating the character, an intuitive character design system can be expected.

(CU02375)

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### **Curve Shortening, Heat Flow, and Global Optimization**

✍ KWONG Chung Ping

□ 1 November 2002

❖ CUHK Research Committee Funding (Direct Grants)

Global optimization is important because many problems in science and engineering are formulated as solving function optimization. In brief we are looking for values of the various controlling variables such that the cost (for example) is minimized. To locate the global minimum will be difficult if there are many local minima which usually have no known structure. We propose in this research the use of curve evolution (based on heat flow equation) to derive efficient algorithms for solving this minimization problem.

(EE02593)

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**A Force and Impact Sensing System for Robotic Micro-assembly**

✉ LI Wen Jung • XI Ning\*

□ 10 September 2002

❖ Research Grants Council (Earmarked Grants)

Our proposed project aims to advance micromanipulation technology with piezoelectric sensors for feedback control and manipulation during micro-assembly and packaging. Piezo-materials such as polyvinylidene fluoride (PVDF) will be used to fabricate highly sensitive force and rate-of-force sensors for contact assembling of micro-mechanical devices. The resulting technology will allow close monitoring of the magnitudes and directions of micro-Newton scale forces in multi-dimensions. The data can then be used to establish a micromanipulation model via an on-line learning scheme. As a result, contact/impact forces can be regulated to maintain safety margins and improve yield and reliability during micro-assembly – factors that will eventually make automated batch micro-assembly feasible. At the conclusion of this project, we will demonstrate a force-sensing micro-assembly system, including hardware and software, integrable to existing commercial micromanipulators, and capable of operating in automated assembling mode or tele-operated mode. Ultimately, this technology can be used to achieve micro-automation in batch assembling of MEMS devices such as micro-mirrors, micro-optical-lenses, and general micro sensing and actuation devices. In addition, this technology can potentially be used in bio-manipulation, including embryo injection and cell separation, to understand the force interactions of micro-biological systems. The main contributions of this technology are: (1) allow force and rate-of-force feedback interaction between a human

operator and micron-scale systems; (2) considerable increase yield and decrease production time for Microsystems; (3) enable automated batch micro-assembly, and thus, greatly reduce production costs of Microsystems; and (4) potentially allow scientific investigation of multi-force interaction between micro-mechanical and micro-biological systems.

(CU02381)

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**Self-Powered Piezoelectric Sensors**

✉ LIAO Wei Hsin • LI Wen Jung

□ 1 December 2002

❖ Research Grants Council (Earmarked Grants)

Sensors play a crucial role in today's increasingly complex structural systems. In recent years, the idea of applying piezoelectric materials for sensing and/or actuating devices has been studied in various disciplines. In this research, self-powered piezoelectric sensors are proposed, in which one piece of piezoelectric element will be simultaneously used as a sensor and a power generator under vibration environments. The application of piezoelectric materials to the development of novel self-powered sensing techniques, and the ability to interpret sensor signals effectively and accurately are promising for improving the reliability of physical systems. Miniaturization technologies could be further applied to devices and components of the integrated structural system to reduce the power consumption, size and weight, while signaling the presence, location, and extent of failure modes. We are aimed to develop innovative self-contained hybrid systems for vibration measurements. Concurrent designs in sensors and power generators are desirable with conventional piezoelectric materials, integrated with efficient energy storage devices and signal

conditioning electronics. We will evaluate sensing and power generating abilities individually, and then their concurrent sensing/powering performance by varying parameters. Experimental efforts will be carried out to implement the synthesized structures with self-powered piezoelectric sensors. The scientific knowledge base created through this project will facilitate the full realization of piezoelectric materials for vibration measurements and stimulate continuing research efforts in this area. The results of this study are essential for advancing the remote sensing technology of various complex systems such as infrastructures and rotating machinery.

(CU02382)

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#### **Croucher Chinese Visitorship 2002-2003**

✉ LIAO Wei Hsin

☐ 10 February 2003

❖ Croucher Foundation Visitorship for PRC Scholars

The purpose of the visitorship programme for Prof. HU Guoqing from Xiamen University is for academic exchange and collaboration between both sides. During this six-month visit, Prof. Hu will be able to develop collaborative research on the MR-fluid based piezoelectric accelerometers.

(MP02904)

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#### **Development of a Service Robot with Lift Interface**

✉ LIU Yunhui • YI Jianqiang\*

☐ 1 August 2002

❖ Chinese Academy of Science (Research Collaboration)

With the advancement of robotics technology, robots

is being applied in various service tasks, such as cleaning floors of offices, transporting devices/documents in hospitals, etc. One of essential ability for those service robots is to reliably interface with lifts so that they move among different levels of buildings. Most of existing robots are working in one level only or use very special interface to access lifts. In this project, we are going to develop a new service robot with the ability of accessing lifts by mounting a robot arm on a mobile platform. The service robot will use its arm to press lift buttons in the way by which humans do. With such a function, the service robot would be able to access various kinds of lifts without the need of retrofitting the control system of lifts. This is a joint project with the Institute of Automation, Chinese Academy of Sciences.

(EE02577)

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#### **Dynamic Control of Robots Using Uncalibrated Visual Feedback**

✉ LIU Yunhui

☐ 1 October 2002

❖ CUHK Research Committee Funding (Direct Grants)

Visual servoing is an approach of using visual information to control motion of a robot, and it has been proven effective for sensor-based task execution of robots. The performance of a vision-based robotic system highly depends on how the information measured by a camera is efficiently and accurately transformed to that useful robot control. To perform such a transformation, it is necessary to calibrate the relation between the vision space and the robot space. The accuracy of such a calibration directly determines the control performance. The process of conducting highly precise calibration is

complicated and requests substantial efforts. Furthermore, off-line calibrations are not possible in many situations such as the case when the camera is mounted on a mobile robot. Therefore, it is desirable to utilize a controller that enables a robot to use directly un-calibrated visual information. In this project, we proposed to develop new controllers that use un-calibrated visual feedback. Compared to existing un-calibrated visual feedback controllers, which are based on kinematics only, we will consider full dynamic effect of robots in controller design. By including dynamics in its controller, a robot would be able to perform fast visual tracking tasks. We will formulate un-calibrated visual servoing as output adaptive regulation and tracking problems in nonlinear control theory. Based on this formulation and properties of robot dynamics, simple adaptive algorithms will be proposed to estimate on-line the unknown transformation from the vision space to the robot space. We will address the following technical issues: (1) dynamic modeling of a vision-based robotic system, (2) design of adaptive visual servoing controller, and (3) visual tracking without using velocity measurement. Furthermore, we will implement the controllers in a 3 degrees of freedom (DOF) robot to verify their performance by experiments.

(EE02504)

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### **Interactive Haptic Simulations for Virtual Fixture Prototyping**

✉ WANG Michael Yu • LIU Yunhui

□ 1 October 2002

❖ Research Grants Council (Earmarked Grants)

This proposed project focuses on interactive haptic simulation methods to integrate haptics into a virtual reality (VR) and on developing a virtual prototyping

system to explore the potential of the haptic paradigm in the area of application to designing fixtures for parts of complex geometries such as turbine airfoils. A key problem to be investigated is the computation methods for simulation of interacting virtual objects of complex surface geometries at real-time speed. Full-surface models are necessary for a realistic representation of mechanical objects such as turbine airfoils which usually have complicated contact and response scenarios during their interactions. For *real-time* haptic “display” of the contact forces, the simulation must be performed at a high update rate on the order of *kilohertz* (1,000Hz) and with high accuracy. The speed and accuracy conditions are necessary for sustaining an acute illusion of reality in the haptic simulation. A primary contribution of this proposed project will be a novel method of interactive, high-fidelity haptic simulation based on a velocity formulation of surface-surface model interaction.

(CU02376)

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### **Wearable Robots as Mobile Devices for Communication and Interaction**

✉ XU Yangsheng

□ 1 October 2002

❖ Research Grants Council (Earmarked Grants)

As we all know, the most significant change in our daily-life in the past few years was the introduction of the mobile phones. The success of mobile phones lies in the fact that interpersonal communication and interaction are vital to the well-being of humans and the mobile phones help people achieving this goal by extending the sense of hearing and power of speech to far away places conveniently. In a sense, mobile phones can be viewed as "extended ears and mouths" (only for the speech function of the mouths).

However, apart from the "ears" and "mouths", we also have "eyes", "nose", "hands", and other organs in our body to sense and interact with the world. It would be so desirable if these functions can also be "extended", so that we can communicate and interact with people remotely. In this way, we can "watch" a football game remotely with a desired, real-time adjustable position and angle. We may also "play" a dance motion for a friend far away from us. This proposal is to develop such a novel class of devices - "wearable robot". It is small, lightweight, wearable, portable, distributed, and intelligent. We will address the issues in development of the device, including design, architecture, self-power generation, human intention learning, and system integration. The proposed research opens up tremendous new human-computer and human-human interface possibilities, resulting in rich academic research contents and potential product lines in consumer electronics and multimedia industries.

(CU02317)

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**Finite Element Software to Investigating Formation Flying of Autonomously Controlled Units**

✍ YAM Yeung

☐ 1 November 2002

❖ CUHK Research Committee Funding (Direct Grants)

Formation flying of multiple spacecrafts as some sort of virtual space truss has generated a lot of interest recently. One advantage of the concept is that the actual structure, which would be complicated to build and costly to put in space, is no longer required. Great flexibility in subsequent system reconfigurations can also be readily facilitated. Successful operation, however, depends strongly on

the dexterous and precision control of spacecraft positions and attitudes.

This project aims at a very generic version of the above problem. We consider a group of autonomously control units, each executing a localized PID control law to maintain a certain fixed distance with respect to its closest neighbors, and we aim to study the performance of such a group using existing finite element software. In this case, each spacecrafts can be in linear arrangement, planar arrangement, or 3D arrangement. Using the finite element software here enables us to conveniently handle the nodal and interaction assignment problem, which can be quite complicated as the number and dimensionality of the formation increases, and to generate subsequent time responses. In this regards, the ACAE department has already the software ALGOR suitable for such investigation.

The problems we will look into include group performance under a fixed formation in presence of disturbance, and also the behavior during maneuvering exercise. For the latter, it is envisioned that a designated leader will start to move into position first, guiding the rest of the spacecrafts to move appropriately. Moreover, we are interested in a special maneuver in which the group of spacecrafts will have to pass through a narrow channel from one side to the other. In this case, fluidic finite element software will be most suitable for our study. We expect the approach and results developed in this project will also be useful in intelligent highway system, robot fleet, and micro-machine application areas.

(EE02511)

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

<u>Edition</u>	<u>Title/Investigators</u>		<u>Edition</u>	<u>Title/Investigators</u>
				✍ LI Wen Jung • LEONG Philip Heng Wai (Dept of Computer Science and Engineering) • TANG William C.*
2001-02	A 2D Reference Image of a 3D Object: How Much Can It Do toward Vision Problems? (CS01177) ✍ CHUNG Chi Kit Ronald		2000-01	Micromachined Nafion Actuators for Tactile-display Systems (CU00206) ✍ LI Wen Jung • GUO Shuxiang* • LIU Yunhui
2001-02	Intelligent e-Diagnosis of Plastic Injection Molding Machines (EE01404) ✍ DU Ruxu • XU Yangsheng		2001-02	Integrated Micromechanical Switches for Adaptive Fractal Antenna Arrays (EE01215) ✍ LI Wen Jung • KWONG Chung Ping • LUK Kwai Man*
1999-00	Practical Output Regulation for Nonlinear Systems (CU99400) ✍ HUANG Jie			
2000-01	Approximation Methods for the Discrete Nonlinear Servomechanism Problem (CU00209) ✍ HUANG Jie		2001-02	Eco-safe Human-motion-powered MEMS Energy Generator for Mobile Electronic Devices (EE01757) ✍ LI Wen Jung • LEONG Philip Heng Wai (Dept of Computer Science and Engineering) • YAM Yeung • XU Yangsheng • WONG Sai Peng Joseph (Dept of Electronic Engineering)
2001-02	Output Regulation in Uncertain Nonlinear Systems (MP01181) ✍ HUANG Jie			
2001-02	Representation and Deformation of 3D Shapes for Design Applications (MP01182) ✍ HUI Kin Chuen		2000-01	Novel Technologies for High-performance Vibration Damping and Compact Motion-stages for Electronics Manufacturing Equipment (EE20004) ✍ LIAO Wei Hsin • WANG Michael Yu • XU Yangsheng • YAM Yeung
2001-02	Computational Algebraic Geometry in Control System Analysis and Design (MP01185) ✍ KWONG Chung Ping		2000-01	Active-Passive Hybrid Vibration Control Using Enhanced Self-sensing Piezoelectric Actuators (CU00205) ✍ LIAO Wei Hsin
1999-00	A MEMs Vibration Electric Power Generator (CU99416)			



2001-02	Dynamics and Control of Train Suspension Systems with Smart Dampers (MP01216) ✉ LIAO Wei Hsin • HUANG Jie	2001-02	Minimally-Invasive Techniques of Particle Vibration Damping (MP01196) ✉ WANG Michael Yu
2000-01	Real-time Control of Cooperative Robots via the Internet with Force Reflection (CU00173) ✉ LIU Yunhui • NING Xi* • WANG Yuechao*	1999-00	A Single-wheel, Gyroscopically Stabilized Robot (CU99403) ✉ XU Yangsheng
2001-02	3D Grasp Planning with Applications to Automated Fixture Layout Design (MP01217) ✉ LIU Yunhui • WANG Michael Yu	2000-01	Smart Wheelchair (CU00197) ✉ XU Yangsheng • NECHYBA Michael*
2001-02	Real-Time Bilateral Teleoperation of Internet Based Robotic Systems (CS01446) ✉ LIU Yunhui • WANG Yuechao* • XI Ning*	2001-02	Human Informed Control of Dynamically Stable Systems (MP01228) ✉ XU Yangsheng • NECHYBA Michael*
2000-01	Recurrent Neural Networks for Real-time Grasping Force Optimization of Dexterous Manipulations Using Multi-fingered Robotic Hands (CU00174) ✉ WANG Jun • LIU Yunhui	2001-02	Development of Technologies on Networked Smart Toys (EE01544) ✉ XU Yangsheng • ZHANG Ping# • LAW Kwok Ho Cedric#
2000-01	Optimal Fixture Layout Design for Workholding Automation (EE20022) ✉ WANG Michael Yu	2001-02	$L_2$ -Representation, Properties, and Applications of Fuzzy Membership Function and Rule Bases (EE01851) ✉ YAM Yeung

## RESEARCH PROJECTS

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### Outlier Detection in Large Databases

✍ FU Wai Chee Ada

☐ 1 November 2002

❖ CUHK Research Committee Funding (Direct Grants)

In the research on data mining, finding patterns from apparent chaos is a major objective. For example, we may discover customer purchase patterns and hence predict customer behavior, which can lead to appropriate strategies in marketing. However, the reverse of this general goal of finding pattern from apparent chaos can also be beneficial. This is to find exceptions form patterns. The exceptions are also called outliers. The detection of outliers can be very useful in applications such as E-commerce for detecting fraud or criminal activities, system maintenance for detecting abnormal behavior, 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 may likely require more computations for detection outlier. (2) What is the relationship between finding clusters and finding outliers? The two problems are obviously related, for example, some clustering algorithms generate outliers as part of its answer set. Studying the relationship may lead to some new insights. (3) How to detect outliers for high-dimensional data? In real databases, data typically has many attributes, giving rise to

high-dimensional data. Detecting outliers in this case becomes more difficult. Relatively few research work has been done. We hope to come up with some new ideas and solutions and help to push forward the frontiers of this line of research and to examine possible applications which can benefit from the research.

(EE02741)

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### Visualization and Virtual Reality Research in Chinese Visible Human Project

✍ HENG Pheng Ann • WONG Tien Tsin • FUNG Ping Fu • CHUI Yim Pan • XIE Yongming

☐ 1 November 2002

❖ The Third Military Medical University

Based on the data that we acquired from the Chinese Visible Human Project, we would focus on developing advanced visualization and virtual reality technologies to facilitate the development of the following virtual environments:

- (1) Virtual Anatomy
- (2) Virtual Liver Surgery
- (3) Virtual Eye Surgery
- (4) Virtual Acupuncture

(EE02941)

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### Virtual Anatomy

✍ HENG Pheng Ann • CHUI Yim Pan • WONG Tien Tsin • XIE Yongming

☐ 5 May 2003

❖ The Third Military Medical University

Virtual anatomy refers to the use of virtual 3D model of human anatomical for the teaching and learning of anatomy. Most of the existing works in virtual anatomy focus on presenting pre-recorded animations

of 3D computer rendered anatomical models on a CD-ROM, or interactive manipulation of rather simple 3D geometrical anatomical models. In this project, we aim to develop a PC-based virtual environment to facilitate interactive learning of anatomy based on the extremely high quality Chinese Visible Human dataset recently collected by the Third Military Medical University. Superior to all existing works in virtual anatomy, the proposed system will provide real-time photo-quality 3D rendering of anatomical details as seen in original color images collected, as well as supporting powerful features such as layer-peeling visualization, motion simulation of the skeleton system and circulation simulation of the vascular system.

(EE02595)

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#### **Target Information Estimation for Relevance Feedback Framework in Content-Based Image Retrieval**

✉ KING Kuo Chin Irwin

☐ 1 September 2002

❖ Research Grants Council (Earmarked Grants)

The Relevance Feedback (RF) framework is an important and powerful technique first developed for text-based information retrieval in early days of computing where the feedback from the user helps to retrieve information more accurately in successive interactive stages. In recent years with the advent of multimedia systems, it is crucial that this framework is adapted to multimedia data and information. However, the basic problem is that although the previously used Bayesian framework for RF is adequate, more recent emerging techniques developed from statistical learning theory may remove some of the limitations and thus extend the capabilities of RF in order to obtain higher accuracy

and better efficiency in the multimedia information retrieval process.

The proposal consists of two main parts: the first part focuses on the theoretical formulation of the novel RF framework based on Target Information Estimation and the second part is to apply the novel framework in a content-based face recognition system.

#### *(1) Expectation Maximization Algorithm for Target Information Estimation*

One of the ways to retrieve information in the RF framework is to use the novel Target Information Estimation (TIE) technique. This is by which the refinement of the RF is used in estimating the intended target multimedia information. We proposed to employ the Expectation Maximization (EM) algorithm for TIE to refine the retrieval process. The intended result will be fewer user feedback interactions and a higher retrieval rate than what have achieved previously.

#### *(2) Application of Target Information Estimation to Content-Based Information Systems*

We also plan to apply the RF technique in content-based multimedia information systems. In particular, we plan to use it for a face recognition system since it seems that this type of RF framework is mostly suitable when the initial query from the user is difficult to obtain and the system must rely on the RF framework to proceed in order to obtain the face match.

With the abundance of multimedia information available, the result of our research will impact the way for multimedia systems to organize and retrieve vast amount of information efficiently and effectively.

(CU02351)

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#### **Efficient Local Search Methods for Soft Constraint Satisfaction Problems**

✉ LEE Ho Man Jimmy • CODOGNET Philippe\* •  
LEUNG Ho Fung

□ 1 December 2002

❖ Research Grants Council (Earmarked Grants)

Constraint satisfaction problems (CSPs) find useful applications in resource allocation, scheduling, binpacking, among many others. Constraints in a CSP are hard, meaning that a solution valuation to a CSP must satisfy all constraints of the CSP simultaneously. An over-constrained system is a set of constraints with no solution, caused by some of the constraints contradicting others. The task becomes how to relax or weaken some of the soft constraints so as to obtain useful partial solutions. Semiring-based CSP (SCSP), parametrized by the semiring structure  $S$ , is to-date the most general framework for constraint satisfaction and optimization, encompassing classical CSPs and other over-constrained frameworks, such as weighted CSPs, valued CSPs, partial CSPs, fuzzy CSPs, and many others. SCSPs, having its origin from CSP however, is also NP-complete. Thus a general algorithm designed to solve any over-constrained problems will necessarily incur exponential complexity in the worst case. The aim of the project is to investigate efficient local search methods, which have demonstrated impressive efficiency and scalability in solving some large-scale and difficult instances of constraint problems, for solving soft constraint problems in general and SCSPs in particular. From the theoretical point of view, this project will advance the understanding of the relationship between local search methods and over-constrained problems. From the practical point of view, the developed technique will be applicable to modeling and solving real-life and practical problems, many of which are over-constrained in nature.

(CU02358)

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### Efficient Local Search Methods for Soft Constraint Satisfaction Problems

✉ LEE Ho Man Jimmy • CODOGNET Philippe\*

□ 1 January 2003

❖ France/Hong Kong Joint Research Scheme

Constraint satisfaction problems (CSPs) find useful applications in resource allocation, scheduling, binpacking, among many others. Constraints in a CSP are *hard*, which implies that a solution valuation to a CSP must satisfy *all* constraints of the CSP *completely* and simultaneously. An *over-constrained system* is a set of constraints with no solution, caused by some of the constraints contradicting others. The task becomes how to relax or weaken some of the *soft* constraints in an over-constrained system so as to obtain useful *partial solutions*. New solution techniques, well summarized by Jampel *et.al.*, are developed to model and tackle over-constrained systems. Semiring-based CSP (SCSP), parametrized by the semiring structure  $S$ , is to-date the most general framework for constraint satisfaction and optimization, encompassing classical CSPs and other over-constrained frameworks, such as weighted CSPs, valued CSPs, partial CSPs, fuzzy CSPs, and many others. The current state-of-the-art language and solver for SCSPs, clp (FD, S), is based on a combination of tree search and local consistency techniques. SCSPs, having its origin from CSP however, is also NP-hard. Thus a general algorithm designed to solve any over-constrained problems will necessarily incur exponential complexity in the worst case. The algorithm used in clp (FD, S), although complete, is no exception. The aim of the project is *to investigate efficient local search methods, which*

*have demonstrated impressive efficiency and scalability in solving some large-scale and difficult instances of constraint problems, for solving soft constraint problems in general and SCSPs in particular.* From the theoretical point of view, this project will advance the understanding of the relationship between local search methods and over-constrained problems. From the practical point of view, the developed technique will be applicable to modeling and solving real-life and practical problems, many of which are over-constrained in nature.

(EE02934)

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**Automated Design and Prototyping of Communication Architectures for Heterogeneous Systems-on-a-chip**

✉ LEE Kin Hong • GLESNER Manfred\*

□ 1 January 2003

❖ Germany/Hong Kong Joint Research Scheme

Due to the rising complexity of systems-on-a-chip (SoC) devices, the automation of the implementation process is an important factor in system design. This project addresses the issue of automatically generating communications interface between functional intellectual property (IP) blocks in an SoC implementation. Specifically, the automated integration of a compiler called “fly”, developed by our group, with other IP blocks will be developed, with emphasis on developing novel methods for data scheduling, rapid prototyping and refinement of the interfaces.

(EE02797)

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**Towards Fast Extraction of Approximate Features for Content-based Access in Visual Informaiton Retrieval**

✉ LEE Moon Chuen

□ 31 December 2002

❖ Research Grants Council (Earmarked Grants)

Recent advances in computing power and innovations in technology have led to the emergence of new leading edge applications, such as internet image/video search engines, image-based e-commerce, video on demand systems, and general multimedia information systems. An underlying part of these applications is a content-based visual database capturing different types of visual data. Content-based visual databases however require the analysis of huge volumes of data. In particular, the feature extraction process is a major bottleneck in the management and operation of such databases, due to the enormous amount of computation involved. The primary aim of this project is to investigate and to develop methods for improving the efficiency of feature extraction for content-based visual databases. From the theory of statistical occupancy, it proposes to develop a model for approximate feature extraction. This requires a formal selection of the minimal subset of the image data to be involved in the feature extraction process. Such minimal proportions should guarantee that the analysis results for different database functions should be the same as (or close to) those from using the image features based on all the image data. In this project, we plan to provide a formal theoretical basis for the use of approximate features as a paradigm in image analysis and content-based visual information systems, and to derive the equivalent approximate features for the traditional image features, such as shape, colour and texture. The reliability of the results form using such features will also be addressed.

(CU02377)

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**Floating Point Computation Using FPGA Clusters**

✉ LEONG Philip Heng Wai • LUK Wayne\*

□ 31 December 2002

❖ Research Grants Council (Earmarked Grants)

In the proposed research, we will develop a tool which automates the translation of a high level algorithmic description to an FPGA implementation. In order to minimise the hardware resources, computations will be computed using floating point or fixed point formats with the minimum necessary precision. The system will consist of an arbitrary precision floating point class for simulation; a profiler which is used to determine the minimum precision required for every signal in the hardware implementation; an optimiser which finds the minimum number of bits required for a specified degree of accuracy in the implementation; and a compiler which takes the information collected by the system and outputs synthesisable VHDL code. It is envisaged that for many applications, the resulting designs would have hardware requirements which exceed that of a single FPGA chip. To address this problem, a cluster of 8 Linux computers, each equipped with a high capacity FPGA accelerator board will be utilised, offering in total more than 10 million equivalent system gates. Issues concerned with interconnecting these boards will be studied. The results will be useful for developing future FPGA clusters with hundreds of millions of system gates and beyond. The ultimate goal of this research is to pioneer the application of FPGA based coprocessors to large scale floating point intensive applications. As a first application, a Monte Carlo simulation accelerator for the pricing of financial derivatives will be developed.

(CU02333)

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**Adaptive Strategies for Soft Bid-Determination in Agent Based Continuous Double Auctions**

✉ LEUNG Ho Fung • LEE Ho Man Jimmy

□ 1 December 2002

❖ Research Grants Council (Earmarked Grants)

The use of autonomous software agents in e-commerce applications has become more and more popular nowadays. Traceable back to as far as ancient Egypt and Mesopotamia, continuous double auction (CDA) is an important auction protocol. It is being widely used around the world to trade securities, commodities, currencies and derivative instruments, including options and futures.

This project aims at the investigation of design, implementation and evaluation of adaptive strategies for soft bid-determination in agent based continuous double auctions. Based on the previous work done by the investigators and others, we aim at achieving two particular objectives. First, we shall propose *soft* bid-determination strategies to be used by software agents in continuous double auctions. With a soft bid-determination, an agent will be willing to transact at good but not 'ideal' prices, and eventually gains more profit by obtaining more transaction opportunities. Second, we shall propose adaptive strategies based on the results we obtain in the first phase of the project. Due to the complexity, unpredictability and openness of the double auction markets, one strategy that works well in one CDA may not behave well in others. We believe that it is more desirable if agents have the ability to automatically adapt themselves to the environment and autonomously select the best strategies most appropriate for the latest auction environment.

On the academic aspect, this project contributes to the research in software agent technology, the study of rational decision-making, and artificial intelligence

in general. On the application aspect, the results of the project can be applied in a large number of real life scenarios, ranging from resources allocation in multiagent systems, to agent based continuous double auctions in e-commerce, and to automatic trading in stocks markets. The potential applications can be found virtually in every academic, commercial and financial sector in Hong Kong, China and worldwide. (CU02346)

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### **GPP: A Novel Framework for Genetic Parallel Programming**

✉ LEUNG Kwong Sak

□ 1 October 2002

❖ CUHK Research Committee Funding (Direct Grants)

Genetic Programming (GP) is a robust method in Evolutionary Computation. There are two main streams in GP, namely, Tree-based GP (TGP) and Linear GP (LGP). TGP evolves programs represented in tree structure. LGP evolves sequential programs directly. LGP suffers from inflexibility while TGP from inefficiency. The overall objective of the project is to develop a novel framework and to implement an integrated system called Genetic Parallel Programming (GPP). We will perform thorough studies on the factors that cause the inefficiency and inflexibility of GP and develop a GPP system to evolve parallel programs to solve real-life problems. In GPP, evolved optimal parallel programs with multiple instructions are to be executed in parallel on an optimally designed parallel architecture.

The aims of this project are:

- (1) To develop a framework for GPP.
- (2) To develop a novel parallel architecture to execute parallel instructions directly.

- (3) To explore the possibility of implementing the architecture on Field Programmable Gate Arrays (FPGAs).
- (4) To explore new genetic operators.
- (5) To compare the effectiveness of GPP with LGP and TGP.
- (6) To evolve parallel programs for real-life problems.
- (7) To discover new sequential and parallel algorithms from evolved programs through reverse engineering.

This project will have significant impacts on GP in terms of efficiency and effectiveness through parallel programming. It opens up an entirely new opportunity for solving problems with appropriate parallel architecture and automatically learned optimal parallel programs/algorithms.

(EE02481)

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### **A Proportional Delay DiffServ-Enabled Multimedia Server: Admission Control, Resource Allocation and Dynamic Adaptation**

✉ LUI Chi Shing John

□ 31 December 2002

❖ Research Grants Council (Earmarked Grants)

The goal of this research is to help computer system designers and engineers to understand various design issues and tradeoffs in designing a Proportional Delay-DiffServ (PDDS) enabled continuous media streaming system.

We propose to build a prototype PDDS-enabled media streaming server which can provide distributed on-demand streaming and multicast streaming services. This prototype system will allow us to take various measurement and fine tune different algorithms so that the system can operate at an optimal operating point.

Lastly, we expect this research will contribute both to the body of theoretical knowledge and give insight to the system implementation in the fields of computer and information technologies, such as distributed multimedia system, high performance network and storage system.

(CU02368)

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**Design Diversity by Component-Based Software Development**

✍ LYU Rung Tsong Michael • STRIGINI Lorenzo\*

□ 1 September 2002

❖ Research Grants Council (Earmarked Grants)

Software fault tolerance is the survival attribute of computer systems that allows seamless delivery of expected service after faults have manifested themselves within a software system. Software fault tolerance by design diversity is employed where functionally equivalent yet independently developed software versions are applied in the system to provide complete tolerance to software design faults. We focus on the identification, formulation, application, modeling, evaluation of the current design diversity technique, which is an important means for achieving dependability, heavily used in safety-critical systems. With the emerging approaches in component based software development, design diversity takes a new outlook. This project will improve on the current understanding of diversity, to deliver:

- (1) methods for developers to investigate diversity in a more cost-effective manner to produce dependable systems for critical applications employing component techniques;
- (2) analysis mechanisms that relate the structure of a system and information about reliability of its components to system reliability; predictions of

failure diversity based on the diverse histories of various components in the new system; and design paradigms for combining components into the system;

- (3) basic scientific information on the general issue of diversity for dependability, that can be ported to other IT applications to benefit the industry and the Information Society in general.

(CU02360)

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**Clustering of Color Map Pixels for GPS/GIS Applications**

✍ MOON Yiu Sang • LUK Tai Cheung Franklin\*

□ 1 November 2002

❖ CUHK Research Committee Funding (Direct Grants)

GPS (Global Positioning Systems) and GIS (Geographical Information Systems) rely their success on the availability of compact digital maps. In this research, we propose a methodology to generate compact digital maps from paper maps. A paper map is usually printed using CYMK primary colors. Due to color scattering, when the map is scanned, millions of color pixels having different CYMK color values are produced due to the screening technology employed to simulate the different target colors from the primary colors in the printing process. Our work aims at clustering the millions of color pixels into the original target colors. The result will produce clean and sharp map images and the file sizes of the maps will be significantly reduced. In addition, the clean color maps can be vectorized more easily and accurately. In the past, least squares strategy is used to cluster the color pixels. In our work, we use a very different approach because we found that the scattered color values actually follow normal statistical distribution



patterns. Our research aims at identifying the critical factors that affect the performance of our approach.

(EE02527)

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**Fault-tolerant and Security Mechanisms for Mobile Agent System**

✉ NG Kam Wing

□ 1 January 2003

❖ CUHK Research Committee Funding (Direct Grants)

Mobile agents are autonomous software processes which can move from node to node in a network to access services provided there and to communicate with other mobile agents. It is widely agreed that mobile agents in conjunction with WWW technology will provide the technical foundation for future electronic commerce. A prerequisite for the use of mobile agents in a commercial environment is, that agents have to be executed reliably and securely, independent of communication and node failure. This research aims to provide solutions for the fault-tolerant execution of mobile agents and the protection of mobile agents against malicious hosts. The solutions consist of a framework of fault-tolerant and security mechanisms that could be deployed in real-world applications. The fault-tolerant mechanisms include a light-weight fault-tolerant protocol for the exactly-once execution of mobile agents, and recovery algorithms based on the partial rollback of mobile agent execution. The security mechanisms include protocols for detecting tampering against a mobile agent's data and execution states, and protocols to detect malicious hosts.

(EE02424)

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**Interactive Deformable Registration & Simulation of Medical Volumetric Datasets**

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

□ 1 September 2002

❖ Research Grants Council (Earmarked Grants)

Medical images and their derivatives play a critical role in timely medical diagnosis and treatment. Exploring their nature and dynamic deforming behavior would be an ideal tool for preoperative surgical planning and training of complex procedures. We will focus on investigating dynamic multi-resolution subdivision surfaces for the deformable registration, which enable feature matching in each refined model of subdivision surfaces. We will continue the work to develop adaptive multi-resolution modeling for subdivision surfaces, to enhance the high-quality visual imaging in real-time interactive simulation. We will also develop intuitive virtual tools with image-guided realistic feedback that can aid physicians to extract more clinically useful information from deforming simulation in order to achieve more accurate diagnosis or a better surgical decision beforehand. The system would be an ideal tool for training medical students or physicians in diagnostic imaging, so critical deforming problem could be discovered and an optimal surgical path planned prior to real operation on live patients.

(CU02356)

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**Low-cost Tele-immersive Display with Multiple Live-video Streams**

✉ WONG Tien Tsin • HENG Pheng Ann • WONG Man Leung\*

- 1 October 2002
- ❖ CUHK Research Committee Funding (Direct Grants)

With the advances of computer hardware and software technologies, the computing power and network bandwidth have been increased by more than ten folds per decant. This opens up new challenging research areas which are not possible before. The idea of *tele-immersion* is to enable geographically distributed users to collaborate in a shared real/virtual environment in a real-time fashion. It is not just simply the video conferencing. Instead, an ideal tele-immersion would generate a full-sensory illusion to each user as being present (immerse) in the real/virtual world, and allow user to interact with each other and the virtual scene. Tele-immersion is an emergent area where extensive research is now being conducted.

The challenge to provide the sense of immersion imposes many tough requirements to current computer and network technologies. For instance, a large field-of-view display of the environment is needed to provide the immersive illusion to the user. Optimally, a 360 degree field-of-view (panorama) has to be captured at the remote site and transferred. This implies a large amount of visual data has to be transferred through the network within a short period of time. Moreover, capturing panorama may require expensive capturing devices and sometimes impossible since fixed obstacles (such as pillar) may block part of the view.

In this project, we propose to investigate and develop a cost-effective tele-immersion system which provides a scalable large field-of-view display of a remote environment across Internet. We first capture multiple *live* video with ordinary CCD cameras. These video streams are then transferred to the receiver side and stitched there to generate a

*live* panoramic video. The composed live panoramic video is projected onto a large spherical screen which covers the user's 180 degree field-of-view. To ensure a smooth streaming of live video across the network, we propose to develop a tailor-made compression algorithm for packing the enormous amount of visual data.

(EE02615)

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### Optimization Algorithm Based on the Less Flexibility First Principal and Its Practical Applications

✍ WU Yu Liang • DONG Sheqin\*

□ 1 February 2003

❖ NSFC/RGC Joint Research Scheme

The academia known *NP-hard problem* can be considered a byname of those "hardest" optimization problems. NP-hard problems are almost ubiquitous, from classical graph theory, sequencing, coding problems, to our many real-life related practical problems like air-flight/shop scheduling, ship cargo packing and so on. To solve these difficult optimization problems, many optimization algorithms such as Tabu search, simulated annealing, genetic algorithms and artificial neural networks have been proposed since 1980s. As these optimization algorithms have been successfully applied for a wide range of difficult optimization problems in the past, they have been considered powerful and general resorts for today's large optimization problems too. However, the optimization algorithms proposed of this kind are generally heuristics emulating certain natural optimization processes, which might involve concepts from biology evolution, mathematics, physics, neural system and statistic mechanics, etc. Since most of these nature-process emulated algorithms involve randomness-based

non-deterministic procedures that will take quite large CPU resources for large problem instances, they are not necessarily practical for our today's real-life problems that tend to have larger and larger input sizes. For example, in a simulated annealing algorithm for the deep sub-micron placement and routing problems, multiple objectives and constraints need to be integrated together in the cost function, which might unfortunately cause mutual conflicts on the penalty function and jeopardize the searching conversion for global optimization solutions. In this proposal, we are proposing a newly invented heuristic, *Less Flexibility First (LFF)* methodology, which can efficiently reflect the multiple optimization goals more effectively and thus should be able to overcome the drawbacks of the simulated annealing based methods. We will apply this new technique for solving two hard problems that possess immense practical values for the Hong Kong and China technology needs: 3D ship-cargo packing optimization and VLSI EDA (Electronic Design Automation) problems.

(CS02573)

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**Structural Rival Penalized Competitive Learning with Automated Model Selection**

✍ XU Lei

☐ 1 August 2002

❖ Research Grants Council (Earmarked Grants)

Unsupervised learning have been encountered widely not only in many classical fields but also in the emerging areas such as data mining, knowledge discovery in databases, and various internet based data processing problems. Each learning task consists of *parameter learning* for estimating each of parameters in a structure at a given scale, and model selection for selecting an appropriate scale. Model

selection is very important but difficult to implement, due to its intrinsic nature. The existing model selection principles or theories are usually implemented in a tedious two-stage way, by which a large number of scales must be enumerated and at each scale a parameter learning process must be made, which not only consumes a huge computing cost but also can not be implemented adaptively. This proposal is motivated to develop a general framework as well as effective implementing algorithms that solves the problems adaptively with model selection realized implicitly and automatically during learning. Our major objectives consists of (1) systematically investigating typical existing model selection principles and developing a cost function theory for RPCL learning on clustering analyses; (2) developing a powerful and general BYY harmony learning framework for implementing parameter learning with automated model selection on two major types of unsupervised learning tasks; (3) developing specific adaptive algorithms for implementing these tasks.

(CU02336)

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

<u>Edition</u>	<u>Title/Investigators</u>
1999-00	Intersection Graphs and Their Recognition Algorithms (CU99410) ✍ CAI Leizhen
2001-02	Efficient Algorithms for a Contamination Control Problem on Graphs (CS01165) ✍ CAI Leizhen

- 1999-00 A Portfolio Management System for the Hong Kong Market (CU99428)  
 ✍ CHAN Lai Wan • KING Kuo Chin Irwin  
 ✍ HENG Pheng Ann • LEUNG Kwong Sak • LEUNG Ping Chung (Dept of Orthopaedics & Traumatology) • WONG Tien Tsin
- 2001-02 Financial Application of Neuro-Dynamic Programming (CS01170)  
 ✍ CHAN Lai Wan
- 1999-00 An Intelligent System for Satellite Meteorological Data Mining and Its Applications (CU99436)  
 ✍ FU Wai Chee Ada • LIN Hui (Dept of Geography & Resource Management) • KING Kuo Chin Irwin • HUANG Qian\*
- 2001-02 Server-assisted Wireless Public-key Infrastructure (EE00720)  
 ✍ FU Wai Chee Ada
- 2001-02 Where is the Beef? Data Mining in High Dimensional Space (EE01179)  
 ✍ FU Wai Chee Ada • KING Kuo Chin Irwin
- 2001-02 High Performance Computing for Centers, Distinguisher and Clusters in Projected Subspace (and Applications to Intelligent Information Retrieval on the Web) (EE01492)  
 ✍ FU Wai Chee Ada • DENG Xiaotie\* • ZHENG Weimin\* • WANG Dongshen\* • WANG Lusheng\*
- 2000-01 An Intelligent Virtual Environment for Chinese Acupuncture Learning and Training (CU00185)  
 ✍ LEE Ho Man Jimmy • LEUNG Ho Fung • STUCKEY P. J.\*
- 2000-01 Augmented Reality System for Endoscopic Surgery Simulation and Operations (CU00012N)  
 ✍ HENG Pheng Ann • LEUNG Kwong Sak • WONG Tien Tsin • SUNG Joseph Jao Yiu (Dept of Medicine & Therapeutics) • CHUNG Sheung Chee Sydney (Dept of Surgery) • TANG Zesheng\* • CHAI Jianyun\*
- 2001-02 Comprehensive Analysis and Interactive Visualization of Cardiac MR Data (CS01180)  
 ✍ HENG Pheng Ann • WANG Yongmei\* • SHI Peng Cheng\*
- 1999-00 The Design and Analysis of Stochastic Clustering Methods for Generating Indexing Structure for Information Retrieval in Image Database Applications (CU99407)  
 ✍ KING Kuo Chin Irwin • FU Wai Chee Ada • CHAN Lai Wan
- 2001-02 Distributed Content-based Image Search Engine (EE01791)  
 ✍ KING Kuo Chin Irwin
- 2000-01 Collaborating Redundant Models in Constraint Satisfaction (CU00183)  
 ✍ LEE Ho Man Jimmy • LEUNG Ho Fung • STUCKEY P. J.\*

2001-02	Reducing Search Space in Local Search for Constraint Satisfaction (CS01204) ✉ LEE Ho Man Jimmy • LEUNG Ho Fung • STUCKEY P. J.*	2000-01	A New Class of Genetic Algorithms with Applications on Data Mining (EE20009) ✉ LEUNG Kwong Sak
2001-02	Fast Approximate Feature Extraction for Content-based Visual Databases (EE01903) ✉ LEE Moon Chuen	2001-02	A Novel Fast Evolutionary Algorithm and Its Application in Unsupervised Learning (CS01212) ✉ LEUNG Kwong Sak • WONG Man Leung*
2000-01	A Micropower Analogue VLSI Implementation of a Scale Invariant Phase Encoded Neural Network and Its Application to a Wordspotting Speech Recognition System (EE20008) ✉ LEONG Philip Heng Wai	1999-00	Design, Analysis and Implementation of Mixed Workload Schedulers with Application to the Multimedia Digital Library System (CU99430) ✉ LUI Chi Shing John
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*	2000-01	Providing Quality-of-Service on the Internet2 via the Differentiated Service Technique (EE20001) ✉ LUI Chi Shing John • SHANKAR A U* • GOLUBCHIK L* • GIULIANA Franceschinis*
2001-02	Integration of Constraint Satisfaction Techniques and Mixed Integer Programming (CS01211) ✉ LEUNG Ho Fung • LEE Ho Man Jimmy	2000-01	Design, Analysis and Implementation of Resource Allocation and Object Synchronization Protocols for Collaborative Distributed Multimedia System (EE20010) ✉ LUI Chi Shing John
1999-00	To Develop a New Class of Fast Genetic Based Evolutionary Algorithms Using Splicing/Decomposable Representation Scheme and Exclusion-based Operators (EE99012) ✉ LEUNG Kwong Sak	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
		1999-00	Architecture-based Software Reliability Engineering Techniques (CU99432)

	✍ LYU Rung Tsong Michael • LAPRIE Jean Claude*	2001-02	Synthesizing Multidimensional Applications on Reconfigurable Computing Systems (EE01437)
2000-01	A Multilingual Digital Video Content Hub (EE20006)		✍ NG Kam Wing
	✍ LYU Rung Tsong Michael • YEN Jerome (Dept of Systems Engineering & Engin. Management) • WONG Wing Shing (Dept of Information Engineering) • KWAN Tze Wan (Dept of Philosophy) • SHEN Vincent*	2000-01	A Multisensory Virtual Environment for Dental Surgical Simulation and Training (EE20011)
			✍ SUN Hanqiu
		2000-01	Advanced Knowledge Discovery & Spatial-temporal Visualization for Georeferenced Information (CU00016N)
2000-01	Dependability and Security Paradigms for Mobile Agent Systems (CU00193)		✍ SUN Hanqiu • LEUNG Yee (Dept of Geography & Resource Management) • LEUNG Kwong Sak • LIN Hui (Dept of Geography & Resource Management) • PENG Qunsheng* • BAO Hujun*
	✍ LYU Rung Tsong Michael		
2001-02	Engineering Distributed Objects for Reliability and Interoperability (CS01222)		
	✍ LYU Rung Tsong Michael	2001-02	A Multisensory Virtual Environment for Dental Surgical Simulation & Training (CS01189)
2000-01	The Development of a Chinese Linux Operating System for Embedded System (EE00961)		✍ SUN Hanqiu • LEONG Philip Heng Wai • QIN Kaihuai* • TSANG Wai Kit Ricky (University Health Service) • TO Wai Hei Edward*
	✍ MOON Yiu Sang		
2001-02	Fixed-Point Algorithms for In-Card Fingerprint Recognition (CS01224)		
	✍ MOON Yiu Sang • LUK Franklin Tai Cheung#	2001-02	Image-based Synthesized Techniques for Augmented Reality (EE01459)
			✍ SUN Hanqiu
1999-00	High-level Synthesis Framework and Tools for Dynamically Reconfigurable Systems (CU99408)	1999-00	Applying Computer Vision Techniques in the Construction of a Virtual Walk-through System (CU99389)
	✍ NG Kam Wing • LUK Wayne*		✍ WONG Kin Hong • OR Siu Hang
		1999-00	Indexing Methods for Numeric Sequence Databases (CU99437)

<p>1999-00</p> <p>Interactive Illumination Control for Image-based Computer Graphics (EE99009)</p> <p>✍ WONG Tien Tsin</p>	<p>✍ WONG Man Hon</p>	<p>2000-01</p> <p>Accelerating High-quality Volume Visualization with Image-based Computer Graphics (CU00186)</p> <p>✍ WONG Tien Tsin • HENG Pheng Ann</p>	<p>✍ WU Yu Liang • HONG Xian Long* • MAREK-SADOWSKA Malgorzata* • WONG Chak Kuen</p>
<p>2001-02</p> <p>Effective and Efficient Compression for Image-based Modeling and Rendering (EE01369)</p> <p>✍ WONG Tien Tsin</p>	<p>2000-01</p> <p>A General Rewiring Based Circuit Transformation Framework for Deep Sub-micron Designs (EE20012)</p> <p>✍ WU Yu Liang</p>	<p>2001-02</p> <p>Unsupervised Learning with Automated Model Selection and Applications to Data Mining (EE01998)</p> <p>✍ XU Lei</p>	<p>2000-01</p> <p>Extending APT Financial Modeling by State Space Approach, Kalman Filtering and Temporal BYY Learning (CU00169)</p> <p>✍ XU Lei</p>
<p>2001-02</p> <p>A Graph-based Rewiring Scheme for Boolean Networks and Its Applications for New FPGA Design Automations (EE01236)</p>	<p>1999-00</p> <p>A Unified Method to Handle All Placement Constraints in Floorplan Design (EE99008)</p> <p>✍ YOUNG Fung Yu • CHU Chris C N*</p>	<p>2001-02</p> <p>Interconnect-Driven Multilevel Floorplan Design (EE01231)</p> <p>✍ YOUNG Fung Yu • WONG Martin D F* • YANG Honghua Hannah*</p>	<p>2001-02</p> <p>Unsupervised Learning with Automated Model Selection and Applications to Data Mining (EE01998)</p> <p>✍ XU Lei</p>

## RESEARCH PROJECTS

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### Reconstruction of 3D Manifold Objects from 2D Images by Face Identification

✉ CHAM Wai Kuen

☐ 1 November 2002

❖ CUHK Research Committee Funding (Direct Grants)

Today computer animation is widely used in advertisement, computer games and movies. It is most desirable if there is a convenient method that enables us to reconstruct the 3D shape of an object from a single intensity image. With such a method, we can easily create a computer animation by extracting an object from an image, performing operations such as rotation, magnification or shrinking, and inserting it into another image or video. Whilst a large variety of image cues have been exploited, the problem is still only partially solved. Remarkably, this task seems exceedingly easy for a human. In this project, we are to develop a convenient and fast method to convey human perception of 3D shape into a computer. Given an object in a 2D intensity image, a human can expose its 3D structure easily by drawing lines along edges of the object in the image such that the line drawing looks like the 2D projection of the 3D object. We shall develop a method for a computer to interpret the line drawing. Hence, the problem of 3D shape reconstruction now becomes the problem of 2D line drawing interpretation.

The problem will be divided into two parts: face identification and 3D geometry reconstruction. We shall develop methods for the face identification problem by exploiting the geometric properties

implied in the line drawings. Our target is that the total computation time on a typical PC is within one second for objects having twenty faces or less.

(EE02806)

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### A CMOS Direct Conversion Receiver for Third Generation Communication

✉ CHOY Chiu Sing Oliver • PUN Kong Pang

☐ 1 January 2003

❖ CUHK Research Committee Funding (Direct Grants)

The third generation (3G) cellular communication systems are under development in many countries/areas including Hong Kong, driving by increasing demand on the broadband data communication via wireless terminals. Although a unified global 3G standard doesn't exist, the WCDMA or CDMA2000 standard shows promising prospect. Adopting direct sequence CDMA as their radio interface, these systems can provide flexible data services with different quality requirements for single or multiple users in the same frequency band. For the mobile receiver, a higher level of integration is necessary because of low power and low cost requirements. The direct conversion receiver is naturally the best candidate for this purpose due to its simplicity, and is specially suitable for the continuously operating, wideband direct sequence CDMA systems as the well-known DC offset problem can be easily solved. In the proposed investigation, we will employ direct conversion architecture to realize a highly integrated receiver in low cost, mainstream CMOS technology for WCDMA applications.

(EE02705)



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### MOVPE Synthesis of InGa(N)As Quantum Dots for Enhanced Luminescence at 1.3 $\mu$ m

✍ HO Ho Pui

☐ 1 December 2002

❖ CUHK Research Committee Funding (Direct Grants)

This project aims to investigate the possibility of growing InGa (N) As quantum dots for enhanced luminescence at the wavelength of 1.3  $\mu$ m. The impetus behind this research project is that currently there is a high demand for vertical cavity surface emitting lasers (VCSEL) operating at this wavelength, while VCSEL working at 0.85  $\mu$ m is already quite a matured technology. The main difficulty in making VCSEL at longer wavelength is due to the lack of appropriate materials lattice-matched to AIAs/GaAs materials, which have relatively large refractive index contrast and can produce highly reflective Bragg mirror with a small number of AIAs/GaAs mirror pairs. Until now, various approaches including the use of InAs quantum dots, GaAsSb-based materials and InGa (N) As-based materials have been tried. So far InGa (N) As quantum wells grown on GaAs have demonstrated the highest possibility of success. Real InGa (N) As lasers with high performance characteristics have already been reported. It is the aim of this project to further advance the InGa (N) AS approach to include the use of quantum dots so that enhanced luminescence may be achieved. The project will begin with growing lightly nitrogen doped InGaAs layers on InP substrate in order to establish the growth parameters of the MOVPE reactor. This will be followed by gradual increase of nitrogen level in the material to establish the solubility limit of nitrogen in the material. Once this has been achieved, GaAs substrate will be used in place of InP. The effect of changing nitrogen

level and growth temperature will be studied. We shall also use characterization data obtained from photoluminescence, atomic force microscopy, X-ray diffractometry and transmission electron microscopy to optimize our growth process.

(EE02317)

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### Interactive Healthcare Measuring, Monitoring, and Assisting Systems Using Wireless WAP Devices

✍ MENG Max Qing Hu

☐ 1 October 2002

❖ CUHK Research Committee Funding (Direct Grants)

Since the concept of telemedicine appeared in the 60s at NASA for providing healthcare monitoring for astronauts orbiting the earth in the space, many systems and devices for telemedicine applications have been developed around the world. Vast majority of these telemedicine systems and devices are for the measurement, monitoring and transmission of the vital signs of a person or a group of people using the services. The systems and devices are typically capable of only one way transmission without interactive bi-directional communications. Recent developments in biomedical devices and communication network technologies make it possible for us to design wireless WAP device based interactive healthcare measuring and monitoring systems and devices. In this proposed project, we will explore the possibility and limits of using modern WAP devices over wireless network communications links to provide interactive healthcare measuring, monitoring, and assisting services for applications such as home healthcare services. We will develop the necessary software and hardware add-ons for commercially

available WAP and medical measuring and monitoring devices to study and implement the interactive capabilities for healthcare services. The outcome of this project will provide opportunities for Hong Kong based biomedical and communications industries to evaluate and provide value-added personal interactive teleoperated healthcare products and services and will help to advance healthcare technologies and capabilities to the benefits of human beings.

(EE02477)

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**Photonic Pre-processors for Ultrafast Analog-to-digital Converters**

✉ SHU Ching Tat C. • LIU Hai Feng\*

□ 1 November 2002

❖ Research Grants Council (Earmarked Grants)

To meet the growing demand for the processing of high frequency microwave signals in radar and wireless communications, technological advances in both the analog-to-digital converters (ADCs) and the digital signal processors have to be matched. While the rapid development in CMOS technology has led to the realization of digital processors at hundreds of giga-flops, the progress in electronic ADCs is relatively slow. State-of-the-art technology has demonstrated a speed upto 8 giga-samples per second. However, the resolution is very limited and the power dissipation is excessive. An elegant approach to solve the problem is to apply emerging photonic technology in the ADCs to increase their sampling bandwidth. Through the use of a high-speed optical modulator, the analog electrical signal can be rapidly sampled by optoelectronic means and transmitted on an optical carrier. By making use of the unique features of optics, including wavelength multiplexing/demultiplexing and time stretching of

pulses in a dispersive fiber, the effective sampling rate can be significantly enhanced. In this project, we propose to develop new optical sources capable of generating high-repetition-rate time and wavelength interleaved pulses. The outputs will be relatively stable, uniform, and suitable for use as sampling pulses in the ADCs. A simple laser configuration and minimal optical loss in the system are distinct features of our approach. An added advantage is that the sources can be electronically reconfigured to produce a different number of wavelengths for applications in various architectures.

(CU02369)

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**Modeling of Building Environments for Augmented Reality**

✉ TSUI Hung Tat

□ 1 October 2002

❖ Research Grants Council (Earmarked Grants)

A building environment may be just a single building or several buildings on a site. Modeling a building environment has many commercial and industrial applications. For example, a model of a building or an actor may be augmented into a real or artificial environment model for computer games or movies. The environment itself may be a site with several buildings or a natural scene. The outside and interior models of a building can be used for selling property on the web, interior decoration of office and homes, tourist information, hotel advertisement etc. Modeling of a private housing estate site is very useful for advertising by the estate developer. Modeling of a building site like a hospital, a school, or a part of a university campus can be very useful for planning future site development and for visual guide to its users. Since some building site may be on a small hill or close by a mountain slope, a certain

amount of natural environment may have to be modeled too. Basically, two different kinds of approaches will be used for modeling in this project: 3D reconstruction with camera self calibration which is more flexible and the panoramic mosaic which has better visual quality and is easier to compute. The choice of an approach is application dependent. It is our objective in this project that we shall develop new and efficient techniques to model a building environment for augmented reality. We plan to turn our algorithms developed into commercial packages eventually for the local companies and institutes. The packages should have a good market in Asia and overseas.

(CU02378)

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**Low Level Birefringence Detection for Study of Stresses in Ultrathin Film/Substrate Systems**

✉ WONG Sai Peng Joseph

□ 1 September 2002

❖ Research Grants Council (Earmarked Grants)

This project proposes to develop a low level birefringence detection (LLBD) system and apply it to the study of stresses in various ultrathin film/substrate systems. The LLBD system measures the stress-induced birefringence using a modulation technique so that the sensitivity can be greatly enhanced compared with conventional methods. The system will first be applied to study the stresses in ultrathin silicon dioxide/silicon system, which is of particular technological importance. The effects of oxidation ambient, wafer type, doping level, orientation and oxidation process parameters can be studied. Extension of the applications of this system to study other materials systems will also be explored.

(CU02370)

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**A Highly Efficient Modal Analysis Methodology for Integrated RF Passive Circuits with Finite Metallization Thickness**

✉ WU Ke Li

□ 1 November 2002

❖ Research Grants Council (Earmarked Grants)

The proposed research aims at developing a highly efficient yet accurate EM simulation methodology for tackling the problem in a semi-analytical manner. The methodology to be developed will be EM modal analysis based, and will be combined with numerical integral equation methods or Finite Element Method (FEM) so that it will take maximum advantage of analytical manipulations of modal analysis while preserving the desirable flexibility of pure numerical techniques.

The deliverables of the research include a novel and state-of-the-art electromagnetic simulation scheme tailored to miniaturized Integrated Passive Device (IPD) and prototypes of market-driven IPD modules for technology transfer to local wireless industry. The output from the research will lay a concrete technical foundation for local electronics industry to get ahead of the current technology in a short time and build up design capability of IPD in Hong Kong.

(CU02371)

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**Engineering and Characterization of Organic Electronic Films and Devices by Scanning Probe Microscopy**

✉ XU Jianbin • KWOK H L Harry\* • LAU Leo Woon Ming (Dept of Physics)

□ 15 October 2002

❖ Research Grants Council (Earmarked Grants)

Organic electronic materials are of widespread interest in science and technological applications. Organic films, such as Alq<sub>3</sub>, CuPc, short-chain oligomers, and conjugated polymers, have numerous potential applications in plastic electronics and opto-electronics such as field effect transistors (FETs), organic light emitting devices (OLEDs), optical switches, optical displays, and portable electronic systems. OLEDs emit light when they are stimulated by an electric current. They use much less power than normal incandescent bulbs, and can last much longer, so they have potential applications in flat LED computer displays and TV screens. Organic electronic devices are envisaged for portable electronics thanks to their good mechanical properties.

Therefore studies of the nature of organic films, their deposition processes and their properties (electrical, optical, and chemical) are of technological importance. The correlation between the microscopic features of the materials and their electrical properties, such as carrier mobility, carrier concentration, and electric potential distribution, is of fundamental interest for understanding an optimizing these properties. In this project we propose to study the properties of organic films and devices by means of scanning probe microscopy, which enables us to achieve extremely high resolution down to the nanometer scale.  
(CU02372)

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

Edition      Title/Investigators

- |         |   |
|---------|---|
| 2001-02 | Generation of 3D Wireframe Face Model from Movies and Face Animation (CS01167)<br>✉ CHAM Wai Kuen • TSUI Hung Tat   |
| 2000-01 | 900 and 1800 MHz Digital Controlled Oscillators for Wireless Communication (CU00218)<br>✉ CHAN Cheong Fat • CHOY Chiu Sing Oliver   |
| 2001-02 | A 900 MHz Double-IF Receiver Integrated Circuit (EE01709)<br>✉ CHAN Cheong Fat  |
| 1999-00 | Stability Improvement Studies of Harmonic Active Mode-locking of Fiber Ring Lasers (CU99434)<br>✉ CHAN Kam Tai • HO HO-pui, Aaron*  |
| 2000-01 | High-energy and High-repetition Rate Mode-locked Fiber Laser (EE20013)<br>✉ CHAN Kam Tai  |
| 2001-02 | Study of Coherent and Incoherent Optical Pulse Coding Techniques for Fiber-Optic CDMA (EE01169)<br>✉ CHAN Kam Tai • LOU Caiyun*   |
| 2000-01 | Harmonic Tuning of Source and Load Impedance to Improve Phase Linearity of Microwave Power Amplifiers for Wireless Digital Communications (CU00210)<br>✉ CHENG Kwok Keung Michael |

<p>2001-02 Novel RF Power Amplifier Linearization Techniques for Next Generation Wireless Communication Systems (EE01174) ✉ CHENG Kwok Keung Michael</p>	<p>2001-02 A CMOS RF Front-end Chip for 3G WCDMA Applications (EE01690) ✉ PUN Kong Pang</p>
<p>2001-02 CMOS Implementation of RF Predistortion Circuits for Mobile Phone Application (EE01440) ✉ CHENG Kwok Keung Michael</p>	<p>2000-01 A New Family of Electrically Wavelength-tunable Semiconductor and Fiber Lasers (CU00220) ✉ SHU Ching Tat C. • TSANG Hon Ki • CHIANG Kin Seng*</p>
<p>2001-02 Adaptive Beamforming and Spectral Filtering for Speech Source Tracking and Recognition (EE01175) ✉ CHING Pak Chung • SO Hing Cheung* • WONG Kon Max</p>	<p>2001-02 Ultrafast Photonic Analog-to-digital Converters (EE01680) ✉ SHU Ching Tat C. • LIU Hai Feng* • CHIANG Kin Seng*</p>
<p>2000-01 Design of an IP Asynchronous Cross-pipelined 16x16-bit Multiplier (EE20014) ✉ CHOY Chiu Sing Oliver</p>	<p>2000-01 Measurement of All-optical Nonlinearities in Ion-Implanted Materials (CU00221) ✉ TSANG Hon Ki • WONG Sai Peng Joseph</p>
<p>2001-02 A Contactless Java Card Chip Using Asynchronous Circuit Techniques (EE01176) ✉ CHOY Chiu Sing Oliver • CHAN Cheong Fat</p>	<p>2001-02 Components for Next Generation All-Optical Wavelength-Division-Multiplexing Networks (EE01192) ✉ TSANG Hon Ki • SHU Ching Tat C.</p>
<p>2000-01 Development of a Cantonese Text-to-Speech System with High Naturalness (CU00219) ✉ LEE Tan • MENG Mei Ling Helen (Dept of Systems Engineering &amp; Engin. Management) • ZEE Yun Yang Eric*</p>	<p>1999-00 3-D Model-based Video Coding for Videoconferencing Applications (CU99402) ✉ TSUI Hung Tat • CHAM Wai Kuen • NGAN King Ngi*</p>
<p>2001-02 Use of Prosodic Information in Chinese Continuous Speech Recognition (EE01206) ✉ LEE Tan • XU Bo*</p>	<p>1999-00 Electrical Transport Properties of Ion Beam Synthesized Low Dimensional Metal Silicide Structures (CU99405) ✉ WONG Sai Peng Joseph</p>

2000-01	Nano-granular Metal-carbon Thin Films by Pulsed Filtered Vacuum Arc Deposition (CU00216)	1999-00	Passivation and Oxidation of Group IV Semiconductors Studied by Scanning Probe Microscopy (CU99390)	Millimeter Wave Wireless Communication Systems (EE01202)
	✉ WONG Sai Peng Joseph		✉ XU Jianbin • KWOK Wai Man Raymund (Dept of Chemistry) • WILSON Ian Howard • Devine R A B*	✉ WU Ke Li
2001-02	Enhancement of Electron Field Emission Properties by Surface Engineering and Ion Beam Processing (EE01200)	2000-01	Size Effects of SrBi <sub>2</sub> Ta <sub>2</sub> O <sub>9</sub> (SBT) Ferroelectric Thin Films (CU00214)	
	✉ WONG Sai Peng Joseph		✉ XU Jianbin • WILSON Ian Howard • WONG Sai Peng Joseph	
2001-02	A Multi-institutional Effort to Establish an Advanced Surface Technology Development Centre (EE01769)	2000-01	The Formation of Metal Nano-clusters in Dielectric Materials by Ion Gettering (CU00215)	
	✉ WONG Sai Peng Joseph • LAU Leo Woon Ming (Dept of Physics) • WONG Hong Kuen (Dept of Physics) • TSUI Yun Cheong Ricky* • YEUNG Lee Kin Kinny* • ONG Chung Wo*		✉ XU Jianbin	
1999-00	Design Methodology of Advanced Multi-chip Modules Using LTCC Technology for Wireless Applications (EE99040)	2001-02	Engineering and Characterization of Low-Dimensional Group IV Materials by Scanning Probe Microscopy (EE01203)	
	✉ WU Ke Li • CHENG Kwok Keung Michael • SMITH W Richard* • CHEN Xiao Jian*		✉ XU Jianbin • HE James Zhongqing#	
2000-01	Simulation and Design Methodology of Advanced Multi-Chip Module (MCM) System for Wireless Communication Applications (CU00213)	2001-02	Development of Medical Devices and Nano-biosensors to Promote Biomedical Electronic industry in Hong Kong (BL01873)	
	✉ WU Ke Li • CHENG Kwok Keung Michael		✉ ZHANG Yuanting • CHAN Kam Tai • CHING Pak Chung • WONG Sai Peng Joseph • LEE Tan • HENG Pheng Ann (Dept of Computer Science and Engineering) • LEONG Philip Heng Wai (Dept of Computer Science and Engineering) • CHENG Chun Yiu Jack (Dept of	
2001-02	Integrated LTCC Antenna Array and Front-end Passive Modules for			

Orthopaedics & Traumatology) •  
SUNG Joseph Jao Yiu (Dept of  
Medicine & Therapeutics) • WOO  
Jean (Dept of Medicine &  
Therapeutics) • NG Ho Keung (Dept  
of Anatomical & Cellular Pathology)  
• LI Wen Jung (Dept of Auto. &  
Computer-Aided Engin.) • TSUI  
Kwok Wing (Biochemistry) •  
WAYE Mary Miu Yee

(Biochemistry) • FUNG Kwok Pui  
(Biochemistry) • CHUNG Sheung  
Chee Sydney (Dept of Surgery) •  
LEE Cheuk Yu (Biochemistry)# •  
CHOU Chien\* • DOV Jaron\* • LU  
Z H\* • ONARAL B\* •  
POURREZAEI Kambiz\* •  
TAMURA T\* • XU Y H\*

## RESEARCH PROJECTS

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### Novel Schemes to Alleviate the Intrinsic Detrimental Effects of In-line Semiconductor Optical Amplifiers in Optical Transmission Systems

✍ CHAN Chun Kit • CHEN Lian Kuan

□ 1 September 2002

❖ Research Grants Council (Earmarked Grants)

Semiconductor optical amplifiers (SOA) have recently found a lot of applications in nonlinear all-optical signal processing including wavelength conversion, all-optical regeneration, etc, due to its fast gain dynamics. Also, it can be integrated to other devices and potentially low cost. Thus SOA is a key enabling component to enhance the transmission capacity and networking capability of optical fiber systems. However, such intrinsic fast gain dynamics, in contrast, induces detrimental effects when SOAs are used as in-line transmission amplifiers. Waveform distortion and crosstalk are resulted when they are operated in gain-saturated regime. These impairments hinder the deployment of SOAs in metropolitan optical systems.

In this project, we study the intrinsic detrimental phenomena in SOAs when they are used as in-line amplifiers in optical transmission systems. Then we study and propose novel schemes to effectively alleviate the saturated-gain-induced waveform distortion in single-wavelength transmission as well as to suppress the unwanted cross-gain modulation induced crosstalk in multiple-wavelength optical systems.

(CU02386)

### Optical Networking Techniques Using High-speed Constant Intensity Modulation

✍ CHAN Chun Kit

□ 1 October 2002

❖ CUHK Research Committee Funding (Direct Grants)

In conventional optical systems, data is carried on the optical carrier by means of intensity modulation. However, the refractive index of the optical fiber is intensity dependent, thus the refractive index of the transmission medium changes according to the data patterns. This gives rise to nonlinear effects such as self-phase modulation and cross-phase modulation that result in signal distortions. Therefore, it is desirable to have a constant intensity modulation technique, which can have much higher tolerance against those undesirable optical nonlinear effects. With the advent of high-speed (10Gb/s) optical phase modulators recently, optical phase modulation becomes a feasible approach to achieve high-speed constant intensity modulation.

In this project, we propose and investigate two novel schemes in applying optical phase modulation technique in optical networking applications. The first scheme is to put a phase-modulated optical header/framing signal in front of a multiplexed stream of data packets in an optical packet-switched network. After the data packet stream arrives at a network node, the intensity of the optical framing signal will be greatly enhanced due to the fiber dispersion induced phase-to-amplitude conversion effect. The obtained intensity difference between the optical framing signal and the data packets can greatly facilitate the framing signal extraction and also the frame synchronization in optical packet-switched networks. The second scheme is to multiplex a slow non-return-to-zero (NRZ) signal,



which carries the network control information, onto a high-speed optical phase modulated data stream. This scheme is useful to distribute the network routing or status information without having an additional optical supervisory wavelength channel, thus facilitates the optical network management.

(EE02749)

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**Investigation of a Novel Polarization Mode Dispersion (PMD) Compensator**

✉ CHEN Lian Kuan • CHAN Chun Kit

□ 1 January 2003

❖ CUHK Research Committee Funding (Direct Grants)

This proposal is to investigate a polarization mode dispersion (PMD) compensation module for optical transmission systems at 40 Gb/s or above. One of the most prominent limitations for high-speed OC-768 (40 Gb/s) systems is the PMD distortion. In this project, a fast polarization controller will be developed for PMD mitigation. The device has fast tracking speed and has a potential for compact packaging and low-cost implementation. Then the device will be characterized and used to implement a first-order PMD compensation module. The device will be implemented with technical support from O-Net on the packaging part and processing of discrete optical component.

(EE02751)

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**Design of Medium Access Control Providing IP QoS for CDMA-based Mobile Communication System**

✉ LEE Tong Tony

□ 1 October 2002

❖ Research Grants Council (Earmarked Grants)

Recent years have witnessed tremendous research to all-IP broadband mobile networks. One of the most important issues is to provide diverse quality of services (QoS) to multimedia applications. The design of the Medium Access Control (MAC) protocol is crucial to achieve the QoS demands. Meanwhile it is also important to utilize the limited radio resources efficiently. In this project, we propose a MAC protocol and its related scheduling architecture in the context of mobile networks using Code Division Multiple Access (CDMA). The proposed MAC protocol adopts the request-and-allocation scheme while the request transmission works in a contention mode. To avoid contention especially in heavy load situation, we introduce mini-slots in both time and code domain in addition to the piggyback mechanism, which reduces contention delay and bandwidth waste. We group packets into the same time slot in transmission according to their bit-error-rate (BER) requirements, promoting the transmission throughput and saving power at the terminal as well. The scheduler to accommodate IP flows with different QoS requirements adopts a two-staged architecture. First, flows are classified as real-time and non-real-time. Then real-time flows are scheduled in fair manner while non-real-time flows in a round-robin pattern. The unique properties of wireless channels such as time-varying and location-dependent errors are considered in our MAC protocol and scheduling algorithms. This will further improve the resource utilization while maintain fairness in both long and short terms. We believe that the outcome of this project will contribute to the evolving 3G and beyond 3G mobile communication networks.

(CU02380)

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**Design, Analysis, and Implementation of a Super-Scalar Architecture for Large-Scale Video-on-Demand Services**

✉ LEE Yiu Bun

□ 1 September 2002

❖ Research Grants Council (Earmarked Grants)

Despite the availability of video-on-demand (VoD) services in a number of cities around the world, large-scale, city-wide deployment of VoD services is still economically impractical. The key problem is that resource requirements in existing VoD systems increase at least linearly with the system scale. This research programme addresses this challenge by investigating super-scalar architectures for building very large-scale and efficient VoD systems. Unlike conventional VoD systems, super-scalar architectures exhibit increasing efficiency as one scales up the system. Therefore, for these super-scalar architectures the system actually becomes more cost-effective when being scaled up. In this research programme, we will thoroughly investigate architectural alternatives and system designs for building super-scalar VoD systems. Design tradeoffs will be identified and analyzed using mathematical analysis and simulation. We will implement a complete system prototype using off-the-shelf hardware and software to prove its feasibility. Our pilot studies have produced very encouraging results and we expect the proposed architecture to offer a cost-effective and easy to deploy solution for large-scale VoD services.

(CU02328)

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**Novel Power Control Schemes for Multicode DS/CDMA Systems**

✉ LOK Tat Ming • WONG Tan F\*

□ 1 November 2002

❖ CUHK Research Committee Funding (Direct Grants)

With the stringent requirements on quality of service and user capacity for future cellular systems, new system designs and communication technologies have to be developed. To allow smooth transition from current systems, however, these new designs and technologies should be readily harmonized with current standards. In this project, we consider multicode CDMA systems, which are compatible to wideband CDMA (WCDMA) systems. We propose and study novel power control schemes in these multicode CDMA systems. Power control is a key element in CDMA systems. However, traditional power control schemes do not exploit the full potential of power control. On the other hand, in multicode systems, there is room to apply innovative power control schemes, which could significantly improve the performance of the systems. We would study power control in multicode systems with different designs. We would formulate optimization problems whose solutions should yield optimal power control schemes. We would also study iterative algorithms that are easy to implement. The results would be practical algorithms that should be valuable to the telecommunication industry.

(EE02757)

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**Negotiation Agents that Learn and React to Changing Market Situations**

✉ SIM Kwang Mong

□ 1 November 2002

❖ CUHK Research Committee Funding (Direct Grants)

The task of negotiation can often be difficult and time consuming. Even though there are many existing automated bargaining and negotiation systems, they are not designed to respond to changing market situations. The conditions for deliberation often change as new opportunities and threats are constantly being introduced when traders enter and leave a market. A previous research by Sim (the PI) addressed the issue of changing market situation by engineering *market-driven agents* to bolster automated negotiation. Sim's market-driven agents determine the best course of actions by considering (1) intrinsic constraints such as approaching deadlines and resource need, and (2) external influences such as degree of competition and opportunities. Theoretical and empirical results obtained by Sim (published in 2 IEEE Transactions, 1 International Journal and 2 conference papers) showed that by considering dynamic adjustment of bids, *market-driven agents* generally outperformed fixed strategies agents (those that do not consider changing market conditions). However, unlike some negotiation agents with learning capabilities such as *Bazaar*, and *SMACE*, market-driven agents are not designed to improve their performance over time, but *Bazaar*, and *SMACE* did not consider the issue of changing market condition. The goal of this research is to develop negotiation agents that both (1) react to changing market conditions and (2) improve their performance over time by learning about the trading patterns and preferences of other agents. This research focuses on devising a learning technique for market-driven agents, which may be a combination of *Bayesian learning*, *reinforcement learning*, and *genetic-based learning*.

(EE02331)

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### Video Based Character Recognition

✉ TANG Xiaoou • PISSALOUX Edwige\* • ZHANG Hong Jiang\*

□ 1 August 2002

❖ Research Grants Council (Earmarked Grants)

In this work, we conduct a systematic investigation of video-based character recognition utilizing both the temporal information and the character spatial structure information contained in video sequences. Especially we develop new algorithms addressing an important application: mobility aid for visually impaired elderly. Our video-based character recognition system will supply a robot-type mobility-aid vehicle for the visually impaired with such valuable directional and location information as office names, direction pointers in corridors, exits/entrances identifications, information tables, canteen and lavatory locations, etc. The information will help a mobility-aid system to guide a visually impaired elderly person to navigate in a nursing home or hospital independently.

(CU02357)

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### On the Constant Weight Codes: Bounds, Constructions and Applications

✉ WEI Keh Wei Victor

□ 1 August 2002

❖ Research Grants Council (Earmarked Grants)

Constant weight codes play an important role in coding theory and have many applications in computer and communication systems. One of the most fundamental problems in coding theory is the problem of determining the maximum size of a constant weight code, given its length, minimum distance and weight. Many researchers around the world are working on constructing good constant weight codes and finding good lower and upper

bounds. A classical problem of the information theory is to estimate the probabilities of undetected and decoding errors when a block code is used for information transmission over a binary symmetric channel. In this project, we propose to study some aspects of constant weight codes, including new construction methods, new good bounds for the maximum size, new properties and bounds for the probabilities of undetected and decoding errors. These results will shed important light on the important properties and applications of constant weight codes, and the solution of the two fundamental and hard problems in coding theory and information theory.

(CU02329)

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**Code Allocation in Multi-Rate Spread Spectrum  
Wireless Systems**

✉ WONG Wing Shing • SUNG Chi Wan\*

□ 1 October 2002

❖ Research Grants Council (Earmarked Grants)

Wireless telephony has taken up an increasingly essential role in our modern society. With the introduction of 3G systems, it is envisioned that wireless multi-media applications will also proliferate. To support multi-media applications, the wireless infrastructure has to support multi-rate channels. Since 3G and “beyond 3G” systems will be mostly based on spread spectrum technologies, the issue of designing algorithms to efficiently support wireless multi-rate channels on spread spectrum, particularly Direct Sequence Code Division Multiple Access (DS-SS), systems is an important research problem.

In this proposed study, the focus will be centered on finding efficient algorithms to assign code sequences and transmission schedules to users in order to satisfy

their specific data rate and Quality of Service requirements. There will be two main tasks in this study. The first study is focused on the performance of accessing schemes based on the concept of Most Regular Code Sequence. In the second study, the objective is to design efficient accessing schemes for asynchronous uplink channels. The problem can be transformed to a task of finding distributed algorithms that can dynamically adjust the code assignment and power level allocation to meet the given set of performance target.

The solutions of these problems could lead to better design of multiple accessing schemes. In particular, system throughput can be increased without requiring an increase of the radio spectrum. The anticipated results will help engineers design better wireless systems beyond 3G.

(CU02366)

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**Quantum Information Theory**

✉ YEUNG Wai Ho Raymond

□ 1 October 2002

❖ CUHK Research Committee Funding (Direct Grants)

Information processing based on quantum mechanic principles finds applications in computing, communications, and cryptography. A quantum computer can solve in polynomial time certain problems which can only be solved in exponential time by conventional computers. Quantum cryptography can also provide security for information at levels which are impossible by using conventional cryptographical techniques. Due to these overwhelming advantages over conventional information processing, quantum information processing has become an important theoretical research area, although implementation of quantum

computers is still in its infancy. (As an example, all existing public key cryptosystems can be broken with quantum computing!)

The classical conditional entropy  $H(X|Y)$  refers to the entropy of a random variable  $X$  when a random variable  $Y$  is given. In Quantum Mechanics, the word “given” can be interpreted as “the measurement results of systems  $Y$  is GIVEN to system  $X$ ” or “the state of System  $Y$  is GIVEN to System  $X$ ”. In classical information processing, both interpretations of “given” give the same physical result because we only have orthogonal basis measurements in the classical world, but this is not the case in Quantum Mechanics.

We have investigated different definitions of conditional entropy in Quantum Information Theory and have proposed new definitions of conditional entropy and mutual information. Using this new definition of conditional entropy and assuming that the quantity of entanglement is an intrinsic property between the two parties involved, a new measure of entanglement is naturally induced. By this new measure of entanglement, we are able to explain why the amount of entanglement is equal to the entropy of any one of the two parties for a pure state.

Entanglement is an important concept in Quantum Information Theory because it does not exist in the classical theory and it can be made use of beneficially in many different areas. Our main objective in this project is to find a way to separate and quantify classical correlation, quantum correlation, and entanglement by the new definition of conditional entropy. Entanglement, conditional entropy and mutual information are fundamental concepts in Quantum Information Theory. A better understanding of these concepts may lead to further results in topics in Quantum Information Theory such as channel capacity. Also, these fundamental studies in Quantum Information Theory may shed

new light in Quantum Mechanics.

(EE02836)

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### OVSF Code Assignment Strategies

✉ YUM Peter Tak Shing

□ 15 December 2002

❖ Research Grants Council (Earmarked Grants)

In UTRA (Universal Terrestrial Radio Access) systems, orthogonal variable spreading factor (OVSF) codes are used to support different transmission rates for different users. As different transmission rates are realized by the use of different spreading factors, this limits the choice of codes that can be economically used. Moreover, the allocation of channels in 3G systems is on a call-by-call basis, thus the allocation of OVSF codes must also be performed dynamically. We propose to *design* and *analyse* the code assignment strategies based on certain optimization criterion. The criterion we choose is the assignment flexibility of the code set. This choice is, in our opinion, quite intuitive as whichever code is used to serve a given call the resulting code set must be maximally flexible in accommodating future multi-rate call requests. Thus we first define an index for measuring the flexibility of an assignable code set. Based on this flexibility index, the *non-rearrangeable* and *rearrangeable compact assignment* schemes are designed and analyzed.

(CU02325)

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

<u>Edition</u>	<u>Title/Investigators</u>
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<p>2001-02 Performance Supervision for Multiple Optical Amplifiers in WDM Transmission Systems (EE01761) ✍ CHAN Chun Kit</p>	<p>2000-01 Hong Kong IP Multicast Initiative (EE20005) ✍ LEE Yiu Bun • CHEN Lian Kuan • LUI Chi Shing John (Dept of Computer Science and Engineering)</p>
<p>1999-00 Channel Tunable Mode-Locked Lasers for High Speed Optical Networks and Optical Signal Processing (CU99372) ✍ CHEN Lian Kuan • TONG Fuk Kay Franklin • HO Keang Po Ricky#</p>	<p>2001-02 Improving Disk Efficiency in Continuous-Media Servers with Soft-scheduling (CS01209) ✍ LEE Yiu Bun • LUI Chi Shing John (Dept of Computer Science and Engineering)</p>
<p>2000-01 System Limitations of Optical Networks due to Crosstalk (CU00225) ✍ CHEN Lian Kuan • TONG Fuk Kay Franklin</p>	<p>2001-02 Study of a Peer-to-Peer Architecture for Building Scalable, Reliable, and Cost-Effective Video-on-Demand Services (EE01594) ✍ LEE Yiu Bun</p>
<p>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</p>	<p>2000-01 Telecommunication Network Research (EE95746) ✍ LI Shuo-yen Robert</p>
<p>1999-00 Design and Analysis of Scheduling Algorithms in Input-Queued Switches Supporting IP-over-ATM (CU99398) ✍ LEE Tong Tony</p>	<p>2000-01 Integrated Retransmission and Adaptation Scheme for Video Streaming over Legacy and Advanced Internet with QoS Guarantee (CU00229) ✍ LIEW Soung Chang • LEE Yiu Bun</p>
<p>2001-02 Design of Large-Scale Fibre Channel Fabric for Storage Area Network (CS01208) ✍ LEE Tong Tony • CHAN Man Chi#</p>	<p>1999-00 MC/DS/CDMA as the Radio Technology for Wireless Multimedia Communication (CU99420) ✍ LOK Tat Ming • WONG Wing Shing</p>
<p>1999-00 Scalable and Fault-Tolerant Video-on-Demand Systems – Design, Analysis, Prototyping, and Performance Evaluation (CU99095) ✍ LEE Yiu Bun</p>	<p>2000-01 Adaptive Transmitter Design for Wideband Communication (EE20017) ✍ LOK Tat Ming</p>

<p>2000-01 Towards Agency and Ontology for Web-based Information Retrieval (EE20023) ✉ SIM Kwang Mong</p>	<p>Kit • CHEUNG Kwok Wai • WU Ke Li (Dept of Electronic Engineering) • CHAN Kam Tai (Dept of Electronic Engineering) • WONG Sai Peng Joseph (Dept of Electronic Engineering) • LI Wen Jung (Dept of Auto. &amp; Computer-Aided Engin.) • WANG Michael Yu (Dept of Auto. &amp; Computer-Aided Engin.)</p>
<p>2001-02 Agents that Negotiate and Brokers (EE01329) ✉ SIM Kwang Mong</p>	<p>2001-02 Investigation of Low-Cost Modulator for a Proposed DWDM Access Network (CS01191) ✉ TONG Fuk Kay Franklin • CHAN Chun Kit • CHEN Lian Kuan</p>
<p>1999-00 Global and Structural Pattern Recognition for Large-Set Databases (CU99378) ✉ TANG Xiaoou • GRIMSON William Eric Leifur* • LIU Jian Zhuang*</p>	<p>1999-00 On the Performance Bounds of Turbo Codes (CU99424) ✉ WEI Keh Wei Victor</p>
<p>2000-01 Automatic Human Face Sketch Recognition (EE20018) ✉ TANG Xiaoou</p>	<p>1999-00 Hong Kong Cyber Campus – Towards Networking all Schools in Hong Kong (ED99003) ✉ WONG Po Choi</p>
<p>2001-02 Face Image and Sketch Recognition (CS01190) ✉ TANG Xiaoou • GRIMSON W Eric L* • LAM Kai Pui (Dept of Systems Engineering &amp; Engin. Management)</p>	<p>2000-01 Power Control for Wireless Multimedia System in a Fading Environment (CU00222) ✉ WONG Wing Shing • YAU Shing Toung Stephen* • CAINES Peter Edwin*</p>
<p>2000-01 Homodyne Crosstalk Reduction using FP Laser Diode (CU00228) ✉ TONG Fuk Kay Franklin • HO Keang Po Ricky# • TSANG Hon Ki (Dept of Electronic Engineering)</p>	<p>2000-01 Fundamental Limits in Information Storage Systems (CU00165) ✉ YEUNG Wai Ho Raymond</p>
<p>2000-01 Photonic Packaging Laboratory (EE00750) ✉ TONG Fuk Kay Franklin • SHU Ching Tat C. (Dept of Electronic Engineering) • TSANG Hon Ki (Dept of Electronic Engineering) • CHEN Lian Kuan • CHAN Chun</p>	

- 1999-00 Efficient Multicast Routing for  
Multimedia Videoconferencing  
(CU99371)      ✍ YUM Peter Tak Shing • TONG Fuk  
Kay Franklin
- ✍ YUM Peter Tak Shing
- 2000-01 Architecture for IP Operating on WDM  
(CU00223)



## RESEARCH PROJECTS

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### Grouping Models in Ready-to-Assembly Products

✍ CHENG Chun Hung

□ 1 December 2002

❖ CUHK Research Committee Funding (Direct Grants)

In this research, we focus on the development of generic grouping models and various solution techniques based on branch-and-bound algorithms and genetic algorithms. These models and methods will be applied to Ready-to-Assemble products and other related industrial applications.

Ready-to-Assemble (RTA) product offerings consist of parts and subassemblies packed in cartons that are typically assembled by customers. Just RTA furniture alone, the total sales in 2000 exceeded US\$2 billion. *In spite of the large size of the industry, few researchers have investigated issues related to RTA business.*

RTA products are unique in the sense that the customers contribute to the value adding activity of the assembly process. Unlike trained factory workers, the level of capability and skill of the customers can vary significantly. Hence, in addition to products being designed for easy assembly, it will be desirable to pay special attention to the kitting and packaging of the products. A logical grouping of parts in the kitting and packaging will be useful in facilitating handling, assembly, and replacement.

(EE02945)

### Optimal Booking Control on Multi-Leg Flights

✍ FENG Youyi

□ 1 August 2002

❖ Research Grants Council (Earmarked Grants)

This project explores the optimal booking control on the multi-leg flights of the airline reservation systems. The prior objective of the project is to develop effective and efficient algorithms to replace the existing single-leg models which are widely used in the airline reservation systems. In the meanwhile the project identifies the structural properties of the optimal booking control. These structural properties are even more crucial than the multi-leg optimal booking control itself. They will guide the seat inventory managers with the precise revenue management rules such as which seats should be cheaper and which seats should be more expensive. In addition, these properties will shed lights on the optimal booking control for the general airline networks. To innovate the effective reservation controls for the general networks, understanding of these properties on the multi-leg flights will help establish appropriate decision guidance to the ticketing processes in the general origin-destination booking controls.

The booking or seat inventory control on the multi-leg flights particularly have a great impact on many airlines in the *Asia* and *Pacific* area. To our best knowledge, these airlines are ordinarily scheduling a large number of flights with one or more stops. The algorithmic optimization models on the booking control of the multi-leg flights will directly strengthen the capability of the revenue management for these airlines. Moreover, the optimization models for the multi-leg booking control essentially are applicable to the airline serial networks and the joint or package sales of the hotel room, tourist plans and airline seats. Tourist, hotel and air travel are the backbone of Hong Kong service industries which occupy the largest proportion of the economic and

production throughput. The completion of the project will benefit these industries in Hong Kong by increasing their efficiency of managing revenue.

(CU02320)

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**A Knowledge Management System Based on Chinese Text Clustering and Classification Algorithm**

✉ LAM Wai • WONG Kam Fai William • LAM Ringo\*

□ 1 August 2002

❖ University-Industry Collaboration Prog.: Matching Grant for Joint Research, ITF, Innovation & Tech. Commission • Wisers Information Limited

Objectives of the project are (1) to research in Chinese text clustering and classification techniques, which will improve service quality of Wisers\*; and (2) to develop the techniques into a generic knowledge management solution development platform, which will increase the company's competitiveness in the growing knowledge management market.

Wisers is a local company focusing on electronic news management. It provides on-line news categorized according to some ad-hoc classification schemes. As the market grows and the demands of the clients increased, their current classification practice is no longer effective. At present, Wisers has to mix with intensive human effort to keep up with the demanding precision level. This project investigates the application of intelligent clustering and classification techniques in order to automate and improve the precision of the Wisers's categorization process. The result will improve quality of service and operation efficiency and widen the business scope of Wisers from data-/information- to knowledge-management.

(CS02112)

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**A Theoretical Framework of Nonlinear Lagrangian Theory**

✉ LI Duan

□ 1 November 2002

❖ CUHK Research Committee Funding (Direct Grants)

Optimization problems with constraints are often encountered in real-world decision-making with resource limitations. The primal-dual method on the Lagrangian theory is one of the most powerful solution methodologies in tackling constrained optimization problems. The traditional Lagrangian theory can be classified as a linear Lagrangian theory since the Lagrangian functions is linear in terms of the objective function and the constraints. In convex situations, the existence of a saddle point guarantees the success of the dual search via a sequential minimization of the linear Lagrangian function. In nonconvex situations, however, the conventional linear Lagrangian method often fails to locate the local and/or global optimal solutions of the primal problem due to the existence of a duality gap. The recent literature has seen an extension from the traditional linear Lagrangian theory to a nonlinear Lagrangian theory to guarantee the identification of an optimal solution of the primal problem via a dual search. Further advancement of nonlinear Lagrangian theory and its applications will have a significant impact on the economic benefits by performing optimization in operations and management.

The primary goal of this project is to further study fundamental properties of nonlinear Lagrangian theory such that a unified theoretical framework can be established for development of nonlinear

Lagrangian theory. Certain numerical implementation issues will be also addressed. The overall research goal will be achieved by carrying out the following two research tasks:

- (1) To establish a unified theoretical framework for the nonlinear Lagrangian theory; and
- (2) To derive new classes of nonlinear Lagrangian functions that can be adopted to successfully identify an optimal solution of the primal problem.

The research outcome from this proposed research should be applicable to a wide range of real-world optimization problems, and the derivation of a theoretical framework of nonlinear Lagrangian theory will advance the state-of-the-art in the above-mentioned academic challenge.

(EE02531)

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### The Use of Belief Networks for Mixed-Initiative Dialog Modeling

✉ MENG Mei Ling Helen

☐ 1 October 2002

❖ Research Grants Council (Earmarked Grants)

Continual advancements in multilingual speech and language technologies have brought the emergence of a diversity of spoken dialog systems (SDS) that support goal-oriented human-computer conversations in restricted domains. The *dialog model* (DM) in a SDS is critical for the system's usability. It constrains *what* the user may ask, *how* the question may be phrased and *when* the request may be issued during the dialog session. The *system-initiative* (DM) assumes complete control by prompting for user input stepwise. Such predictability often leads to high task completion rates, but is inflexible for use. The *user-initiative* dialog model offers maximum flexibility by processing free-form queries, but these

may fall beyond the system's competence level which hinders task completion. The *mixed-initiative* (MI) dialog model strikes a balance by allowing the dialog initiative to shift strategically in between system and user in order to converge on a solution for the task at hand. Hence the MI model can potentially achieve high task completion rates and user satisfaction. This project investigates the use of Belief Networks (BNs) as a principled methodology for MI dialog modeling. BNs are directed acyclic graphs for organizing knowledge and can make predictions and decisions under uncertainty by applying Bayes rule. They offer a probabilistic framework for inferring the communicative goal of the user's request, capturing domain-specific constraints for language understanding and selectively inheriting discourse for a coherent dialog. Trainability of the BN framework also enhances portability and scalability across domains. Such properties are conducive towards the widespread provision of speech-enable information services.

(CU02326)

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### Towards Multi-modal Human-computer Dialog Interactions with Minimally Intrusive Biometric Security Functions

✉ MENG Mei Ling Helen • CHING Pak Chung (Dept of Electronic Engineering) • LEE Tan (Dept of Electronic Engineering) • MOON Yiu Sang (Dept of Computer Science and Engineering) • TANG Xiaoou (Dept of Information Engineering) • MAK Man Wai\* • MAK Brian\* • SIU Man Hung\*

☐ 28 June 2003

❖ RGC Central Allocation • Supplementary Funding for RGC Central Allocation

This project aims to develop human-centric interface

technologies to support secure computing by a diversity of users in a variety of usage contexts. Human-centric interface technologies embrace the user's natural communicative modalities at the center of human-computer interaction (HCI). For example, the user can speak and point to the computer, and the computer can "see" the user's face through the camera, "hear" the user's spoken commands via handsets and microphones, and "sense" the user's touch during pointing with his fingers/stylus pens/mice. As computing permeates our everyday lives, security to computers, networks and content becomes an issue of prime importance. Classical user authentication relies on tokens and passwords that may be easily lost or forgotten. The problem can be overcome by biometric authentication, i.e. verifying the claimant's identity based on his physiological/behavioral characteristics such as facial features, speech and fingerprints. User authentication should also be transparent to the human-computer interaction. In this project, we will focus on a speak-and-point interface secured with facial identification, speaker and fingerprint authentication on a mobile platform that presents a variety of usage contexts. Our team's expertise achieves full coverage of the entire spectrum of technologies in our proposed research agenda. By timely collaboration across institutions and engineering disciplines, we have a uniquely competitive position in the international research scene to make significant technological contributions. (EE02512)

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**XML Database: Technology and Applications**

✉ WONG Kam Fai William • LAM Wai • YANG Christopher Chuen Chi • YU Jeffrey Xu

□ 1 June 2003

❖ CUHK Strategic Research Program

XML poses many new challenges to different aspects of data and knowledge management for Internet applications. This strategic research program aims to investigate five important and inter-related technical issues in XML database and further study their practicality in a very large-scale real world application. Specifically, the program will involve the following research projects:

- (1) *Native XML database.* Investigate ways in building efficient semi-structured data management systems specifically for XML data.
- (2) *Parallel XML data processing.* Conduct in-depth studies to understand how to construct high performance systems for managing large quantities of XML data. This will involve research in parallel database and computing.
- (3) *Web mining.* Research into novel mining techniques for extraction of relevant XML-based data, which may be originated from multiple Web sites.
- (4) *XML assisted temporal information processing.* Study how to use XML tags to facilitate temporal information management and inference.
- (5) *XML-based news management.* Investigate the use of XML for effective news clustering delivery, etc.
- (6) *XML for Chinese medicine database.* Research and develop an XML-based information infrastructure to facilitate information sharing of different Chinese medicine databases.

(EE02536)

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**Digital Asset Management System - NewsML CIDAX Gateway**

✉ WONG Kam Fai William • FUNG Ivan\*

□ 1 June 2003

- ❖ Hong Kong Science & Technology Parks Corp.
  - LinkPOWER Tech. Co. Ltd.

CINTEC and LinkPOWER will co-develop a Digital Asset Management System – NewsML CIDAX Gateway” by adopting the Digital Asset Management Technology of LinkPOWER and the NewsML-related Technology of CINTEC. Both parties will collaborate with each other in relevant sales and marketing activities to promote the system. (EE02653)

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**Automatic Generation of Chinese/English Cross-lingual Concept Space by Associate Constraint Network**

✉ YANG Christopher Chuen Chi

□ 1 August 2002

- ❖ Research Grants Council (Earmarked Grants)

The information available in languages other than English on the World Wide Web is increasing significantly. It is predicted that 57% of Internet users will be non-English speakers by 2005. A report by CNN.com shows that the number of Internet users in China has been increased from 8.9 million to 16.9 million from January to June in 2000. All of these evidences reveal the importance of cross-lingual research to satisfy the needs in the near future. Digital library research has been focused in structural and semantic interoperability in the past. Searching and retrieving objects across variations in protocols, formats and disciplines are widely explored. However, research in crossing language boundaries, especially across European languages and Oriental languages, is still in the initial stage. In this project, we focus on *cross-lingual semantic interoperability* by developing automatic generation

of cross-lingual concept space based on Chinese/English parallel corpus. When searchers encounter a retrieval problem, professional librarians usually consult the concept space to identify other relevant vocabularies. In the problem of searching across language boundaries, cross-lingual concept space, generated by co-occurrence analysis and associate constraint network, can be used to generate additional semantically relevant terms that cannot be obtained from dictionary. In particular, the automatic generated cross-lingual concept space is able to capture the unknown words that do not exist in dictionary, such as names of persons, organizations, and events, in different languages.

(CU02335)

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**Large Bio-sequence Analyzing and Mining from a Database Perspective**

✉ YU Jeffrey Xu

□ 1 October 2002

- ❖ CUHK Research Committee Funding (Direct Grants)

Ever since the structure of DNA was unraveled in 1953, molecular biology has witnessed tremendous advances. Recent advances in sequencing technology have allowed the rapid accumulation of DNA and protein data. A huge amount of bio-sequences has been and is being generated in laboratories all over the world. The entire DNA of an organism comprises that organism’s genome. The human genome has an estimated 3 giga base pairs (a way to refer to a pair of facing nucleotides within the DNA double helix). It is difficult to keep up with the study of such large sets of full sequence genomes, impaired by the limits of existing analysis tools.

Data mining is a powerful technology being widely adopted to help decision makers focus on the most important nontrivial/predictive information/patterns that can be extracted from large amounts of data. The discovery of interesting patterns in bio-sequences (DNA, RNA and protein sequences) has become an important task in both research and applications.

In this project, we focus on analyzing and mining large bio-sequences with a reasonable memory constraint efficiently. It is challenging because the size of human genome is estimated 3 giga base pairs. Our main objective is to study scalability and investigate how to apply up-to-date mining and DBMS (database management system) technique in computational molecular biology.  
(EE02868)

✉ CHENG Chun Hung

2001-02 Optimization of Reservation Process on Two-Leg Flights with Cancellations and No-Shows (EE01306)

✉ FENG Youyi

1999-00 Integrative Intelligence Techniques for Money Laundering Detection (CU99396)

✉ LAM Kai Pui

2001-02 Nonlinear Modeling Approaches for Quantifying NASDAQ Pre-market Indicator/Composite Index Relationship (EE01925)

✉ LAM Kai Pui

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

1999-00 Learning Classification Knowledge From High Dimensional Data and Its Application to Intelligent Text Filtering (CU99385)

✉ LAM Wai • LING Charles X\* • CHOI Philip L S\*

Edition      Title/Investigators

1999-00 Earliness/Tardiness Scheduling Subject to Known Due Dates and an Unknown Deadline (CU99418)

✉ CAI Xiaoqiang • ZHOU Xian\*

2001-02 Hierarchical Information Extraction Learning Framework and Its Applications to Event Tracking and Filtering (CS01187)

✉ LAM Wai

2001-02 Scheduling with Negotiable Third-Party Machines (MP01166)

✉ CAI Xiaoqiang • LEE Chung Yee\*

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

✉ LEUNG May Yee Janny • LAM Ko Kin\*

2001-02 Incentives for Advance Ordering in a Supply Chain (EE01684)

✉ CHEN Youhua

1999-00 On the U-shaped Production Line Problem (EE99023)

2001-02 Logistics Support for Mobile Commerce (MP01213)

	✍ LEUNG May Yee Janny • CHENG Chun Hung		✍ WONG Kam Fai William • LAM Wai • LI Wenjie (Dept of Translation)
1999-00	Multiobjective Differential Dynamic Programming (CU99392) ✍ LI Duan • LIAO Li Zhi*	1999-00	OCF – Open Component Foundation (EE99001) ✍ WONG Kam Fai William • CHEUNG Kwok Wai (Dept of Information Engineering) • LYU Rung Tsong Michael (Dept of Computer Science and Engineering)
2001-02	Efficient Solution Schemes for Solving Multidimensional Nonlinear Knapsack Problems (MP01214) ✍ LI Duan		
2000-01	Semi-Automatic Grammar Acquisition for Understanding Natural Language Queries (CU00177) ✍ MENG Mei Ling Helen • CHING Pak Chung (Dept of Electronic Engineering) • LAM Wai	1999-00	Translingual Access of Chinese Text Using English (EE99041) ✍ WONG Kam Fai William • LAM Wai • Kwok K L*
2001-02	Mandarin-English Information (MEI): Investigating Multi-Scale Query and Document Expansion for Translingual Spoken Document Retrieval (CS01223) ✍ MENG Mei Ling Helen • KWOK Kui Lam* • WANG Hsin Min*	2000-01	Extracting Temporal Information from Chinese Financial News (EE20021) ✍ WONG Kam Fai William • LI Wenjie (Dept of Translation)
2001-02	Domain-Optimized Generation for Computer Speech Output with High Naturalness (EE01810) ✍ MENG Mei Ling Helen	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*
2001-02	"The Author Once, Present Anywhere (AOPA)" Software Platform (EE01512) ✍ MENG Mei Ling Helen • CHING Pak Chung (Dept of Electronic Engineering)	1999-00	Supply Chain Structure and Information Dynamics (BS99004) ✍ YAN Houmin • YAO David Da Wei • CHEN Jian* • LIU Lu*
1999-00	Extracting Temporal Information from Chinese Financial News (EE99025)	1999-00	Constraints Based Reasoning Approach for Tolerance Analysis and Tolerance Synthesis (CU99031) ✍ YANG Christopher Chuen Chi

2001-02	Concept-based Chinese/English Cross-lingual Information Retrieval (EE01564) ✍ YANG Christopher Chuen Chi		✍ YU Jeffrey Xu • LU Hongjun*
		2000-01	Conic Optimization: Theory and Methods (CU00181) ✍ ZHANG Shuzhong
1999-00	Performance Analysis and Optimization of Assemble-to-Order Systems (CU99376) ✍ YAO David Da Wei	2001-02	Primal-Dual Interior Point Approach to Multi-Stage Stochastic Programming (MP01233) ✍ ZHANG Shuzhong
2000-01	Linear Quadratic Control via Semidefinite Programming, with Applications (CU00175) ✍ YAO David Da Wei • ZHANG Shuzhong • ZHOU Xunyu	1998-99	Optimal Dividend Distributions and Risk Controls for Financial Companies (CU98054) ✍ ZHOU Xunyu
2000-01	Dynamic Aggregate View Selection and Maintenance for Large Financial Data Warehouses (CU00198) ✍ YU Jeffrey Xu • LU Hongjun*	1999-00	Optimal Controls of Forward-Backward Stochastic Systems with Financial Applications (CU99435) ✍ ZHOU Xunyu
2000-01	Large Incomplete Datacube Computation (EE20024) ✍ YU Jeffrey Xu	2001-02	Risk-Sensitive Control (MP01234) ✍ ZHOU Xunyu • YAO David Da Wei
2001-02	Concurrent and Personalized Data Mining with a Large Number of Users (CS01229)		



## RESEARCH PROJECTS

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

Edition      Title/Investigators

2000-01    Open Secure Time-stamping Platform for E-commerce and Protection of Intellectual Properties (EE20003)

✉ HU Stanislaus Yung Chi • LEUNG Philip Kwong Hon • LAM Shing Yung Anton • WONG Siu To • LEUNG Tak Cheong# • LING Ka Hong

