Geoinformation and Earth Sciences

Biomedical Sciences

Economics and Finance

Green Technology

Information Sciences

香港中文大學
The Chinese University of Hong Kong

Innovation for Better Life

2009-2010

Preface 序言

Founded for more than forty years, The Chinese University of Hong Kong has committed to the pursuit of excellence in academic research, and the exploration of new knowledge and technology which is transferable to the community. Thus, Hong Kong and the region can migrate towards a knowledge-based economy.

As a bridge between the University and the industry, the Centre for Innovation and Technology (CINTEC) of CUHK has been fostering connections, communications and collaborations with the industry actively in the past ten years. We understand that, unceasing innovation of products and services is the key to success in today's hyper-competitive market. However, in reality, not every company can afford the huge expenses for R&D. So, tapping into the research resources of universities to look for breakthrough technologies is a way out for those companies.

Through the participation in local and overseas technology exhibitions, CINTEC provides circumstances for the industry and our research teams to communicate and look for collaboration opportunities. We also help our graduates to start enterprises with innovative technologies in order to nurture more capable and creative young entrepreneurs for Hong Kong.

香港中文大學創校四十多年來一向致力追求卓越的學術研究，亦積極探索能用於社會的新知識、新技術，從而推動香港以至區內邁向知識型經濟體系發展。

中大創新科技中心作為大學與業界之間的橋樑，在過往十年間一直積極與業界連繫及溝通，並促成產學合作。我們明白，在現今競爭激烈的市場環境下，產品及服務的不斷創新是企業成功的關鍵。但現實中，並非所有企業都能負擔研發需用的龐大開支，故此利用大學的研發資源突破本身於創新上的限制，成為這類企業的出路之一。

創新科技中心透過參與國內外不同的科技展覽，讓業界人士與大學科研人員有機會面對面接觸，共同發掘合作空間與機會。我們亦會協助本校畢業生憑創新科技概念創業，希望為香港培育更多有實力、敢創新的年輕企業家。

Prof. WONG Kam Fai
Director, Centre for Innovation and Technology
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香港中文大學
創新科技中心主任
黃錦輝教授

CUHK signed a memorandum of cooperation with the Shenzhen Municipal Government on March 19 2009 on the basis of the memorandum signed in 2006. It was agreed to further enhance collaboration in education and research, and in advancing technology transfer. Additionally, with the completion of CUHK's Shenzhen Research Institute Building by the end of 2010, it surely will stimulate more fruitful collaborations between academia and industries in the region.

Environmental protection and energy saving are the current major global concerns. As an institute of higher education aiming at connecting with the world, CUHK responds to these issues by carrying out innovative research. This year, we especially collected several research projects related to these two topics and listed in the chapter of "Green Technology" of this brochure. The projects are diversified, which include new technologies for reducing energy consumption, renewable and clean energy; automatic machinery and systems for reducing pollution, and software for environmental education. Besides, according to CUHK's strategic research areas, we also listed out many research achievements in the fields of Biomedical Sciences, Information Sciences, Geoinformation & Earth Sciences and Economics & Finance.

This brochure is compiled to give you a snapshot of CUHK's latest R&D projects. If you are interested in any of the listed projects, you are welcome to contact us. We are pleased to provide you more detailed information, or arrange meetings with our research teams.

中大於2009年3月19日與深圳市政府簽訂了全面合作備忘錄，在2006年的合作備忘錄基礎上，加強雙方在教育及科研上的合作，並共同推進科研成果的產業化。再配合將於2010年底啟用的香港中文大學深圳研究院大樓，相信必能刺激深港兩地更多的產學合作與成果。

環保及節能是現時全球的重要關注，中大作為一所與世界接軌的高等學府，當然要以創新研究作回應。今年，我們特別搜集了多項關於環保及節能的研究項目，列於本小冊子的「綠色科技」系列之內。當中包括能減少能源消耗、增加再生能源採集及製造潔淨能源的新技術，亦有用於減少污染的自動化機械及系統，和作環保教育之用的軟件，研究方向可謂極之多元化。除此之外，我們亦根據中大的策略性研究重點領域，列出了多項關於生物醫學科學、訊息科學、地球信息與地球科學，及經濟與金融的研究成果。

本小冊子只簡單介紹了中大的最新科研項目。如閣下對其中的項目感到興趣，希望獲得更詳盡的資料，或有意跟我們的研究隊伍見面，了解合作的可能性，歡迎以下列方法跟我們聯絡。

Contact 聯絡

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Drug Development for Treating Multiple Cancers

開發治療多種癌症的抗TBX2和TBX3的多肽類藥
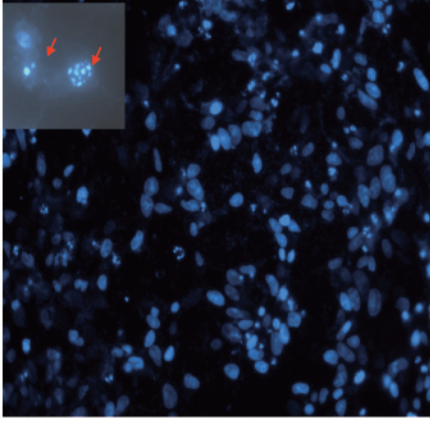
Blue luminance shows successful binding of synthetic peptide against TBX3 protein to induce death of cancer cells

藍光點代表合成肽能有效附在致癌蛋白**TBX3**上引致癌細胞死亡

Cancer is the second killer of human diseases worldwide. Many factors, including chemical and environmental carcinogens, virus infections (such as HBV/HCV infection), dysfunction of tumor suppressor genes, and amplification or false activation of proto-oncogenes, contribute to the carcinogenesis and the process of tumor development. TBX2 and TBX3 are highly conserved oncogenes which are amplified in multiple types of cancer specimen and contribute to cancer development, including breast cancer, liver cancer, bladder cancer, melanomas, ovarian cancer, and colorectal cancer. The conserved transcriptional repressor domain of TBX2/TBX3 is essential to the tumor growth.

CUHK research team identified a small TBX2/3 antagonist peptide (TAP21) which could specifically eliminate the transcriptional repression function of TBX2/TBX3, inhibit the cell growth of cancer cells and induce apoptosis. The peptide will be developed into potential therapeutic agents for the treatment of multiple cancers.

Prof. HE Ming liang
Prof. KUNG Hsing Fu
Stanley Ho Centre for
Emerging Infectious Diseases

何鴻燊防治傳染病研究中心
何明亮教授
孔祥復教授

癌症是人類疾病中的第二號殺手。致癌因素有多種，化學致癌物和環境致癌物、病毒感染、抗癌基因的失效，以及癌基因的擴增和錯誤啟動。TBX2和TBX3是結構和功能相似的癌基因，其基因倍增和過量引發多種癌症，包括乳腺癌、肝癌、膀胱癌、黑色素瘤、卵巢癌和腸癌等。這些腫瘤的生長依賴於TBX2和TBX3的序列相似的轉錄抑制域。

中大研究隊發現了一個細小的多肽（TAP21），這個多肽專門消除TBX2和TBX3轉錄抑制活性，阻止癌細胞生長和誘導癌細胞凋亡。本研究的成果將為治療多種癌症的多肽藥開發奠定基礎。

Development of HPV Therapeutic Vaccine for Treating Cervical Cancer

開發用於子宮頸癌的HPV治療性疫苗
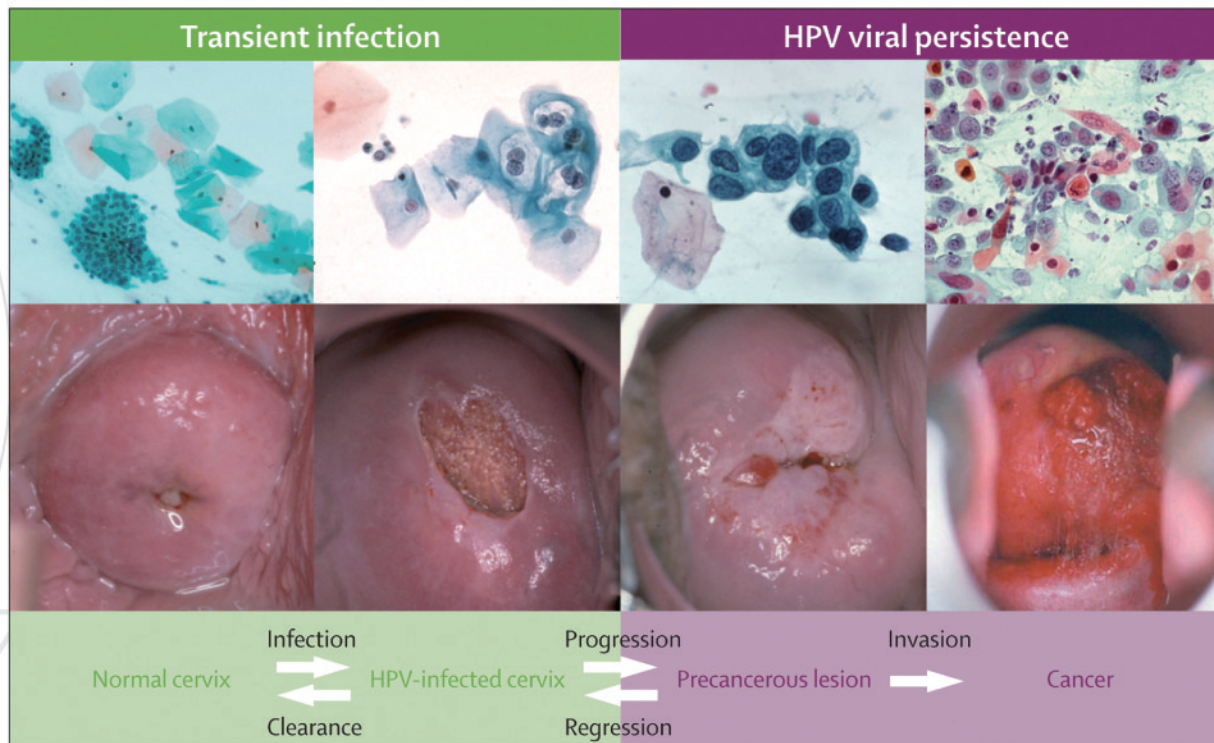
Prof. CHEN Yangchao
Prof. KUNG Hsiangfu
Department of Medicine and
Therapeutics

內科及藥物治療學系
陳揚超教授
孔祥複教授

| Transient infection | | HPV viral persistence | |

| Normal cervix | Infection / Clearance → | HPV-infected cervix | Progression / Regression → | Precancerous lesion | Invasion → | Cancer |

Cervical cancer is the second leading cause of cancer deaths in women worldwide. The majority (98%) of all cervical cancers are the result of Human Papillomavirus (HPV) Infection. Current available prophylactic vaccines protect subjects without HPV infection and lack therapeutic efficacy against established HPV infection and HPV-associated lesions.
This project is to develop HPV therapeutic vaccine using genetic engineering technology.
The anticancer efficacy of fusion protein therapeutic vaccine is tested in preclinical animal models.

子宮頸癌在全球最常見的女性癌症中居第二位。大部份案例（98 ％）都由人乳頭狀瘤病毒（HPV）所引致。現有預防性疫苗，只對從未感染HPV病毒的女性有效，對已感染者體內病毒及病毒引致的創傷並無治療效用。
這項目利用基因工程技術製造HPV治療性疫苗。
疫苗的抗癌成效會利用臨床前的動物樣本進行驗證。

Cancer Epigenetics Identifies Novel Tumor Suppressor Genes and Epigenetic Tumor Markers

表觀遺傳學鑒定新的抑癌基因及腫瘤分子標記物

Promoter methylation and tumor suppressor gene (TSG) silencing

Normal cells:

Cancer cells:
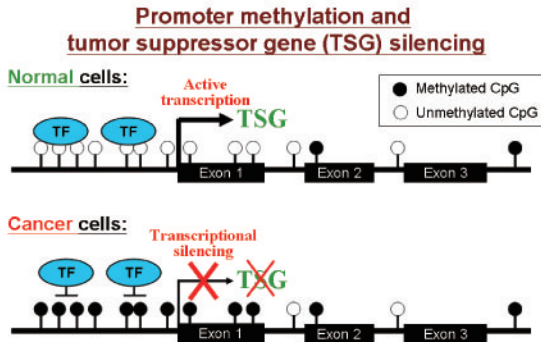
Top 10 Killer Diseases in Hong Kong (2002/03) 2002/03年「十大殺手」病症（香港）		
1	Malignant Tumor 惡性腫瘤（癌症）	34.0%
2	Heart Disease 心臟病	14.5%
3	Cerebrovascular Disease 腦血管病	9.4%
4	Pneumonia 肺炎	9.3%
5	Chronic Lower Respiratory Tract Infections 慢性下呼吸道疾病	6.0%

Cancer is the leading cause of death (~34% of all deaths) in Hong Kong, causing serious social and economic problems. Standard radiotherapy and chemotherapy are only effective to early tumors. Thus, early diagnosis is the key to cancer patients' survival, needing better molecular tumor markers and more specific and safer therapeutics.

At the molecular level, carcinogenesis is a multi-step process involving multi genetic and epigenetic alterations including the disruption of tumor suppressor genes (TSG) through genetic (mutations) and/or epigenetic (promoter CpG methylation) mechanisms, resulting in the loss of TSG functions. The presence of epigenetic abnormalities in tumor cells provides us with not only a novel way of identifying new TSGs, but also non-invasive, epigenetic biomarkers (detectable in serum, sputum, stool and other bodily fluids from cancer patients) for tumor diagnosis and therapeutics.
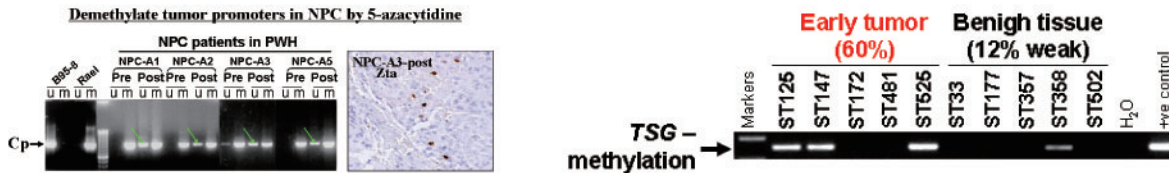
This Laboratory studies the epigenetic alterations of common Hong Kong tumors (carcinomas and lymphomas), identifies novel TSGs epigenetically inactivated as specific tumor markers. We also use DNA methyltransferase inhibitors to reverse CpG methylation, reactivate silenced genes and restore normal cell growth control or induce apoptosis of tumor cells, to develop epigenetic cancer therapies.

Prof. TAO Qian
Department of Clinical Oncology

腫瘤學系
陶謙教授

Demethylate tumor promoters in NPC by 5-azacytidine

NPC patients in PWH

Early tumor (60%)   **Benigh tissue (12% weak)**

TSG – methylation

癌症是香港人的最主要死亡原因（約佔死亡總數的34%），帶來了嚴重的社會及經濟問題。目前的化學治療及放射治療僅對早期癌症有效。故早期診斷是病人生存的關鍵，迫切需要分子診斷標記物及其他有效的治療方法。

在分子水平，癌症病發涉及多個步驟，其中牽涉多種遺傳學和表觀遺傳學的變化，包括抑癌基因（TSG）通過遺傳學（基因突變）和表觀遺傳學（啟動子甲基化）的機制遭到破壞或沉默，從而喪失功能。腫瘤細胞的表觀遺傳學異常不僅有助於我們發現及鑒定新的抑癌基因，也提供可用於分子診斷的非侵入性的腫瘤特異標記物。這些標記物可在腫瘤病人的血清、痰液、糞便或其他體液中檢測到。

本實驗室研究香港常見腫瘤（如鼻咽癌、食管癌和淋巴瘤）的表觀遺傳學改變，鑒定新的抑癌基因及腫瘤分子標記物。同時，我們採用去氧核糖核酸甲基轉移酶抑制劑以逆轉抑癌基因的甲基化，進而恢復細胞的正常生長調控或誘導腫瘤細胞凋亡，從而建立新的表觀遺傳學癌症治療方法。

Development of Safe and Effective Drugs from Traditional Chinese Medicine

以傳統中藥開發安全有效新藥

地骨皮　丹參　射干　苦參　黃柏　黃芩

Prof. LEUNG Ping Chung
Institute of Chinese Medicine

中醫中藥研究所
梁秉中教授

Antibiotic resistance in bacteria is a serious global problem. Novel antimicrobial compounds against new bacterial targets and drug resistance mechanisms are urgently needed.

CUHK Joint Laboratory of Molecules from Traditional Medicine aims to identify new potential compounds in Chinese medicine that can lead to the development of safe and effective drugs for the treatment of multi-drug resistant *Staphylococcus aureus* (*S. aureus*), anti-cancer herbs and other areas of common interest. The laboratory is administered by the Institute of Chinese Medicine (ICM) of CUHK and the Laboratoire de Synthese selective organique et produits naturels of Centre national de la Recherche Scientifique (CNRS) and Ecole Nationale Supérieure de Chimie de Paris (ENSCP).

ICM of CUHK is experienced in Traditional Chinese Medicine (TCM) research, especially on bioassay of herbs, isolation, identification and modification of compounds from herbs. The Biochemistry Laboratory of UMR7573 CNRS-ENSCP (UMR CNRS), France, is experienced in the study of drug resisnance mechanisms in bacteria such as *S. aureus* and has developed cellular and enzymatic assays, targeting on several key drug resistance mechanisms in a high-throughput way for screening of compounds with activity against resistant bacteria or with inhibitory activities on these mechanisms.

The joint research between ICM and UMR CNRS on TCM for the treatment of methicillin-resistant *Staphylococcus aureus* (MRSA) infections is expected to provide a scientific basis for clinical usage of TCM and the identification of new potential compounds leading to the development of safe and effective drug for the treatment of multi drug-resistant S. aureus.

In antibacterial studies, initially 33 Chineses herbs were screened, 9 out of 33 herbs showed antibacterial activities against *S. aureus* and/ or MRSA.

細菌耐藥是治療感染性疾病的世界性難題。研究和開發抗感染及其抗耐藥機能的新藥是當務之急。

中大傳統藥物聯合實驗室旨在找出傳統中草藥內潛在的新有效成份，以發展出有效及安全的藥物，治療有多種抗藥性的金黃葡萄球菌、研製抗癌草藥及其他與大眾健康息息相關的藥物。實驗室將由香港中文大學中醫中藥研究所、法國國家實驗室及法國國立巴黎高等化工學校共同管理。
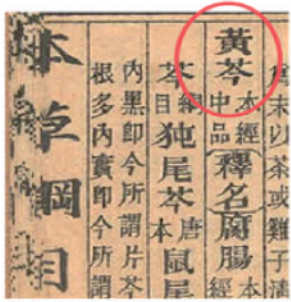
香港中文大學中醫中藥研究所對中草藥有效成份的研究、分離、鑒定和改良有豐富的經驗。而法國國家實驗室則對細菌抗藥性研究，尤其是金黃葡萄球菌有豐富經驗，並發展出不同針對細菌抗藥機理能抑制其活性的細胞及酵素高通量測試方法。

兩所之合作期望能對中藥提供一個有效、安全的科學基研應用於抗藥性的金黃葡萄球菌的臨床治療。

三十三種中藥當中，有九種中草藥在抗菌測試中，對普通及抗藥金黃葡萄球菌的生長抑制呈陽性反應。

Treatment of Experimental Ulcerative Colitis with Scutellariae Radix (Huangqin)

以黃芩治療實驗性潰瘍性結腸炎

The use of Huangqin was recorded in Chinese Materia Medica
本草綱目記載了黃芩的使用

Scutellaria baicalensis Georgi (Huangqin)
黃芩

Dried root of *Scutellaria baicalensis* Georgi
乾燥的黃芩根

Inflammatory bowel disease (IBD) includes both ulcerative colitis (UC) and Crohn's disease (CD), which are major chronic inflammatory diseases of the gastrointestinal tract in human. Conventional therapies used in IBD are not totally successful and their side effects remain a major clinical problem. Therefore, there is an increasing interest in using Traditional Chinese Medicines (TCM) as an alternative or adjunct therapy. The most frequently used TCM is Oren-gedoku-to (Huang Lian Jie Du Tang). It is a Traditional Chinese herbal medicine consisting of a mixture of four herbs, including *Scutellariae Radix*. Among the four herbs, recent studies suggest that *Scutellariae Radix* has the strongest pharmacological effect against murine colitis. However, the physiological basis and the precise mechanism of action of *Scutellariae Radix* or its individual constituents are still unclear.

In rats suffered from UC, oral *Scutellariae Radix* extract was given to them for eight days. Our findings indicated that the herbal extract of *Scutellariae Radix* was effective in treating UC, as gauged by reduced clinical disease, improved macroscopic and histological damage scores, and enhanced recovery of normal colonic electrolyte secretory function.

Apart from confirming the well-known anti-inflammatory effect of *Scutellariae Radix* on experimental colitis, this is the first evidence showing that the therapeutic potential of this herb is related to the restoration of electrolyte transport function of the colonic mucosa. It also demonstrates that TCM has a scientific and biological basis for its effectiveness. The results support further evaluation of the therapeutic potential of this herbal extract and its active component(s) for the treatment of IBD.

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Prof. HUANG Yu
School of Biomedical Sciences

生物醫學學院
高永雄教授
黃聿教授
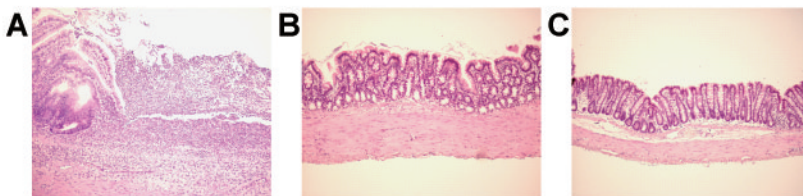
Hematoxylin & Eosin (H&E) histological sections of colons from: (A) colitic group showing extensive ulceration with a severe inflammatory cell infiltrate; (B) treated group showing recovery with less severe ulceration ;(C) control group showing normal morphology of the colon (X 100).
經蘇木紫和伊紅染色的結腸組織切片取自：(A) 結腸炎組別顯示了廣泛性的潰瘍及嚴重的炎症細胞浸潤；(B) 治療組別顯示出康復的現象，結腸組織的潰瘍比較輕微；(C) 對照組別顯示形態正常的結腸（100倍）。

潰瘍性結腸炎（UC）及克隆氏症（CD）兩種發炎性腸道疾病（IBD），都是人類主要的慢性消化道疾病。現有治療 IBD 的方法未能盡如人意，其副作用也一直為人詬病，所以用傳統中醫藥（TCM）為另類或輔助治療的做法，吸引了愈來愈多人注意。其中，最常用的中醫藥就是傳統中國草藥黃連解毒湯，其成份包括了黃芩等四種藥草。最近研究顯示，黃芩在這四種藥草中對小鼠結腸炎有最強的藥用效果，但黃芩或其成份的生物學基礎及確實作用機制仍然未明。

在實驗中，患有 UC 的老鼠連續八天被餵飼黃芩。結果顯示，它們的臨床疾病減退，宏觀及組織損傷評量改善，結腸分泌電解質的功能也有顯著恢復，顯示黃芩的草本提取物能有效治療 UC。

本研究除確認黃芩對實驗性腸炎的抗炎效果以外，也是首次有實驗顯示，它的療效與大腸黏膜的電解質輸送功能復原有關。同時，研究也說明 TCM 的效用有科學及生物學根據，能為未來以黃芩及其活躍成份治療 IBD 的進一步評估打好基礎。

Auriculotherapy for Hypertension

針對高血壓的耳穴療法治療

Preparing for auriculotherapy 準備耳穴療法

Stimulating an acupoint 刺激耳穴

Locating an acupoint 探測穴位

Prof. SUEN Kwai Ping Lorna
The Nethersole School
of Nursing

那打素護理學院
孫桂萍教授

Even on anti-hypertensive therapy, some patients may not consistently achieve the recommended blood pressure level. In our placebo-controlled clinical trial, the participants in the experimental group received integrated treatment of Auriculotherapy (AT) on seven auricular acupoints plus Western medication. The acupoints were thought to be related to blood pressure control. The entire treatment period was four weeks. The participants in the experimental group demonstrated a significant improvement in blood pressure regulation as evidenced by a decrease in their Mean Arterial Blood Pressure (MABP) after the therapy.

This study enhanced our understanding of hypertension control in clients with regard to the integration of Chinese and Western models of care. In addition, our research team has also conducted other research projects in relation to the use of AT on relieving sleep disturbances and constipation in the elders.

有些病人雖定時服用降血壓藥，但仍未能持續及有效地控制血壓。在有對照組臨床實驗中，研究員刺激參加者耳朵上七個與血壓控制有關的穴位，期間參加者繼續使用西藥，整個療程為四個星期。實驗組之參加者接受治療後，在控制平均動脈血壓方面有顯著改善。

這研究使我們對結合中西療法來控制血壓有進一步的了解。此外，我們的研究小組亦進行其他研究項目，探討耳穴療法對改善老年人的失眠及便秘問題之成效。
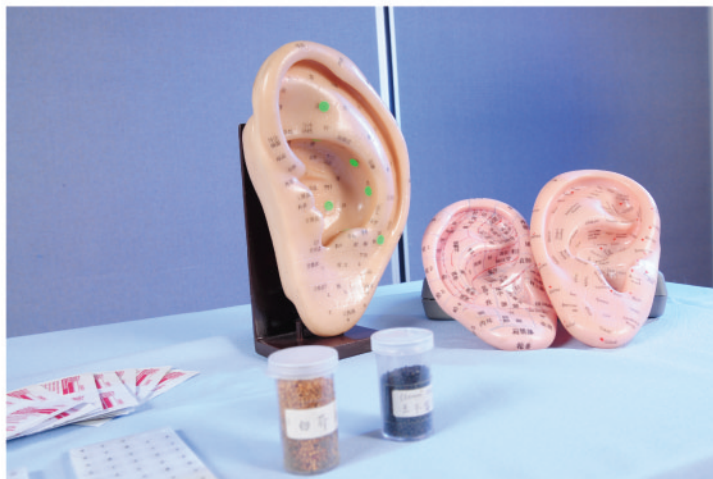
Surface Enhanced Raman Sensors (SERS)

表面拉曼感測器

The scanning electron microscopy images of various metallic structures for enhancing the Raman signals.
電子顯微鏡下不同的納米金屬結構以增加拉曼信號

a) Two-dimensional gold circular dot array. 兩維金圓點陣
b) Two-dimensional gold diamond dot array. 兩維金鑽點陣
c) One-dimensional silver grating. 單維銀排線
d) Two-dimensional gold hole array. 兩維金洞陣列
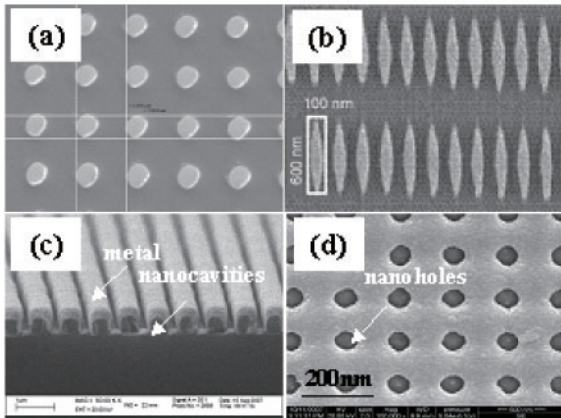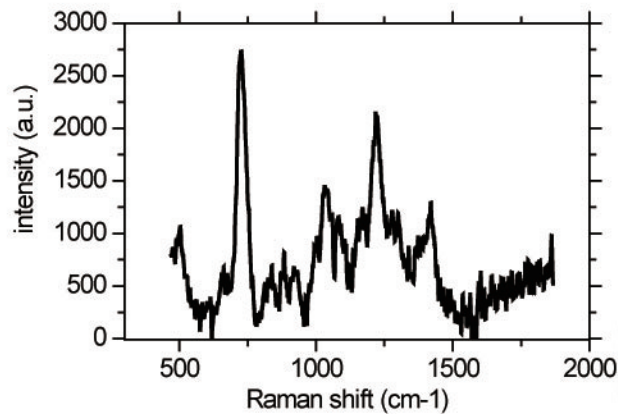

The SERS spectrum of BRCA1 breast cancer gene monolayer on 2-D Ag hole arrays.
單層BRCA1乳癌基因在二維鍍銀洞型陣列上的SERS譜

The scattered Raman light from target molecules displays rich information about the molecules and thereby offers a sensitivity tool for biological and chemical sensing. However, it is found that the Raman signals can be enhanced by many orders of magnitude when the molecules are placed in close proximity to appropriately prepared metal surface. As a result, these surface enhanced Raman sensors could provide both good sensitivity and specificity.

The metal surface is engineered with features at a length scale of nanometers, which increases the Raman sensitivity. The target molecules are then attached to the metal surface. A laser beam is illuminated on the metal surface and the corresponding Raman signals are displayed as a spectrum for identification.

Features of SERS sensors

- High molecular sensitivity and specificity
- Real time detection
- Cost effective and handy sensors for mass production
- No fluorescent label required

拉曼散射光提供了有關分子的豐富信息，因此可作為敏感的生物及化學感測工具。將分子放在特設金屬表面附近，拉曼信號的幅度可增強很多數量級。所以，表面增強拉曼感測器具有良好的靈敏性和特徵性。

用納米工程可改造金屬表面以增加拉曼靈敏度。將分子附著在金屬表面，然後用激光照射，對應的拉曼信號以特徵譜的形式表示。

表面拉曼感測器特性

－ 高分子敏感性和特徵性
－ 實時探測
－ 可大量生產的經濟便攜式感測器
－ 無需螢光標記

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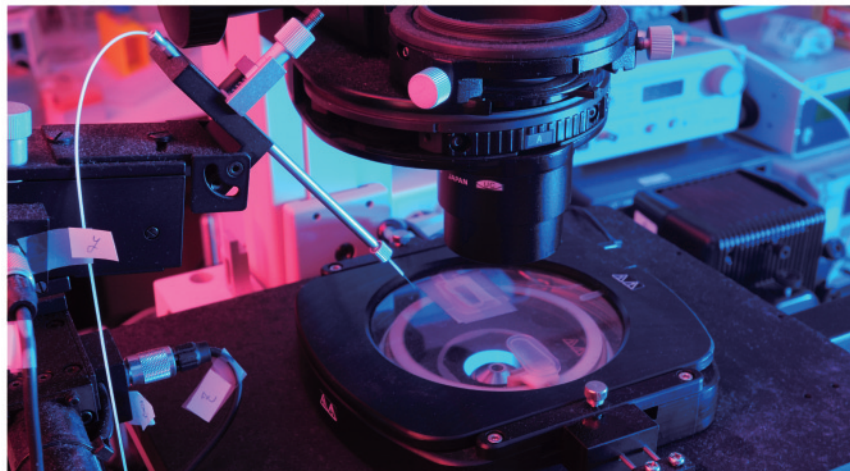
Femtosecond Laser for DNA and RNA Transfection

利用飛秒激光導入DNA或RNA細胞技術

Research staff is examining cultured cells
科研人員正檢查細胞情況

Microscope and electrode for transfection
用作轉染的顯微鏡及電極

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Transfection is a process of introducing foreign DNA or RNA into cells. This process is performed frequently at medical and biomedical laboratories to study the function of DNA and its counterpart protein. There are various methods to introduce DNA or RNA into target cells, including the use of chemicals, viruses, magnetic nanoparticles and laser.

Conventional optical transfection can only have 30-50% transfection efficiency in the sense that only 3 to 5 out of 10 cells could survive and possess the desired DNA or RNA for further experiments. By applying femtosecond laser for transfection, the transfection efficiency is about 76-78%, far better than conventional methods.

Laser can be made to produce pulses of very short duration, as short as a few femtoseconds, ie.10^{-15} second. In transfection, laser will hit an individual cell for 7 seconds to open a transient pore on the cell membrane. DNA and RNA dissolved in surrounding solution will go into the irradiated cell through the transient pore. Since this method select and transfect cells one by one, it is particularly useful for studying a single cell. A specific cell type can also be selected out in a mixture of cells. By controlling how long the cell is exposed to laser, the amount of DNA or RNA transfected into a target cell can be regulated. Compared with chemical transfection, femtosecond laser transfection does not add any chemicals to the cell which would affect target cell growth and its metabolism.

轉染是一個導入外來DNA或RNA到細胞的過程。此過程經常用於醫療和生物醫學實驗室中，以研究基因與其對應蛋白質的功能。要把DNA或RNA導入細胞有多種不同的方法，包括利用化學品、病毒、磁性納米粒子和激光。

傳統光學轉染方法只有30-50％的成效，即在10個細胞中只有3-5個細胞生存並擁有理想的DNA或RNA作下一步的實驗。利用「飛秒激光」在轉染應用上，其轉染率可高達76-78％，遠勝於傳統方法。

「飛秒」指10的-15次方，「飛秒激光」則是一種超快速輻射激光。在轉染中，激光照射個別細胞達7秒並在細胞膜上打開一個短暫的小孔。溶解在周圍溶液的DNA和RNA便透過小孔進入細胞。

由於這種方法選擇並逐一轉染細胞，故有助於單一細胞研究。特定的細胞類型也可以從一個混合的細胞樣本中篩選出來。通過控制細胞暴露在激光下的時間，導入細胞的DNA或RNA量亦可以調較。

對比於化學轉染，飛秒激光轉染不會添加任何化學劑，可減低轉染對細胞生長及其代謝作用的影響。

Non-contact Monitoring of Cardiovascular Signals on Sleeping Bed

非接觸式心血管系統監測睡床
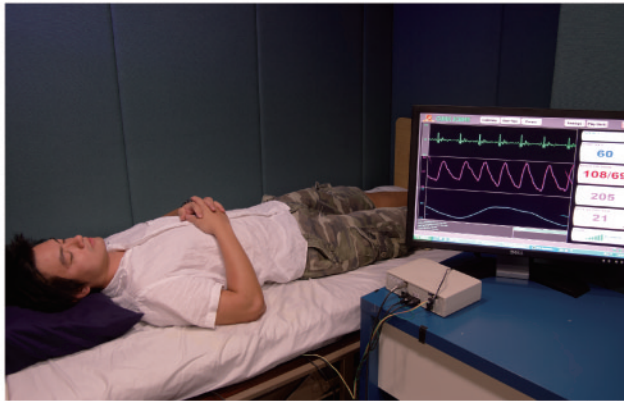
Non-contact monitoring of cardiovascular system on sleeping bed
非接觸式心血管系統監測睡床

The monitoring system can display heart rate, blood pressure and respiration rate
監測系統能同時顯示心率、血壓及呼吸率

According to some medical reports, human's physiological activities and their variabilities at sleep can reflect the health condition directly. For example, obstructive sleep apnea is associated with an increased risk of hypertension, heart disease and stroke. Therefore, physiological monitoring during sleep is very useful for early diagnosis of cardiovascular diseases. However, the existing monitoring systems usually depend on the direct contact of sensors or probes with the skin, which discomforts the users and affects their normal sleep.

We developed a household monitoring system for cardiovascular parameters without affecting users' normal sleep. The conductive textile, infrared light emitting diode and photodetector are integrated in a sleeping bed for non-contact detection of electrocardiogram and photoplethysmogram. The system provides continuous monitoring of heart rate, respiration rate, pulse transit time and blood pressure. Unlike those common blood pressure measuring methods, the blood pressure estimation in this project does not require a cuff during measurement.

醫學報告指出，睡眠期間的生理活動與變化可直接反映人體的健康狀況，例如睡眠窒息會增加患上高血壓、心臟病及腦中風的風險。因此，睡眠期間的生理參數監測對心血管疾病的預防尤其重要。然而，現有的檢測方法主要依賴皮膚接觸式感測器或探頭，監測期間往往會為使用者帶來不適，繼而影響睡眠。

本項目是研發一套能夠在不影響使用者睡眠的情況下，整夜實時地連續監測心血管參數的家用裝置。本裝置採用了電子紡織物、紅外發光二極管和光電感測器，在無須接觸皮膚的情況下連續地檢測心電信號和血容積信號，從而測量心率、呼吸率、脈搏波傳輸時間及血壓。與現時常見的血壓測量方法不同，本裝置在進行測量時，用戶無須穿上袖帶。

Hong Kong ICT Awards 2008:
Best Lifestyle Gold Award (Home Life and Healthy Living)

2008香港資訊及通訊科技獎：
最佳生活時尚獎金獎（家居及健康生活）

Prof. ZHANG Yuan Ting
Department of Electronic Engineering

電子工程學系
張元亭教授

Prof. CHENG Chun Yiu Jack
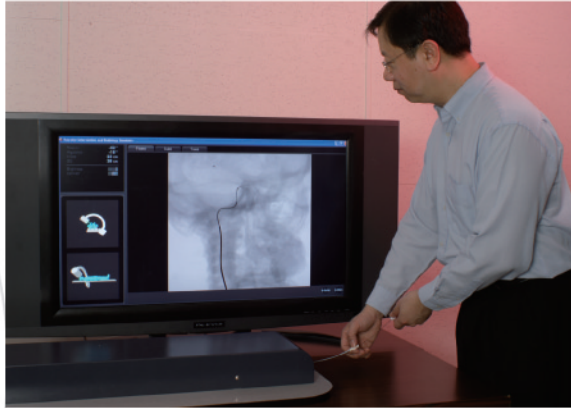Department of Orthopaedics and Traumatology

矯形外科及創傷學系
鄭振耀教授

Prof. YU Cheuk Man
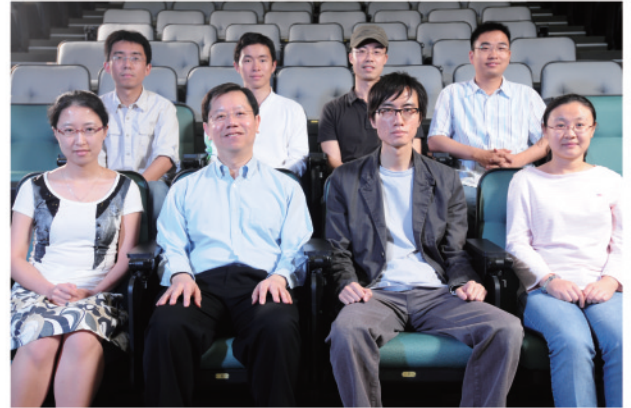Department of Medicine and Therapeutics

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Vascular Intervention Simulation System
血管介入治療模擬系統

Vascular intervention simulation system for medical training
用作培訓醫護人員的血管介入治療模擬系統

Prof. Heng Pheng-Ann (first row, second from left) and his research team
王平安教授（第一排左二）及其研究小組

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Department of Computer Science and Engineering

計算機科學與工程學系
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Common killer diseases, such as blood vessel blockage, cerebral aneurysm and cancer, were previously great challenges for doctors. Surgery was considered the only treatment option. With the development of Vascular Interventional Radiology (VIR), doctors can perform image-guided and minimally-invasive therapeutic operations by using medical imaging devices and high-technology medical equipment through tiny pin-hole punctures on patients' bodies. VIR operation has become an indispensable standard component in the modern medical arsenal and the demand in Hong Kong has increased rapidly in recent years. However, safe and effective performance of precise VIR procedures requires highly skilled doctors with specialized training. The restrictions of the traditional training mode through hands-on practice on animals and real cases call for the development of a comprehensive computerized training system in this regard. Simulation systems for VIR training currently available in the West have been developed on the data of local clients, focusing on the treatment of diseases common in the West, and thus may not be applicable to the Asian region.

The system makes use of patients' data to reconstruct the 3D anatomic model of organs and vascular network, and simulate the whole VIR procedures and patients' bodily responses, including the slight resistance to the guidewire and catheter, and patients' respiration and blood flow. The system can greatly enhance the effectiveness of VIR training and can also be used for education and evaluation of medical personnel.

一些常見的殺手疾病，如血管閉塞、出血性中風及癌症等，以往必須透過大手術治療。但自從發明透視微創手術後，醫生就可以透過醫學影像器材透視人體內部，再以微型的高科技儀器經針孔般細小的皮膚傷口直達體內病源，徹底治療。故此，透視微創手術已成為現代醫學不可缺少的一項常規技術，近年在本港的需求亦迅速增加。透視微創手術要求極精確的手術技巧，醫生必須有足夠培訓才能安全、有效地操作手術。傳統培訓需利用動物或真實個案，極具限制，若能運用完善的電腦化模擬系統訓練，定能更有效提升醫生的手術技巧。現時歐美等地也有採用電腦化模擬系統進行相關培訓，但由於該等系統都是以西方人士的數據研發，而且集中處理西方常見的疾病，故未必適用於亞洲地區。

此系統利用病人數據，重建血管網等不同組織的三維解剖影像，模擬整個透視微創手術的過程及病人的身體反應，包括導線及導管進入病人身體後所承受的微量阻力，以及病人的呼吸及血液流動情況等，大大促進培訓成效。除培訓外，此技術亦適用於教育及醫護人員的操作評估。

Terahertz Imaging for Biomedical Applications

兆赫成像的生物醫學應用

A researcher examines the skin by using the terahertz imaging device
研究人員以兆赫成像儀器檢查皮膚

Prof. MacPherson Emma (centre) and her research team
MacPherson Emma教授（中）及其研究小組

"Tera" means 10^{12} and "terahertz" (10^{12} Hz) is the frequency of radiation that is used in terahertz imaging techniques. For comparison, X-ray imaging uses radiation at a frequency of 10^{20} Hz. Thus terahertz imaging is done at a much lower frequency than X-ray and poses no known safety risk to humans. It is a totally non-destructive and non-ionizing imaging modality. Terahertz imaging has only become possible in recent decades as generating radiation at terahertz frequencies is difficult. Advances in semiconductor physics and laser technology have overcome this issue.

A point measurement with our terahertz imaging system is analogous to an ultrasound acoustic scan. Reflections off different layers are used to determine the structure at various depths. As there are strong water absorptions in the terahertz region and soft tissue is mainly composed of water, terahertz reflection imaging would be a useful tool to investigate soft tissues in a safe and non-invasive way. Therefore we are developing techniques to perform terahertz imaging *in vivo* with a view to improving diagnosis of cancers such as breast cancer and skin cancer.

「兆」是指10的12次方，而「兆赫」（10^{12} Hz）則是兆赫成像技術中所用的放射線頻率。對比X光成像中所用的10^{20} Hz放射頻，兆赫要低頻得多，因此兆赫成像不會為人體帶來任何已知的害處，是完全無破壞性及非離子化的成像方式。在過去很長一段時間，產生兆赫放射線是非常困難的事，但隨著半導體物理學及雷射技術的提升，兆赫成像技術得以在這十多年間迅速發展。

我們的兆赫成像系統所採用的單點測量方法，相類於超聲波掃瞄。透過收集來自檢測樣本不同層面的反射，系統能夠判斷樣本的內在結構。兆赫放射線極容易被水份吸收，而軟組織主要是由水份組成，所以兆赫反射成像技術可以通過分析反射結果的吸收率，在安全及非侵入性的情況下檢測軟組織。我們正在發展一門技術，以將兆赫成像用於活有機體身上，希望令乳癌及皮膚癌等癌症的診斷結果更為準確。

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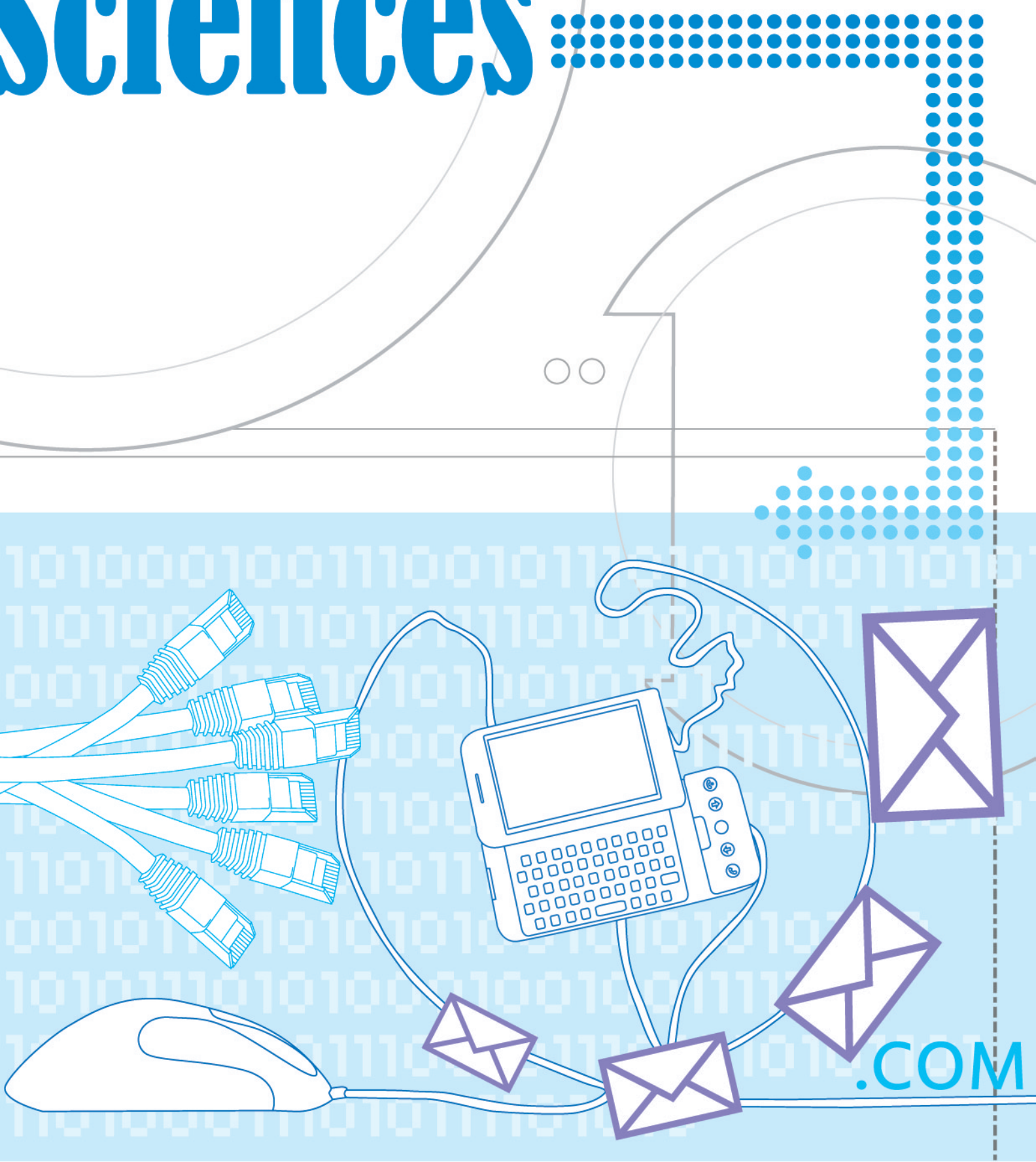
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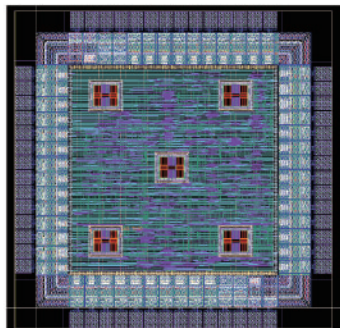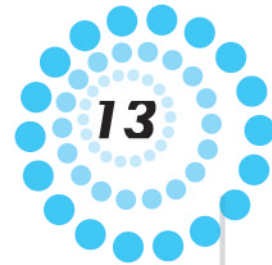Department of Orthopaedics and Traumatology

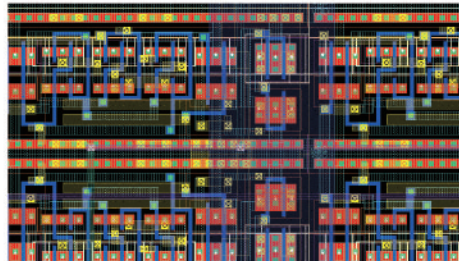矯形外科及創傷學系
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訊息科學

Structured Application Specific Integrated Circuit Platform

結構化專用集成電路開發平台

First target application – controller for adaptive LED backlit LCD-TV
第一個應用方案：用於液晶電視的發光二極管背光控制器

Compact, metal-programmable cell design
設計簡潔、接線可編控的單元

A sample image of the target application with a high definition still picture (1080p). The insert in the top-left corner shows the brightness of the LED backlight panel. (Photo courtesy of ASTRI)
配置了首個應用方案的1080p高清電視影像，左上角為LED背光的亮度分佈。（圖片由應用科技研究院提供）

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Structured ASIC[1] is an intermediate technology between ASIC[1] and FPGA[2]. It offers high performance (characteristics of ASIC[1]), and low NRE[3] cost (characteristics of FPGA[2]). It allows electronic products to be quickly introduced to market at low cost and to be designed with ease. This technology will open new opportunities in the market of Programmable Logic Devices.

To support structured ASIC[1] development, the CUHK research team has developed (1) a design and application mapping methodology, (2) a prototype platform using FPGA[2], (3) a novel programmable fabrication architecture and the corresponding test chip.

The advantages of the technology over conventional approaches (i.e. standard cells, FPGA[2]) are:
- Lower NRE[3] costs (about 1/6 of full mask set cost[4])
- Lower design risk because of proven silicon and regular fabrication structure
- Fast turn-around-time (about 1/3 of ASIC fabrication time[4])
- Comparable speed and power consumption as standard cells

Notes:
1. Application Specific Integrated Circuits
2. Field Programmable Gate Array
3. Non-Recurring Engineering
4. Estimation for a 0.13um CMOS process.

結構化ASIC[1]是介乎ASIC[1]與FPGA[2]之間的集成電路技術。它具有ASIC[1]的高性能特質，也有FPGA[2]的低開發成本特性。這技術可以令電子產品設計過程比較簡易，從而更快以合理成本推出市場。它亦對可編碼邏輯器件市場帶來新機遇。

為支援發展結構化ASIC[1]，中大研製了(1)一系列繪製與設計應用方案的方法，(2)一個利用FPGA[2]來製造原型器件的開發平台，(3)一套既新穎又可以編改的集成電路結構組合和對應的測試晶片。

新技術與傳統方法（標準單元集成電路或FPGA[2]）比較：
－ 開發成本低（光罩底片成本約是傳統方法全套的六分之一 [3]）
－ 由於半導體的結構與組合已驗證可靠，設計風險因此降低
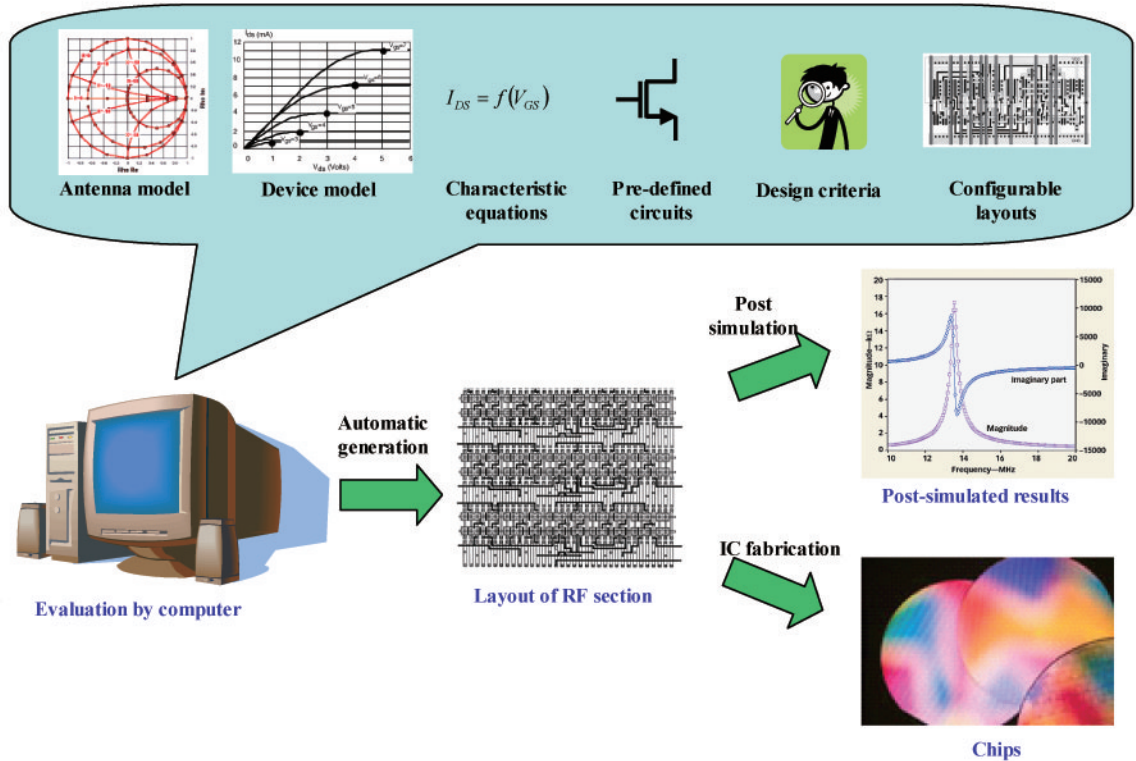－ 開發時間短（大約是製造ASIC的三分之一 [3]）
－ 運算速度與功耗保持在標準單元集成電路的水平

註：
1. Application Specific Integrated Circuit 專用集成電路
2. Field Programmable Gate Array 可編改閘門距陣
3. 0.13微米CMOS生產程序下的估計

Configurable RF Interface Module for UHF RFID Tag

用於極高頻射頻標籤的可重設射頻接口模塊

Antenna model | Device model | Characteristic equations | Pre-defined circuits | Design criteria | Configurable layouts

$$I_{DS} = f(V_{GS})$$

Evaluation by computer

Automatic generation

Layout of RF section

Post simulation

Post-simulated results

IC fabrication

Chips

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潘江鵬教授

RFID has extensive applications. However, since the design of RF interface module is application and IC technology dependent, full-custom design approach is commonly used. Re-design is always necessary when changing applications or switching to another IC technology. So, the production procedure is time-consuming and expensive.

This project aims at developing a hardware development platform for the configurable RF interface module for different IC technologies. It can overcome the IC technology dependence of RFID-tag design for low-cost production.

The technology-independent hardware development platform allows the design to be deployed in different IC technologies. Automated RFID-tag design minimizes effort and shortens design time in developing customized RF module for RFID-tag. So, companies can focus on the RFID applications, such as supply-chain management, access control and biomedical monitoring.

射頻標籤的應用相當廣泛，但由於標籤中的射頻模塊要因應用途及所用半導體工藝而設計，故往往需要個別訂製。而當用途或相應的半導體工藝有變，射頻模塊更要重新設計，工序既費時又昂貴。

本項目旨在開發一個用於低成本射頻標籤的可重設射頻接口模塊之硬件開發平台，從而克服射頻標籤設計對半導體工藝的依賴性。

利用這個硬件開發平台，可將標籤設計放到不同的半導體生產工藝上。而自動化的射頻標籤設計，使開發射頻模塊時所花的資源及時間減至最少，公司就可以集中開發射頻標籤的不同應用，例如用於供應鏈管理、門禁進出控制及生物醫學監測等。

Building Recognition System

建築物識別系統

Input image
輸入圖像

Searching
檢索

Library
圖書館

Database
資料庫

Segmentation & recognition
分割及識別

Prof. NGAN King Ngi
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電子工程系
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程邦勝博士
馬林先生

Photo taking function has been increasingly common in electronic gadgets. Most of the mobile phones have such a built-in function. By capturing images of a building, our system can recognize that building accurately and effectively through object classification, segmentation and identification. When linked up with global positioning system (GPS) and corresponding database, this system can also be used to show the name of the target building as well as its location.

自從拍攝功能在數碼產品日趨普遍，大部分手提電話都具備拍攝功能。若在街道上迷路或發現新型建築物，只要把建築物外形拍下，通過系統對建築物圖像的分析、分類及切割，系統便能精確及有效地自動識別圖中的建築物。若連接到全球定位系統及相應資料庫，系統更可顯示目標建築物名稱，甚至建築物位置。
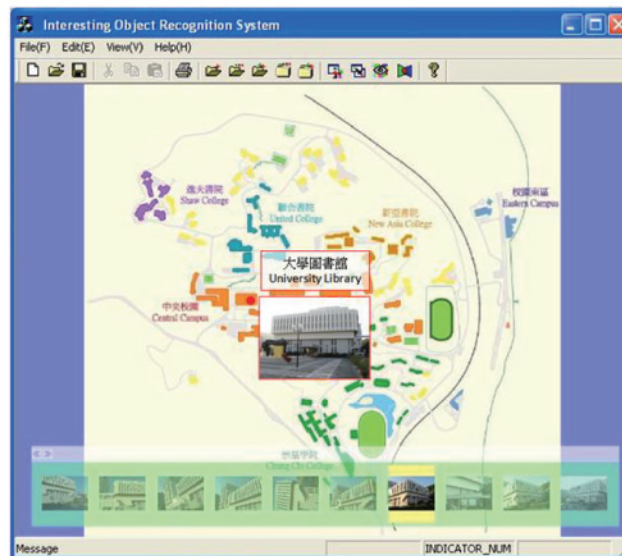
User interface of the building recognition system
建築識別系統的用戶界面

Fast Image/Video Upsampling

圖像或錄像解像度快速提升技術

Original images (left) and the upsampled outputs (right)
原有圖像（左）及提升了解像度之結果（右）

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High-definition (HD) display devices, such as HDTV, are getting more and more popular and eventually more affordable. However, to obtain HD contents, special capture devices are generally required. With numerous videos captured and movies made before any HD standard ever coming into existence, an efficient upsampling algorithm is in great demand for enhancing these image/video contents.

In this project, we develop a simple and yet effective image/video upsampling algorithm to reconstruct images/frames of a higher resolution with a total of 16 times of pixels. The operation which estimates a fine-resolution image/video from a coarse-resolution input is often referred to as image/video upsampling. This is a fundamentally important imaging research topic, where the main purpose is to recover sharp edges and textures, and to suppress pixel blocking (known as jaggies) and other visual artifacts. For videos, there is an additional requirement – that is, to maintain the natural temporal coherence and to avoid flickering among the upsampled frames during playback.

Image/video upsampling finds many applications in resizing, surveillance, and texture mapping. It is vital for all image browsing and video play-back softwares, where the zoom-in function is almost standard.

Video demonstration can be found at:
http://www.cse.cuhk.edu.hk/~leojia/projects/upsampling/index.html

高清顯示設備（如高清電視）愈趨流行，其價格最終也會變得大眾化，但要獲得高清內容，就需要特別的擷取設備。由於很多錄像或電影在高清質素面世之前已經製成，所以一種能有效率地提升圖像或錄像解像度的技術就有很大的需求。

本項目中，我們開發了一套簡單但高效率的圖像或錄像解像度提升演算法，能重建共十六倍像素的高解像度圖像或畫面，從粗糙的輸入估量出細緻的影像。這研究是成像研究範疇中一個根本性上重要的題目，其主要目標是要恢復銳利的邊線及紋理，同時抑制方格效應（稱之為邊沿鋸齒化）及其他視覺錯誤。而處理視頻時則需要多一個要求，就是要保持自然連貫性及避免畫面閃動。

這種技術能廣泛應用於調節大小、監控及紋理繪圖上。這亦是各種圖像瀏覽及錄像播放軟件中不可或缺的功能，因為將畫面放大幾乎是這類軟件的標準功能。

可瀏覽以下網址觀看錄像示範：
http://www.cse.cuhk.edu.hk/~leojia/projects/upsampling/index.html

High-quality Motion Deblurring

高質素去除移動模糊技術

Original images (top) and the deblurred outputs (bottom)
原有圖像（上）及去除模糊後之結果（下）

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One of the most common problems in digital photography is motion blur caused by camera shake. In many situations, there simply is not enough light to avoid using a long shutter speed, and the inevitable result is that many of our snapshots come out blurry and disappointing.

We present a new algorithm for removing motion blur from a single picture and recover as much visual information as possible. This technique performs much better than simply sharpening the blurred images. It computes a deblurred image using a unified probabilistic model of both blur direction and unblurred image restoration. It employs an advanced and efficient optimization scheme to compute the results. This approach has been tested on a variety of pictures and found to be very effective to solve the blur problem due to camera shake. The obtained statistics from extensive experiments show that this method is able to produce results of comparable quality to techniques that require additional input images beyond a single blurry photograph, and to methods that require additional hardware. It has potential to be built into hardware chips for cameras and other imaging devices.

由相機振動引致的相片模糊，是數碼攝影中最常見的問題之一。在很多情況下，因為攝影環境的光線不足，相機無可避免地用了較長的曝光時間，結果很多相片變得模糊及令人失望。
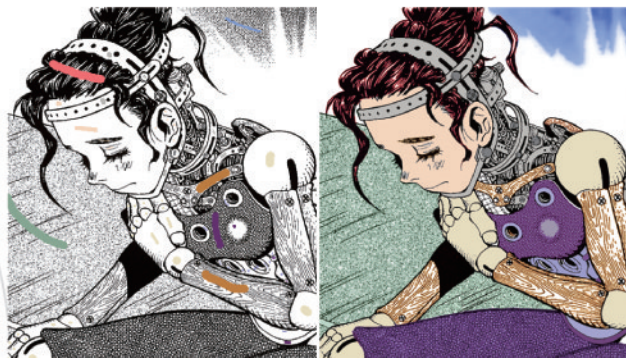
我們提出了一項去除移動性模糊的新演算方法，憑單一照片就能恢復最多的視覺資訊。這項技術比簡單地以銳利化功能處理模糊照片所得的效果好得多。它以一個同時估算模糊方向及處理影像修復的統一機率模型，計算出一個去除模糊的影像，並再利用先進及高效能的優化方案得出結果。這項技術已透過不同種類的照片進行測試，發現能非常有效地修正因相機振動而引致的模糊問題。大量測試後所得的統計數字更顯示，這方法所得的結果在質素上能比得上其他需要額外附加圖片或硬件的技術。它有潛質被用於相機或其他影像器材的晶片中。
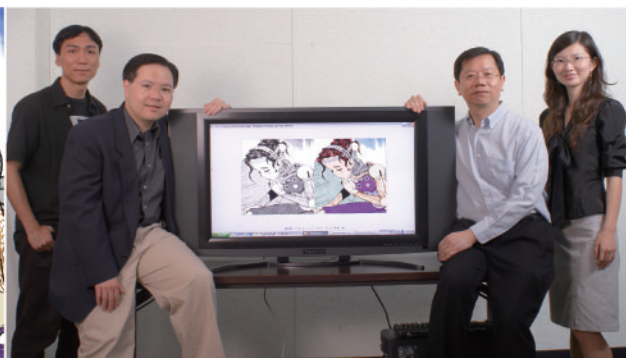
Computational Manga System

數碼漫畫系統

The system can automatically fill up colors by identifying similar hand-drawn hatching and printed screening patterns
系統能按手繪影線或印刷網紙的紋理自動著色

Prof. Wong Tien-Tsin (second from left),
Prof. Heng Pheng-Ann (second from right) and the research team
黃田津教授（左二）、王平安教授（右二）及研究小組

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This project is for efficiency and consistency enhancement, and cost reduction of manga production. It comes with two functions – 'Manga Colorization' and 'Manga Screening', enabling easy colorization and de-colorization, respectively.

'Manga Colorization'
Colorization is the most time-consuming procedure in manga production. Using the existing software to colorize regions without enclosed boundaries will result in leakage, as computers have no idea of the semantics of the manga. 'Manga Colorization' can automatically identify similar hand-drawn hatching and printed screening patterns, and fill up similar regions with the desired colors intelligently and quickly.

'Manga Screening'
It can mimic the way a manga artist lays screens with different patterns to convert color images into b/w manga, with a much more promising result than the traditional halftone technique. The new technology helps manga artists to substantially reduce their time and manpower spent on preparing the background, so that they can focus more on the design of characters.

為了提升日式漫畫的製作效率，降低製作費用，並統一風格，「數碼漫畫系統」有「漫畫著色」及「照片漫畫化」兩項功能，分別為漫畫著色或褪色。

「漫畫著色」
製作漫畫的過程中，其中一項最費時的工序就是為漫畫著色。使用現有軟件為非閉合線條的內部著色時，由於電腦無法識別應著色的範圍，往往會有顏色「出界」的問題。「漫畫著色」功能能夠識別相似的手繪影線或印刷網紙的紋理，自動識別著色範圍，一次過快速而準確地著色，大大減少著色工序所花的時間。

「照片漫畫化」
這項功能可以自動為彩色圖片褪色，以不同網紙紋理代替顏色，模仿漫畫師的手筆製成黑白漫畫，比一般以半調色技術所得的效果更理想，更接近傳統漫畫創作，能幫助漫畫師大大減少處理場景所花的時間，以便騰出更多時間設計漫畫中的角色。

Original
原稿

Halftone
半調色效果

Our Result
本項目效果

The system can prevent color leakage
系統能避免漏色問題

The function of "Manga Colorization"
漫畫著色功能

System for Animating Animal Motion from a Still Picture

單一圖片合成動物動畫系統

animated motion of a bird

source image

(a) birds

source image

animated motion of an elephant

(b) elephants

Given a still picture of a group of moving animals, for example a flock of flying birds, or a group of walking elephants, is it possible to simulate the motions of bird and elephant solely from the single picture?

In this project, we studied this interesting academic problem. It seems that it is impossible, as the motion information is missing. However, we found that it is possible to infer the continuous motion of different species of animals, even from a still picture. As the still picture captured multiple individuals and their movements may not be synchronized, these different individuals can form the "key frames" of the motion cycle. By deducing the order of these "key frames", we developed an optimized motion cycle. Finally, we can refine their pose, morphology, and appearance by morphing to ensure the consistency and get a smooth and surprisingly realistic result. The same method can be applied to simulate motions of a wide variety of species, like elephant, bird, fish and turtle.

The recovered motion is surprisingly realistic. This technique helps people to recover motions even when the amount of captured images is very scarce.

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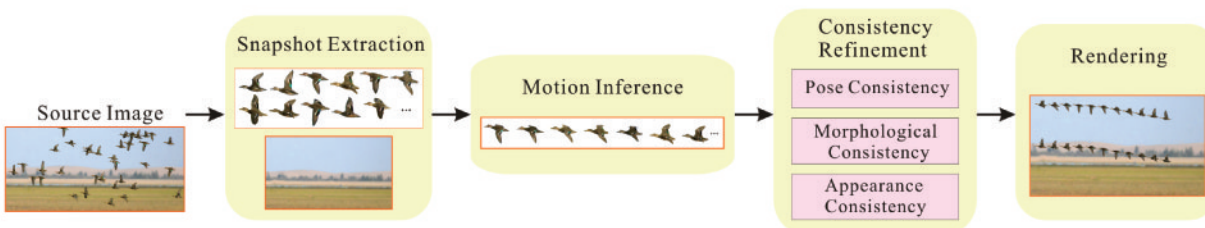
單靠一張動物群的照片，例如一群飛行中的雀鳥或一群行走中的大象的照片，能否模擬出這些動物的動作呢？

此項目研究了這個有趣的學術問題。這個問題似乎不可能解決，因為圖片中缺乏動物的移動資料。然而我們卻發現，即使只有一張圖片，我們仍是有機會推斷出這些動物的連續動態的。因為一張動物群照片內包含了同一物種的很多不同的個體，而每個個體都可能處於不同的動態。我們可以把這些移動個體想像成同一個個體在不同時間表現出來的動態，只要把這些動態進行排序，就能模擬出這種動物的移動序列。由於動物的移動往往是週期性的，我們可以進一步從這些排好的移動序列中得出動物的移動週期。最後以變形技術完善其在形狀、形態及外觀方面的連貫性，就能產生一個流暢而逼真的動物動態。這種方法亦適用於不同物種的照片，如大象、雀鳥、魚及烏龜等。

這種方法模擬出來的動物移動出奇地逼真。即使當相片數量非常不足，這技術仍有助模擬出各種動物的動態。

Farmtasia 2

農場狂想曲 2

Screenshots of Farmtasia 2 and the research team
「農場狂想曲 2」的遊戲版面及其研究小組

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資訊科技教育促進中心
李浩文教授

Commercial digital games are usually addictive with controversial contents, while conventional educational games are usually unattractive and focus on assessment rather than learning. Farmtasia 2 is a carefully designed multi-player online game which serves both education and entertainment purposes for students.

Farmtasia 2 is a Massively-Multiplayer Online Role-Playing Game (MMORPG) with near-real-situation farming environment. It can simulate 11 types of climates, 256 cities and 60,000 farms around the world. There are 20 types of crops, 4 types of farm animals and 20 types of buildings, providing countless possibilities of gameplay.

Besides, it has the following technical features:
- Web-based, no installation required
- Server supporting up to 2,000 concurrent users
- Fast response time (under 0.3 second delay)
- Dynamic game contents, no patch required

This educational online game is designed for primary and secondary school students, with administration tools for teachers and parents. It can be used in project-based learning and the Liberal Studies curriculum.

商業電子遊戲通常容易使人成癮，而且內容具爭議性；反觀傳統的教育遊戲則往往不夠吸引力，著重評估而不是學習。而「農場狂想曲 2」則是一個經過小心設計的多人網上遊戲，它能同時達到教育及娛樂學生的目的。

「農場狂想曲 2」是一個大型多人在線角色扮演遊戲，它有一個非常貼近真實的農場環境，能模擬世界各地11種氣候、256個城市及6萬塊田。當中有20種農作物、4種農場動物及20種建築物，令該遊戲有無數的可能性。

此外，它有下列技術特性：
- 網上操作，無須安裝附加軟件或硬件
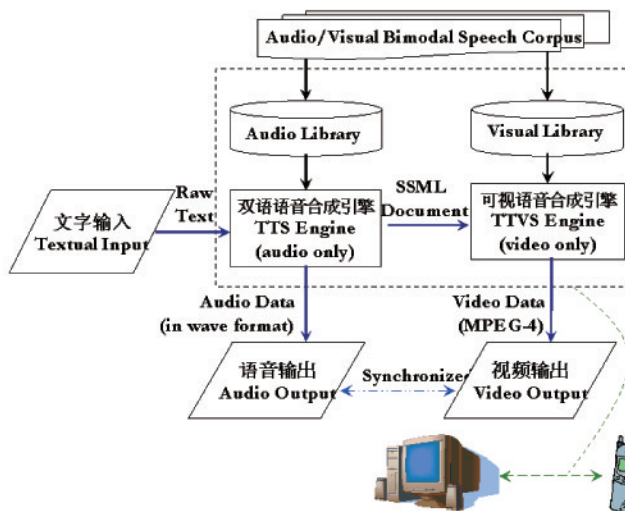- 伺服器可同時支援2,000個用戶
- 快速回應時間（延緩少於0.3秒）
- 動態遊戲內容，無須附加程式

此網上教育遊戲是為中、小學生設計，附有供老師及家長使用的監察工具，適用於專題研究及通識課程上。

Crystal: Text-to-Audiovisual-Speech Synthesis in Putonghua and Cantonese

晶晶：普通話與廣東話文本到視聽語音合成技術

Embedded version of Crystal
「晶晶」嵌入式版本

We have developed a real-time Chinese text-to-speech synthesizer named Crystal. It accepts Chinese textual input and generates audiovisual output with natural sounding Cantonese/Putonghua speech synchronized with animated lip movements of a virtual speaker (or avatar). The avatar can exhibit facial expressions and head movements that are conducive to communication.

- Desktop version – run on Windows platform
- Web-based version – a platform and browser independent edition
    • Support asynchronized streaming
    • Synthetic results can be downloaded in MP3 or MP4 format
- Embedded version – run on WinCE
    • Support mobile and multimodal applications, e.g. SMS reading

我們開發了一個實時的由漢語文本到語音合成器，名為「晶晶」。她通過一個虛擬人物的形象，將漢語的文本輸入以視聽兼備的方式表示出來。「晶晶」可以用廣東話或普通話進行語音合成，並同時做出唇部的動作，還可以做出面部表情和頭部動作以幫助交流

– 桌面版本– Windows平台上運作
– 網絡版本–獨立於平台和瀏覽器
    • 支持非同步視頻流
    • 綜合結果可以MP3或MP4的格式下載
– 嵌入式版本– WinCE平台上運作
    • 支持手提和多式聯運軟件，如：閱讀短信

Desktop version of Crystal
「晶晶」桌面版本

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Building Multilingual Meta-search Engine over the Web

建造萬維網上的多語言搜索引擎

User interface of the SO!ME search engine
「搜我」搜索引擎的用戶界面

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While search engines become increasingly powerful, they mostly concentrate on searching the web pages in the same language as that of the given query. As a result, relevant pages in other languages are neglected. These pages could be even more relevant than those of the original language. In this project, we use multilingual information retrieval techniques to help web searchers overcome the language barrier between users and documents by finding the relevant pages in different languages regardless of the query's language. However, this problem is challenging due to the difficulties in several aspects: query translation, searching, and merging (or re-ranking) of search results in different languages; additionally, it is often necessary to translate the results into the user's language for browsing. Our work aims to tackle these challenges.

For the above purpose, we created an online search system in the world wide web, called SO!ME, standing for Search Optimization in Multilingual Environment. Our technique in SO!ME proposes to build a multilingual meta-search engine on top of multiple existing monolingual search engines, such as Google, Baidu, Live search, etc, and aims to effectively optimize the performance on translating queries and merging search results in different languages. To translate query, we exploit state-of-the-art web data mining techniques to automatically discover the translations of the input query from the search results; for result merging, we use machine learning methods to re-rank the items in different ranked lists based on their strength of relevancy to the query; to facilitate user reading and browsing, we adopt online machine translation site like Google translate to translate the results according to the user's preference.

儘管搜索引擎的功能日益強大，但是它們幾乎全都集中搜索與用戶查詢語言相同語言的網頁。因此，其他語言的相關頁面則無法被找到，而這些頁面的相關性與源語言頁面相比可能會更高。多語言資訊檢索的目標正是要克服搜索用戶和頁面內容之間的語言障礙，通過找到不同種類語言的相關網頁而無需理會查詢時所使用的語言。然而，這項技術很具挑戰性，在以下各方面均會遇到困難：翻譯查詢請求，搜索過程自身，不同語言結果的合併，以及經常有必要將搜索結果翻譯成用戶能夠閱讀的語言。我們的任務是如何解決這些困難。

基於以上的目標，我們創建了一個在線萬維網搜索系統稱為搜我，意即多語言環境下的搜索優化的英文首字母縮寫。搜我採用的技術是在現有的單語言搜索引擎（比如Google, Baidu, Live 等）的基礎上開發一個多語言的元搜索引擎，並且有效地優化查詢翻譯和搜索結果合併兩個方面的性能。例如，對于查詢翻譯，我們就採用了先進的萬維網數據挖掘技術自動地從搜索結果中為輸入的查詢請求找尋適當的翻譯；對於結果合併，我們就使用機器學習的方法在不同的排列表中，根據搜尋結果的相關性來重新排列搜尋結果，最後，為了方便用戶的閱讀和瀏覽，我們還利用用在線機器翻譯工具根據用戶的語言偏好來翻譯搜索結果。

DJX: A Personalized Music Recommendation System

DJX: 個性化的音樂推薦系統
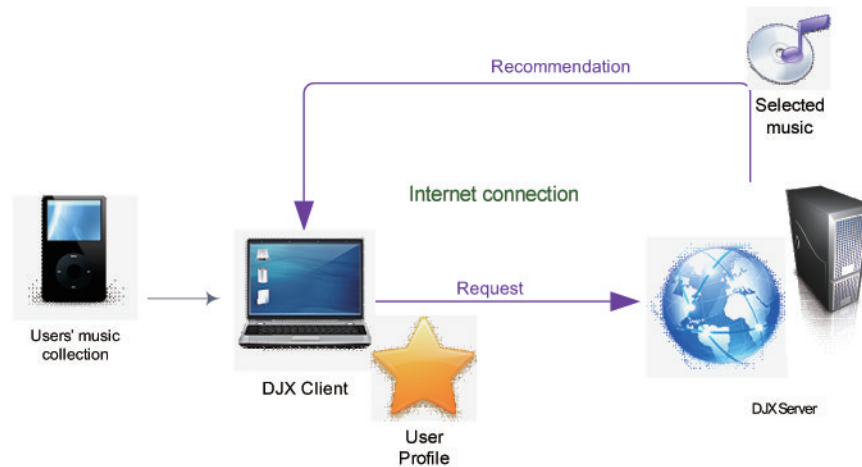
Music recommendation refers to the technology by which computers automatically recommend music assets to users. In this project, we adopt a content-based approach to facilitate truly user-centered recommendation. The key component of the DJ X system consist of a set of audio signal analysis and classification algorithms. The algorithms analyze the audio signal and extract various music-related features about singing voice characteristics, instrument timbre, rhythm, and music structure. In addition, the lyrics of a song, if available, are analyzed by natural language processing techniques to detect the sentiment that the song intends to express. The extracted audio and textual properties are used to establish a quantitative similarity measure between two music pieces. This similarity measure forms the basis for recommendation.

The DJ X system consists of a client software running on the user's personal computer, and a server system that can access and process a huge music collection. The client software automatically captures the user's music preferences from his/her existing music collection and listening habits. On the server side, the system identifies music items that best match the user's taste and makes recommendations accordingly.

- The DJ X system focuses on Chinese pop songs and therefore benefits a large user population
- The system is largely based on audio signals, which most faithfully reflect the music content
- The system does not require users to explicitly describe their music preferences. Instead it can learn from their personal collections and listening habits
- The design of the system provides the flexibility to enable many different recommendation functions, e.g., user community groups, recommendation with surprise
- The client part of the system can also be used as a music organizer by individual users

音樂推薦指的是一種由計算機自動向用戶推薦音樂作品的技術。我們的DJX系統採用基於內容的匹配和過濾方法來實現真正以用戶為中心的音樂推薦。DJX系統的核心是一系列音頻信號分析與歸類的算法。這些算法能提取音樂信號中關於噪音、樂器、節奏、音樂結構等特徵。另一方面，我們也利用自然語言處理技術來分析歌詞以提取歌曲的情感信息。DJX 系統倚靠這些音樂特徵和情感特徵來量化地比較各個音樂作品，以比較作品之間的相似程度，並以此作爲音樂推薦的基礎。

DJX系統包括一個運行在用戶電腦上的客戶端軟件和一個能處理龐大音樂數據庫的伺服器。客戶端軟件能根據用戶的音樂收藏集和欣賞習慣自動分析用戶的音樂欣賞喜好。而伺服器則負責自動搜索並推薦最符合用戶音樂喜好的音樂作品。

- DJX系統專注于中文流行樂曲的推薦，其受眾將數以億計
- 該系統主要依據音樂的音頻信號本身，能真實地反映音樂作品的本質
- 系統不需要用戶具體描述其音樂喜好，它能通過用戶的個人音樂收藏集和欣賞習慣自動分析其音樂喜好
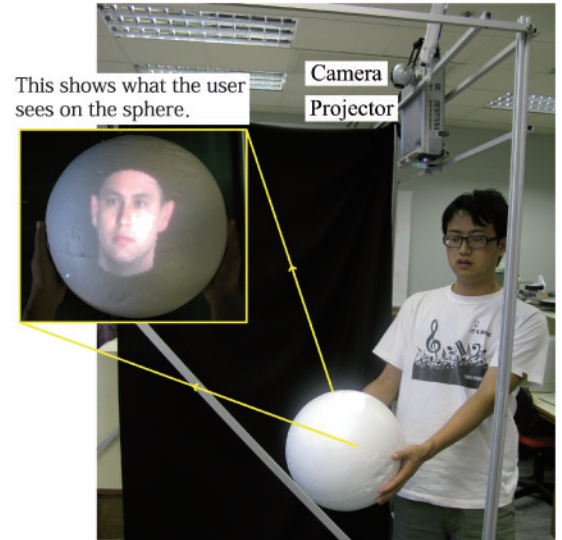- 系統的設計提供了很大的自由度以實現多種多樣的推薦功能，如用戶交流組的推薦，以及"意外驚喜"的推薦模式等等
- 用戶也可以將系統的客戶端軟件作爲一個音樂管理器使用

Prof. LEE Tan
Department of Electronic Engineering

電子工程系
李丹教授

3D Hand-held Display for Viewing without Spectacles

無須立體眼鏡的三維手提式顯示技術

This shows what the user sees on the sphere.

Camera
Projector

Prof. WONG Kin Hong
Department of Computer
Science and Engineering

計算機科學與工程學系
黃健康教授

Viewing 3D models usually requires the user to wear specially designed spectacles and the cost of building such a system is high. This project proposed a low cost solution for viewing 3D models without spectacles.

We designed a new 3D display interface using multiple projectors projecting images on the surface of a "screen" (a white sphere or a white cardboard) which can be held and moved freely by the user. By tracking the position and angle of rotation of the "screen" and the head of the user, a real-time, corresponding 3D image will be generated and projected on the "screen". Using this system, the user will experience as if he is holding the real object in hand and control the viewing angle freely.

The technology can be used in education, digital games and medical applications for showing 3D models easily at low cost.

觀看三維模型時，觀眾通常需要配戴特別設計的眼鏡，而且建立這類顯示系統的成本很高。本項目則提出了一種既低成本，又無須配戴立體眼鏡的顯示方案。

我們設計了一種嶄新的三維顯示介面，運用多個投影器將影像投射在由觀眾手持並可隨意移動的「顯示面」上，這個「顯示面」可以是一個白色球體或一塊白卡紙板。透過追蹤「顯示面」及觀眾頭部的位置及移轉角度，一個相應的三維影像就會即時產生並投射於「顯示面」上。觀眾會感覺猶如手持影像中的實物一樣，更可以隨意控制觀賞角度。

這項技術可用於教育、電子遊戲及醫療應用上，實現低成本的三維影像顯示。

Indoor Ionic Propulsion Technology
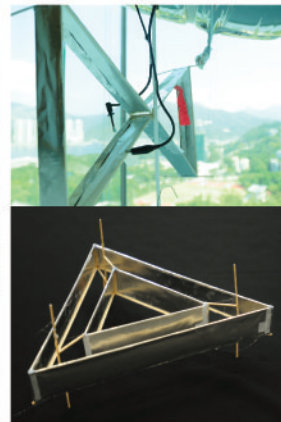
室內離子噴射技術

Ionic Propulsion Blimp
離子噴射飛艇

Research team members
研究小組成員

Components of Ionic Flyer
離子飛行器的組件

Strong mechanical vibration and significant noise generated by mechanical moving parts are some of the intrinsic problems of conventional aerodynamic flying devices. Besides having negative effects on the environment, these problems affect the ability of surveillance flyers to capture real time video information stably. Autonomous navigation using conventional Inertia Measurement Unit (IMU) and vision-based control strategies are also hard to achieve due to these intrinsic problems.

To resolve the above intrinsic problems, our group invented a novel ionic propulsion technology which converts high voltage electrical energy directly into thrust force for propulsion without moving parts and noise. Thus far, we have demonstrated a new kind of propulsive unit called "Ionic Flyer", which provides lift or thrust force using ions to propel mechanical structures. An indoor flying system – an Ionic Propulsion Blimp, has been developed to show one of the applications of the Ionic Flyer technology.

傳統空氣動力學飛行系統中一個難以克服的根本性問題，就是機械運轉部件所產生的強烈機械震動和噪音。這些問題除了對環境帶來負面影響外，往往更會大幅度降低監察飛行系統上的即時視訊監視系統的穩定性。因此，配備傳感器和攝影機的智能控制航系統亦難以應用於這些飛行系統上。
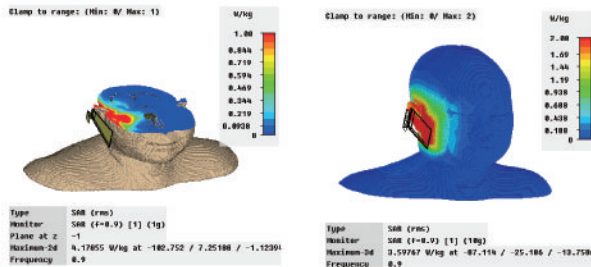
為了解決上述問題，本項目小組發明了一項創新的離子噴射技術，此技術將高壓電力直接轉化為機械動能以產生推進力，完全無需任何機動配件，故此運作時不會製造噪音。利用這項技術，我們開發了一種新型飛行系統──離子飛行器，它能利用離子於機械結構上產生升力或推進力。其後，我們更進一步開發了一艘室內飛行艇──離子噴射飛艇，來示範離子噴射技術的實用性。

Prof. LI Wen Jung
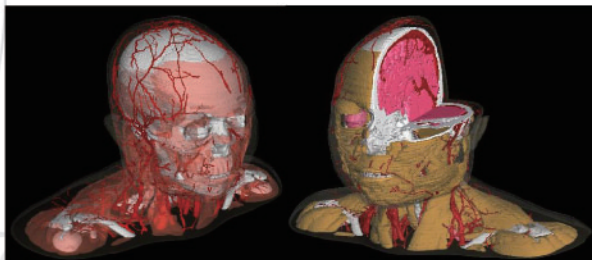Department of Mechanical and Automation Engineering

機械與自動化工程學系
李文榮教授

# A High-Resolution Electromagnetic Human Head Model for Calculation of SAR

計算手機比吸收率的高解像度電磁人頭模型

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Department of Electronic
Engineering

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Department of Computer
Science and Engineering

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王平安教授

10g averaged SAR distribution (900MHz) of CEMHM model
比吸收率分布為平均10克 (900MHz)時的中國電磁人模型

The high-resolution CEMHM head model
高解像度中國電磁人頭部模型
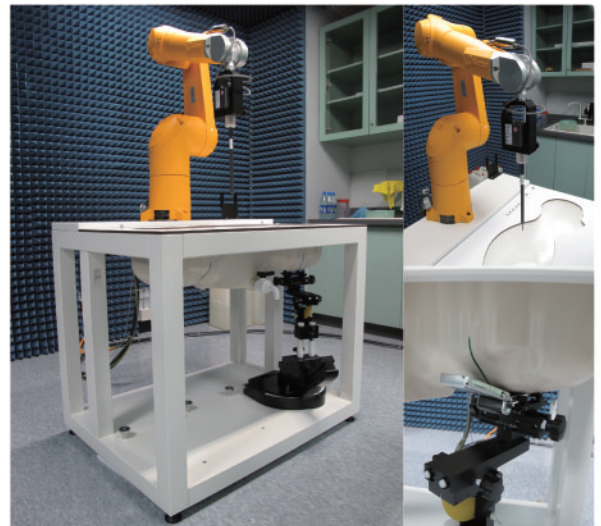
The system for assessing SAR by using head simulating liquid
使用人類頭部模擬液體進行電磁波能量比吸收率測試之系統

Following the pervasive use of wireless devices, electromagnetic energy absorption in human body has brought up tremendous concerns for the possible consequences on health. The human head's exposure to electromagnetic fields from a mobile phone is a major area of worry. Many studies have been carried out to calculate the Radio Frequency (RF) Specific Absorption Rate (SAR) in a human body when exposed to an electromagnetic field.

A high-resolution anatomically realistic human head model for the calculation of SAR has been developed by CUHK. This model is a part of the Chinese EM Human Model (CEMHM) which has a voxel resolution of 0.16 x 0.16 x 0.25 mm for the head and 0.16 x 0.16 x 0.5 mm for the rest of the body. In the head model 49 biological tissues have been identified. The electric properties of the tissues published by Federal Communications Commission (FCC) of USA have been used in the electromagnetic simulation. The CEMHM head model is particularly useful for calculating the detailed SAR distributions in human head.

隨著無線設備的普及，人體吸收電磁波能量後對健康的影響成為一項重大的關注。而最令人憂慮的是接近人類頭部的手機電磁輻射，很多研究亦紛紛計算人體暴露於電磁場下的射頻比吸收率（即身體吸收輻射量的水平）。

中大開發了一個高解像度的人頭解剖學真實模型，用作計算手機的比吸收率。這模型是「中國電磁人模型」的其中一部份，它有一個頭部為0.16 x 0.16 x 0.25毫米，及身體其他部份為0.16 x 0.16 x 0.5毫米的立體像素解像度。於頭部模型中，共有49種生物組織被標示出來，而美國聯邦通信委員會所發表關於這些生物組織的導電屬性亦有運用於電磁模擬之中。這個中國電磁人頭部模型對於計算比吸收率於人類頭部的詳細分布極之有用。

2008 Asia-Pacific Microwave Conference (APMC) prize
2008亞太微波學術會議獎

"VeriGuide" Text Similarity Detection System

「維誠」文字相似性檢測系統

VeriGuide promotes academic honesty amongst students
「維誠」提高學生間的學術誠信

Screenshot of VeriGuide
「維誠」網頁

The VeriGuide system is a new generation plagiarism detection software designed for promoting and upholding academic honesty in the academic community. The system supports English, traditional and simplified Chinese, and provides a user-friendly web interface for class assignment management and submission. It can handle documents in different formats including Microsoft Office, Acrobat PDF, OpenOffice, HTML, plain text and zip archive. Submitted documents are compared among one another, and with other documents in the central database and the Internet. Output from the system is an originality report highlighting suspected plagiarized contents, and giving detailed analytical and statistical data.

Besides, VeriGuide can assist educators to assess students' writing ability over time with the readability features. The paragraph-based readability analysis can help teachers to identify suspected plagiarized works with abnormal readability grades. It can also perform as an assignment collection system to provide an integrated educational service for institutions.

Prof. KING Kuo Chin Irwin
Department of Computer Science and Engineering

計算機科學與工程學系
金國慶教授

「維誠」系統是一個為提高及維護學術誠信而設計的新一代剽竊偵查軟件。此系統能支援英文、繁體及簡體中文，並提供一個容易使用的網上介面，作功課管理及提交之用。它能處理Microsoft Office、Acrobat PDF、OpenOffice、HTML、純文字及壓縮檔等不同格式的文件。系統會對已提交的文件進行相互比對，並與其他於中央數據庫內及互聯網上的文件作比較。最後輸出一份原創性報告，標明文件中疑似剽竊的內容，並提供詳細的分析及統計數據。

另外，「維誠」以其可讀性分析工具，能協助教育家不斷評估學生的寫作能力。當中的段落可讀性分析工具，更會顯示出異常的可讀性等級，幫助教師識別涉嫌剽竊的文件。它同時能作為一個功課收集系統，為教育機構提供一站式的綜合教育服務。

🏅 Champion, CUHK Vice-Chancellor's Cup of Student Innovation 2007
The Third Prize, the 9th Challenge Cup

2007年香港中文大學校長杯－學生創新比賽冠軍
第九屆「挑戰杯」全國大學生課外學術科技作品競賽三等獎

Collaboration with the Education Bureau (EDB) of HKSARG,
SpringerLink, Wan Fang Data, ProQuest, Emerald, Mergent Online,
China National Knowledge Infrastructure (CNKI),
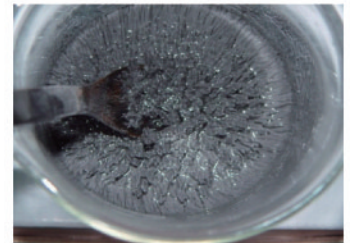Elsevier, SCA, ISI Web of Knowledge, Wiley, Ovid and EBSCOhost

合作夥伴為香港特別行政區政府教育部、SpringerLink、萬方數據、ProQuest、Emerald、Mergent Online、中國國家知識基礎設施工程、Elsevier、SCA、ISI Web of Knowledge、Wiley、Ovid及EBSCOhost

Technology for Making Large Telescope Mirrors

大型望遠鏡鏡頭製造技術

Electro-magnetic Coil
Self-rotating Axis
Soft-magnetic Material

Natural status of MR fluid
液體磁流的自然狀態

MR fluid under magnetic field
液體磁流在磁場下變成固體狀態

Prof. YAM Yeung
Department of Mechanical
and Automation Engineering

機械與自動化工程學系
任揚教授

Prof. CHU Ming Chung
Department of Physics

物理學系
朱明中教授

We are developing a novel grinding and polishing machine which utilizes magneto-rheological fluid as a medium for making aspheric lenses. Conventional processing relies on controlling the movement of a tool lap for material removal, and lacks the ability to closely adhere to the optical surface.

By contrast, magneto-rheological fluid is a mixture of magnetic particles, nonmagnetic abrasive particles, water and stabilizing agents. Under proper magnetic excitation, the fluid can conglomerate into a locally semi-solidified lump, which can be maneuvered as a sub-aperture grinding tool with close conformity to the local curvature. As such, optical lenses of higher quality can be achieved compared to usual conventional processing. Among other advantages, there is also no tool wear and debris produced is removed by the continuous slurry flow.

The machine will greatly enhance the technological capabilities of the Hong Kong optical industry towards the production of high end precision optical components and instruments.

我們正開發一種利用液體磁流作為磨料介質的新型非球面研磨/拋光加工機。傳統光學加工工藝通過控制剛性或半剛性接觸式磨頭的轉動去除多餘材料，研磨過程中，磨頭易磨損、與工件表面貼合度差進而導致去除量不穩定。

比較而言，液體磁流是由磁性微粒、非磁性磨粒、水及穩定劑按一定比例配製而成的一種特殊功能材料。在適當磁場激勵下，液體磁流會變成具有粘彈性特徵的半固態緞帶凸起狀，可作為柔性小磨頭，緊密貼合被加工工件表面的局部曲率，並借助於液體的流動去除磨屑，結合柔性小磨頭的無磨損特性從而有望製造出比傳統光學工藝更高品質的光學鏡面。
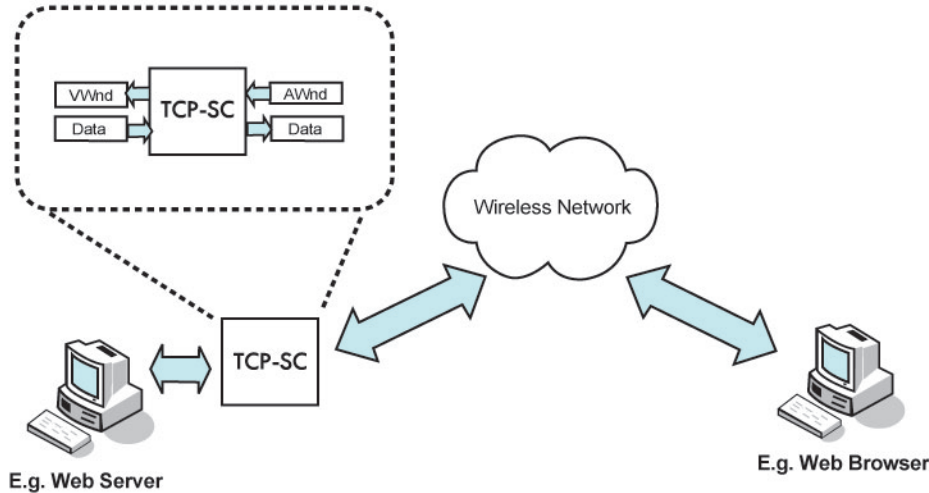
該研究的成果包括增強功能型磁流加工機、納米精度非球面透鏡研磨/拋光系統工藝規範各一套。該科研的成功將會顯著地提高香港光學工業專有技術水準，促進香港光學工業高端元件及儀器的發展。

Traffic Accelerator for Mobile Networks

手機網絡的流量加速裝置

E.g. Web Server

Wireless Network

E.g. Web Browser

Prof. LEE Yiu Bun Jack
Department of Information Engineering

訊息工程學系
李耀斌教授

It is well-known that TCP (Transmission Control Protocol) does not perform well in networks with large bandwidth-delay-product, such as mobile networks and satellite networks. The result is severe under utilization of the wide bandwidth available in modern wireless networks.

This invention proposes novel systems and methods to enable TCP to fully utilize the underlying network bandwidth without modification to the applications or support from the operating system.

The TCP-SC gateway in the figure above is designed to carry out this new function. Specifically, when it receives an acknowledgement (ACK) packet from the receiver which carries an updated advertised window size (AWnd), it will compute a new virtual advertised window size (VWnd) that takes into consideration of the receiver's processing capability and buffer availability to enable it to forward more data than AWnd would allow so that a higher throughput can be achieved. Experimental results show that the invention can improve the throughput of existing TCP flows over large bandwidth-delay-product networks by over one order of magnitude.

It will work on any operating system and is compatible with all existing applications such as web browsers, ftp, email and p2p software. It does not require an increase in memory consumption at the receiving host, thus suitable for mobile phones.

眾所周知，傳輸控制協議（TCP）於較大頻寬延緩積數的網絡（如手機網絡或衛星網絡）中不能暢順地運作，結果造成無線網絡中的寬頻出現嚴重的低使用率。

上圖中的TCP-SC通道是為這項新功能而設計，當它從接收器取得載有最新通知視窗大小（AWnd）的確認訊息包時，它就會將接收器的處理能力及緩衝可用性考慮在內，從而計算出一個新的虛擬視窗大小（VWnd），使它能比AWnd傳輸更多數據，達到更高的吞吐量。

此發明提出了新穎的系統及方法，令TCP能夠在不改變應用或沒有操作系統的支援下，充分地使用網絡頻寬。而實驗結果顯示，這項發明能改善現存TCP通過大頻寬延緩積數網絡時的吞吐量，加速超出一個數量級。

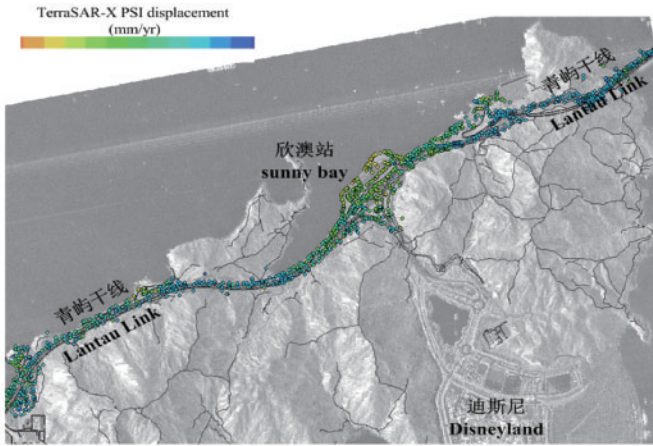此裝置能用於任何操作系統上，並兼容所有現存的應用介面，如瀏覽器、ftp、電郵及點對點軟件。接收的一方無須消耗更多記憶體，所以適合在流動電話中使用。

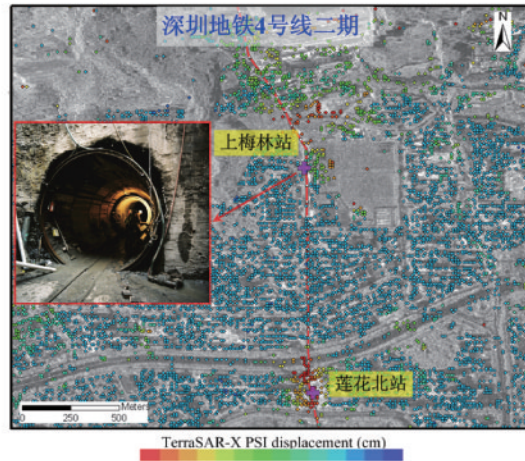# Geoinformation and Earth Sciences

地球訊息與地球科學

Development of Industrial Standards for Ground Deformation Monitoring in Transportation Infrastructures Constructions Using A-PSI-Based Satellite Measurements

採用衛星A-PSI 技術開發監測交通基礎設施地表變化的工業標準

Satellite ground deformation monitoring along the MTR Tung Chung Line

沿港鐵東涌線衛星地面變形監測

Satellite ground deformation monitoring along the construction sites of the Shenzhen Subway line 4 phase 2

沿深圳地鐵4號線2期建築地盤的衛星地面變形監測

This project builds on the success of the previous ITF project: "Development of the Advanced Radar Satellite Remote Sensing Technology for Monitoring Urban Ground Deformation" and aims to transfer the developed new technologies – the A-PSI framework, into industry adoptable standards so that the research products can be effectively transfered to the local industry.

Satellite Permanent Scatterers Interferometry, (PSI) is a promising technology that offers low cost, large-coverage deformation monitoring and up to sub-millimeter accuracy. However, due to insufficient archive images available to many China and Asian cities, PSI can hardly be widely applied in the region.

Advanced PSI (A-PSI) overcomes PSI's limitations in the region. A-PSI relaxes the PSI's constraints and can be applied in linear or non linear deformation (e.g. landslide) scenarios. Moreover, A-PSI can also be applied to areas of interests even with a limited SAR archive images (e.g. China and other countries in Asian).

在「開發應用於城市地表變形監測的先進雷達衛星遙感技術」的成功基礎上，本項目目的是將已開發的新技術—A-PSI方法，轉化為工業標準，有利於新技術在本地工業有效應用。

衛星雷達遙感永久散射體干涉測量(PSI)擁有低成本、大範圍監測及毫米級準確度等優點。但很多中國及亞洲城市只有少量雷達遙感存檔影像，使PSI很難普遍應用。

衛星雷達遙感地面沉降監測高級技術(A-PSI)並不局限於線性地表形變亦可應用在非線性形變(如山泥傾瀉)，並且A-PSI可以在只有小量SAR影像的地區推廣應用（如中國和亞洲城市）。
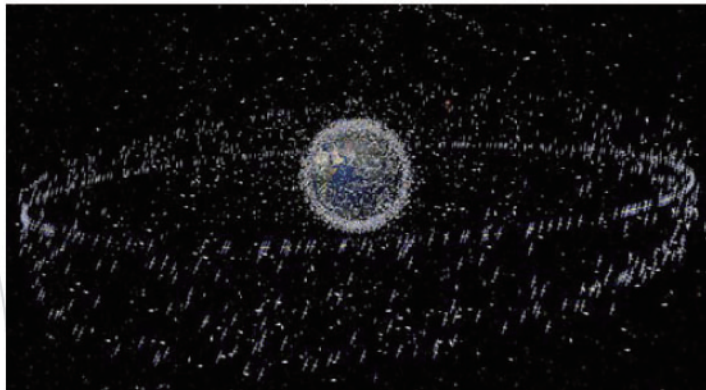
Prof. LIN Hui
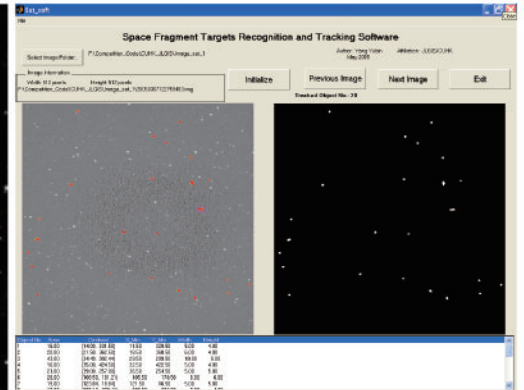Institute of Space and Earth Information Science
太空與地球信息科學研究所
林琿教授

Automatic Space Debris Identification and Tracking System

自動偵測與追蹤太空碎片系統

Space debris on Earth's Orbit (European Space Agency)
地球軌道上的太空碎片（歐洲航天局）

Automatic Space debris recognition and tracking system
太空碎片自動識別與追蹤系統

Prof. LIN Hui
Dr. YANG Yubin
Institute of Space and Earth
Information Science

太空與地球信息科學研究所
林琿教授
楊育彬博士

The impact of space debris is one of the major results of spacecraft damage or even explosion. In order to prevent damage caused by space debris, manufacturers of spacecraft shall provide special protective coating materials and introduce redundancies for key equipments as back-up facilities. The extra facilities not only increase the development costs but also degrade the performance of satellite, by increasing its weight and shortening its working life.

Hence, if we can develop economical, simple and effective means to track and monitor the location and trajectory of space debris and use such information to provide collision warning, collision can be avoided by adjusting the spacecraft's orbit. The risk of damages to spacecraft will thus be substantially reduced, which will in turn enhances the performance and greatly reduces the overall costs of development.

This study makes use of the optical astronomical CCD images. By applying computer image processing, image recognition and analysis, vision and artificial intelligence and related technologies, an automatic system was developed. It can be used to identify the space debris, stars and calculate the target locations, size, length, width and the characteristics of eccentricity from the CCD images.

Then, based on the principle that space debris moves faster than other space objects, the CCD image sequences are combined with the methods of active contour tracking and similarity comparisons to develop an algorithm of target space debris automatic identification and trajectory tracking. The results could be used to establish a dynamic database system of space debris.

太空碎片的撞擊是造成航天器損壞其至爆炸的主要原因。為防止航天器因太空碎片撞擊而導致損壞，目前各國在製造航天器時往往需要為航天器鋪設特殊保護層材料，並對其關鍵設備採取雙備份甚至三備份設計。這些額外措施不但提高了研製成本，更會增加衛星的幹重及縮短衛星的工作壽命，大大影響衛星的性能。

因此，如果能利用既經濟簡單又有效的觀測方法對太空碎片位置和運行軌跡進行準確追蹤和監測，並據此提供有效的碰撞預警機制，調整航天器的運行軌道，避免與太空碎片相撞，我們將能大幅降低航天器損壞的風險，提升航天器的性能及降低研製成本。

本研究利用天文光學探測方法獲得太空觀測CCD圖像序列，採用電腦圖像處理、圖像識別與分析、電腦視覺和人工智能等相關技術，自動識別出每幅CCD圖像中的太空碎片以及背景恒星等空間目標，並定量計算其灰度質心（表示空間目標的位置）、面積、長、寬和偏心率等空間特徵。

根據太空碎片移動較快的特點，在CCD圖像序列中結合主動輪廓追蹤和特徵相似性比較兩種方法，對其中出現的太空碎片目標進行自動識別和追蹤，並根據自動追蹤的結果，得出其在空域中的移動軌跡，建立可追蹤的太空碎片目標位置資訊動態資料庫。

Flying into the Future ---- Space Exploration Innovation Contest, 2004 -2005, 3rd Prize
飛向未來－太空探索創新競賽 2004－2005, 三等獎

Build and Operate CBERS-02B Satellite Ground Receiving Station to Support Earth Resources and Environmental Monitoring

建立和運行CBERS-02B遙感衛星地面接收站以支援地球資源和環境監察

Dr. Sun Laiyan, Administrator of China National Space Administration (CNSA) confirmed the authorization of the CUHK Station to receive data from the latest CBERS-02B Satellite
孫來燕博士，中國國家航天局局長確認授權香港中文大學衛星站接收最新的中巴地球資源衛星02B衛星數據
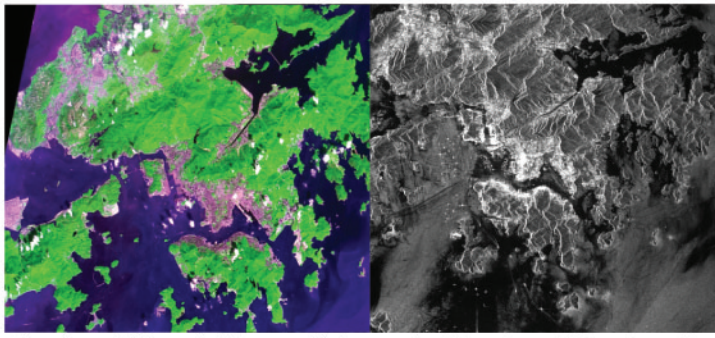
Timely multiple satellites, multiple spectral bands and in all-weather environmental monitoring
多衛星，多光譜，全天候的環境監察。多顆衛星，多光譜波段和及時的全天候環境監測

With the initial success of the Satellite Remote-sensing Ground Receiving Station of CUHK, the China National Space Administration (CNSA) has authorized the CUHK Station to receive the latest China-Brazil Earth Resources Satellite (CBERS-02B) data. The CBERS-02B Satellite was launched on 19 September 2007, it is equipped with 20m multi-spectra cameras and a brand new 2.7m optical high resolution panchromatic camera.

New CBERS-02B satellite ground receiving station inside the CUHK campus will be built with the new CBERS-02B acquisition capability. The CUHK Station can monitor the area of Southern China as well as Southeast Asia with multiple satellites, multiple spectral bands and in all-weather conditions.

The project will develop massive, timely high resolution satellite data products to support environmental monitoring applications in the region. The data products will also bring new business opportunities for the local industries to provide professional services to the prospective clients in China as well as Southeast Asia.

Prof. LIN Hui
Institute of Space and Earth Information Science
太空與地球信息科學研究所
林琿教授

承接香港中文大學衛星遙感地面接收站初期運作成功，國家航天局已准許中大地面站接收最新的中國巴西地球資源衛星數據 (CBERS-02B)。CBERS-02B衛星剛於二零零七年九月十九日發射，並載有20米多光譜照相機及全新的2.7米高解像度光學全色照相機。香港中文大學將在校園內建立全新的CBERS-02B衛星地面接收站，當正式接收CBERS-02B數據後，中大地面站便能對華南以至東南亞地區進行多衛星、多光譜、全天候的環境監察。

本項目將為區內環境監察系統提供大量適時的高解像度衛星數據，並為業界開拓為華南以至東南亞提供專業服務的新商機。
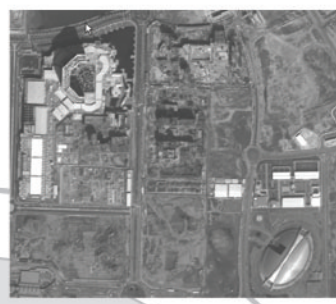
A sample of CBERS-02B High Resolution Image: The Macau Stadium and the Venetian Resort
中巴地球資源衛02B星高分辨率圖像樣本：澳門體育場和威尼斯人度假村

Green Technology

綠色能源

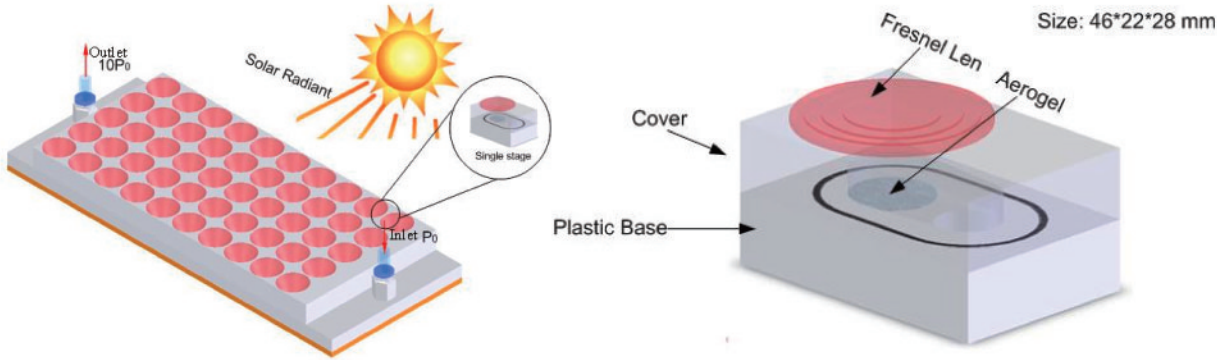# Energy Harvesting Device Based on Knudsen Effect

根據努森效應的能量採集裝置

Illustration of the new design

Solar energy has been regarded as one of the widely available renewable energy on Earth. However, using traditional thermal energy harvesting devices in subtropical area is not sensible because thermal energy collected is not sufficient to drive the whole system.

Knudsen effect describes a rarefied flow phenomenon of thermal creep. This effect can be used to make a micro-scale gas pump called Knudsen compressor. Recent studies show that the Knudsen compressor can operate efficiently under low inlet pressure near vacuum.

This project aims at developing a new method to harvest thermal energy based on Knudsen effect. Based on numerical simulation, a device has been designed for thermal energy harvesting.
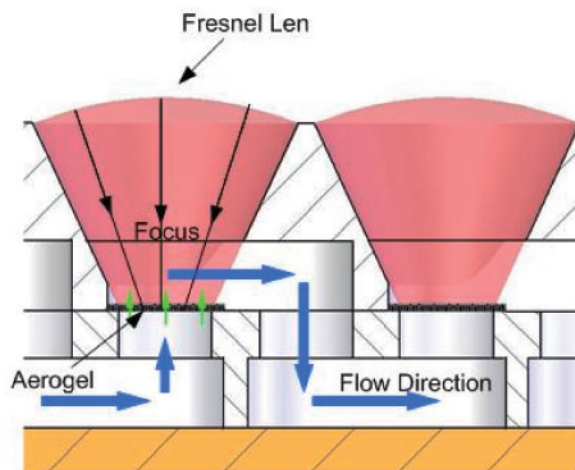
The proposed device offers a new method for harvesting thermal energy. It could be driven by the solar radiation. In a typical tropical summer day, it will generate 74.3W kinetic energy per square metre area. This device can also be used together with the vacuum-tube solar heater to creat a self-sufficient heating system useful for many applications.

Prof. DU Ru Xu
Department of Mechanical and Automation Engineering

機械與自動化工程學系
杜如虛教授

太陽能在地球上一直被認為是最容易得到的可再生能源。但在亞熱帶地區，利用傳統熱能收集裝置，因熱能不足，收集到的熱能不足以驅動整個系統。

努森效應是指稀薄氣體流動時的熱蠕動效應。利用這一效應製造的微型氣泵稱為努森壓縮機。最近的研究表明，這種努森壓縮機可以在進口壓力接近真空的條件下高效運行。

此計劃根據努森效應，研究採集熱能的新方法。利用數值模擬結果設計一個努森壓縮機。

建議裝置為採集熱能提供了一種全新的方法。它也可以在太陽輻射的驅動下工作。在低緯度地區的夏日，裝置可以在一平方米的面積上輸出74.3W的能量。這一裝置與真空集熱管結合，將成為一套高效的熱能採集系統，可用於許多領域。
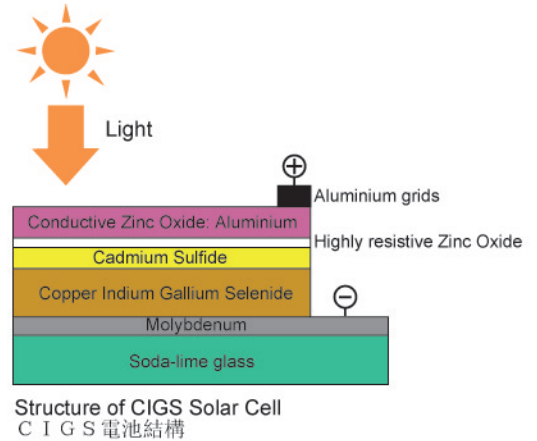
Industrial Production of Low Cost and High Performance Solar Cell

工業生產低成本高效能太陽能電池

Equipment for making solar cell
製造太陽能電池設施

Light

Aluminium grids
Conductive Zinc Oxide: Aluminium
Highly resistive Zinc Oxide
Cadmium Sulfide
Copper Indium Gallium Selenide
Molybdenum
Soda-lime glass

Structure of CIGS Solar Cell
ＣＩＧＳ電池結構

Prof. XIAO Xudong
Prof. LI Quan
Department of Physics

物理學系
肖旭東教授
李泉教授

With the rapid consumption of fossil fuel and subsequent environmental problems, it is urgent to find clean and renewable energy sources. In current photovoltaic technologies, mono-crystalline silicon solar cell dominates but the production cost is high. The thin-film solar cell, however, can reduce manufacturing energy consumption remarkably, therefore is a promising low cost solar cell technology in the future.

The Copper Indium Gallium Selenide (CIGS) based thin-film solar cell can be fabricated on soda-lime glass with low cost and high performance. The fabrication technology of large-area CIGS solar cell is immature. Ultra-high vacuum co-evaporation method combined with vacuum laser grooving technology can manufacture high performance large-area CIGS solar cell.

Features

1. Unique ultra-high vacuum four-source co-evaporation method for CIGS absorption layer deposition
2. Industrialization-orientated fabrication technology of large-area CIGS layer with high homogeneity
3. Vacuum laser grooving technology avoiding atmospheric impurities

隨著化石燃料的快速消耗，及其所導致的環境問題日益嚴重，開發清潔可再生新能源的需求迫在眉睫。目前的光伏產業技術廣泛使用單晶硅太陽能電池，但生產成本較高。而薄膜太陽能電池能顯著減少製備能耗，是極具前景的低成本太陽能電池技術。

基于銅銦鎵硒(CIGS)的薄膜太陽能電池可在鈉鈣玻璃片上以高性能、低成本製成，但目前大面積CIGS電池的製備工藝還不成熟。利用超高真空共蒸法及真空鐳射刻槽技術可製備大面積高性能CIGS太陽能電池。

特點

1. 獨有超高真空四源共蒸CIGS吸收層製備技術
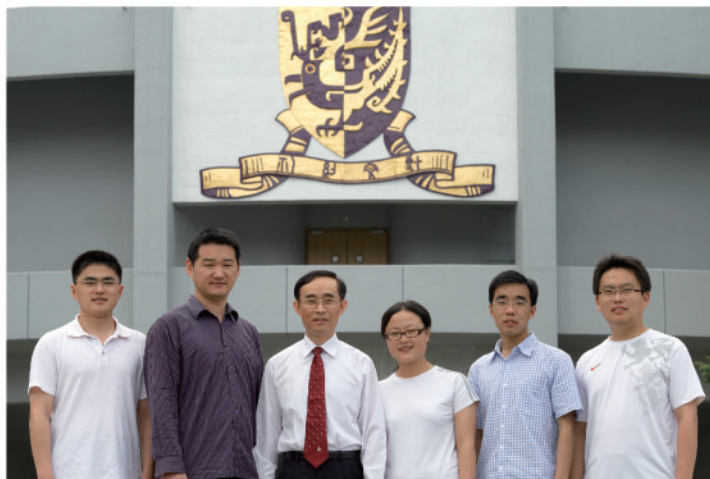2. 大面積均勻CIGS吸收層製備技術
3. 避免大氣雜質污染的真空鐳射刻槽技術

Solar-Driven Photocatalytic Formation of Hydrogen from Water

太陽光解水製氫

Prof. Yu Chai Mei Jimmy (third from left) and his research team
余濟美教授（左三）及其研究小組

Laboratory set up for the prototype
設置於實驗室的原型

Hydrolysis is one of the methods to produce clean fuel hydrogen. Photo-splitting of water molecules by sunlight requires a high-efficient catalyst. Traditional titanium dioxide photocatalyst, however, is only active under UV irradiation. For solar-driven systems, it is sensible to couple Titanium (IV) Oxide (TiO_2) with a strong visible-light absorbing small bandgap semiconductor such as Cadmium Sulfide(CdS). Methods for embedding the highly active CdS quantum dots into the lattice of TiO_2 are much needed.

CdS embedded TiO_2 is prepared through pre-planting cadmium oxide (CdO) as crystal seeds into the framework of ordered mesoporous titanium dioxide, and then converting CdO to CdS quantum dots through ion-exchange. The presence of CdS quantum dots in the TiO_2 framework can extend its photo-response to the visible-light region by accelerating the photo-generated electron transfer from the inorganic sensitizer to TiO_2.

This research may revolutionize clean energy production.

Prof. YU Chai Mei Jimmy
Department of Chemistry

化學系
余濟美教授

分解水分子是製造潔淨能源氫氣的一種辦法。若利用太陽光來作水解能量，需要高效能的催化劑，傳統的光催化劑二氧化鈦只能在紫外光下才能運作。若利用有強吸收力的半導體和二氧化鈦在可見光環境下結合起來，問題便迎刃而解。關鍵技術在於怎樣把高活性的硫化鎘量子點注入到二氧化鈦的晶格裡面。

本技術利用和二氧化鈦同是金屬氧化物的氧化鎘為種子，先將其置於中孔二氧化鈦的晶格內，然後用離子交換方法轉變為硫化鎘。所產生的硫化鎘量子點，能有效的把光生電子轉移到二氧化鈦，在太陽光下就可以分解水而取得氫氣。

本項目可能為生產未來潔淨能源帶來革命性的改變。

Lake Surface Cleaning Robot

湖面清潔機械人

The prototype robot
機器人原型

Prof. Liu Yun Hui (middle of first row) and his team
劉雲輝教授（第一排中間）及其研究小組

Prof. LIU Yun Hui
Department of Mechanical
and Automation Engineering

機械與自動化工程學系
劉雲輝教授

Cleaning rubbish floating on surfaces of ponds or small lakes is one of the major tasks in protecting the environment of public parks. The current method, which fully relies on human workers, is not efficient and costly in a long run. Aiming at an innovative and effective solution, we propose to develop a lake cleaning robot for cleaning the floating rubbish. The robot can work under either tele-operation or autonomous control. By tele-operation, users can remotely control the robot from their offices via the Internet. By autonomous control, the robot can autonomously find and identify floating rubbish, learn rubbish distribution, and to plan a path to explore the lack surface and remove the floating rubbish.

The cleaning robot is equipped with a super-media enhanced tele-operation interface that enables the user to feel the remote environment. It is also able to self-charge its batteries and autonomously carry out its tasks without human intervention. We will also incorporate a function enabling it to remove oil.

清理懸浮於池塘或小湖表面的垃圾是公園環境保護其中一項重要任務。現行的方法完全依賴人力，不但效率低，而且長遠來說很昂貴。我們建議了一個既創新又有效的方法，以一個湖面清潔機械人來清理懸浮的垃圾。此機械人能以遙控或自動操作。遙控操作時，用家可以透過互聯網，於辦公室遙遠控制機械人；自動操作時，機械人則能自動尋找及確認懸浮的垃圾、得知垃圾分布、計劃探察湖面路線，並將垃圾移除。
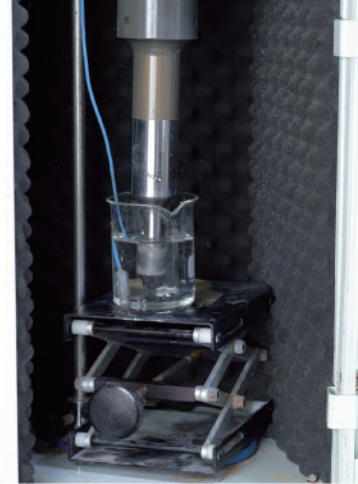
此清潔機械人配備附有超媒體的遙控介面，能讓用家感受遙控的環境。它更可以自動充電，完全無須人手介入都能執行任務。稍後，我們更會引入能清理湖面油污的功能。

Industrial Scale Sonochemical Fabrication of Mesoporous Photocatalysts

中孔光催化劑的聲化學工業化製備

Prof. Yu Chai Mei Jimmy (left)
余濟美教授（左）

Sonochemical process at work
聲化學過程進行中

Prof. YU Chai Mei Jimmy
Department of Chemistry

化學系
余濟美教授

Fabricating chemicals with porous structures requires high energy consumption. By using our novel technology in fabrication, at least 50% of energy can be saved. Fabrication process would become more cost-effective and eco-friendly. Chemical manufacturers can benefit from this technology by reducing the cost of chemical production.

The process is based on the utilization of high-intensity ultrasound. The sono-irradiation causes acoustic cavitation. That is the formation, growth and implosive collapse of the bubbles in a liquid. The implosive collapse of the bubbles generates a localized hotspot through adiabatic compression or shock wave formation within the gas phase of the collapsing bubble. The extremely high temperature and pressure produced by the localized hot spots lead to many unique conditions for chemical synthesis. Mesoporous photocatalyst powders can be fabricated by this sonochemical approach.

製造多孔結構化學品乃高耗能工序。利用此新技術，生產過程可節省50 ％或以上能源。整個製造過程變得更具成本效益及環保。化學品及催化劑製造商亦受益於這項技術來降低生產化學品的成本。

這項目基於超聲合成技術，主要是利用超聲波的振動在液體產生急促變化的氣泡，使得一些特殊的化學反應可以在這種局部高溫高壓的環境中進行，從而有效地合成中孔光催化劑。

Virtual countryside of Hong Kong - Understanding Local Flora & Fauna

虛擬香港郊野—認識本地動植物

Prof. HUI Kin Chuen
Department of Mechanical
and Automation Engineering

機械與自動化工程學系
許健泉教授
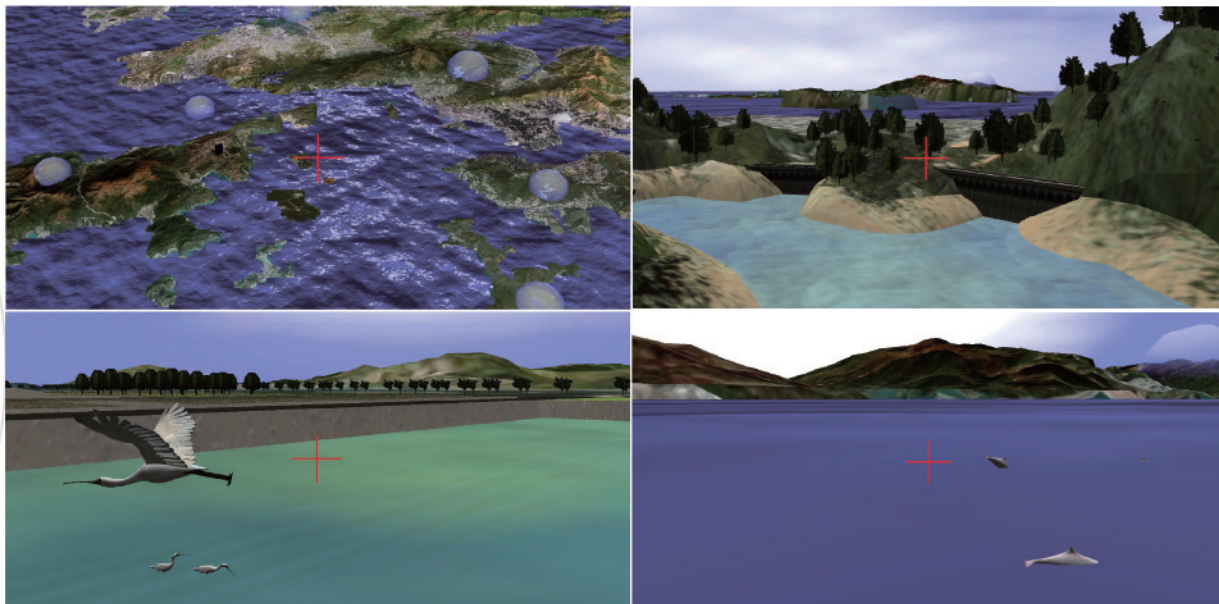
Simulated scenes
模擬景觀

"Local Flora & Fauna" is an interactive virtual environment simulating the countryside of Hong Kong. This project requires the construction of an accurate 3D model of Hong Kong. Besides, special species of animals found locally are to be simulated.

This application requires an integration of different 3D modeling and various interactive rendering techniques. Through this application, users can explore virtual countryside of Hong Kong interactively. They can find some unique flora and fauna in different areas of Hong Kong like Chinese White Dolphin, Pitcher Plant, Little Egret etc.
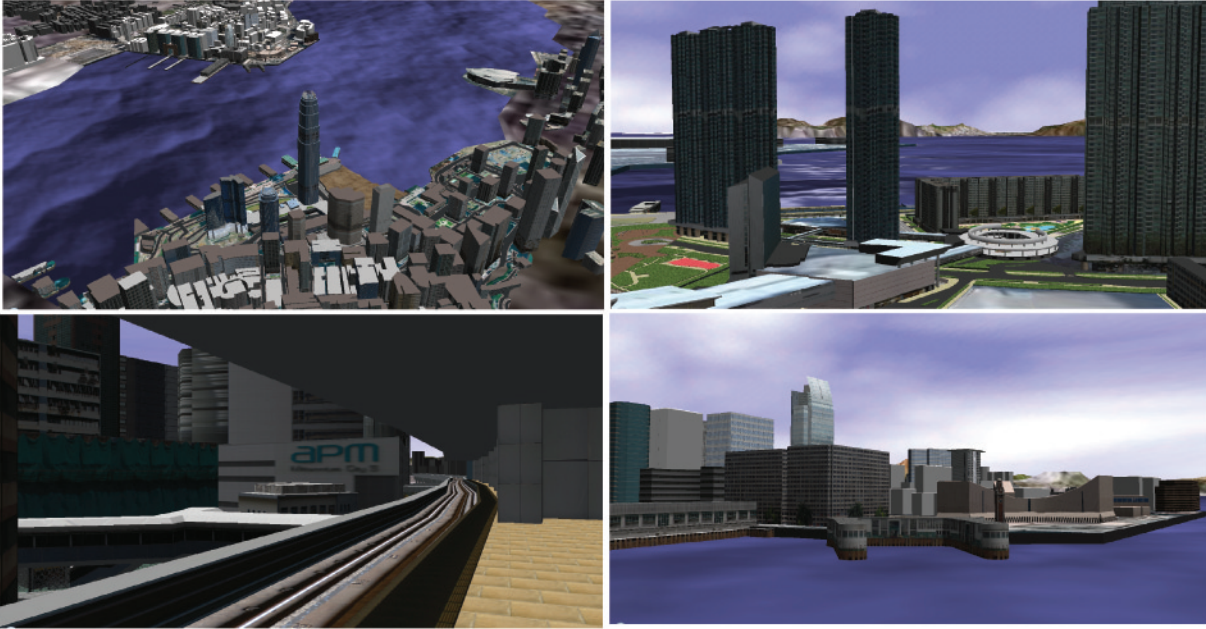
"香港動植物" 利用互動虛擬環境技術模擬香港郊野。此項目需要建立一個準確的三維香港模型。此外，香港常見的動物亦是模擬目標。

此應用程式開發時需綜合不同的三維建模及利用多種互動繪圖技術。用戶利用這應用程式更可互動地探索虛擬香港郊野。更可以從中找到一些分散在香港不同區域獨有的動植物群如：中華白海豚、豬籠草、小白鷺等。

Interactive Virtual Hong Kong Landscape

互動虛擬香港

3D models of the city
城市三維模型

Prof. HUI Kin Chuen
Department of Mechanical
and Automation Engineering
機械與自動化工程學系
許健泉教授

A 3D model of Hong Kong is to be constructed providing sufficient details for interactive exploration. Rendering of large 3D model and detecting collision in a large 3D landscape model are time consuming processes. Special techniques have to be adopted for enhancing the performance of the system. Besides, finite precision in numerical computation is often a problem in the manipulation of large scale 3D model. This may cause undesirable flickering and shaking of object images.

Based on a spatial enumeration of a landscape model, an efficient visibility and collision detection technique have been developed for improving the performance of the system. A special spatial partitioning technique is adopted for reducing the possible numerical errors in the manipulation of large scale 3D models.

A virtual environment of Hong Kong allows interactive exploration in different districts of the city. This includes both the urban and country side of Hong Kong. The system can be integrated with other scientific computation software for visualization purposes, e.g. visualization of noise and air pollutions, etc.

香港三維模型正逐步繪製，細緻度更足夠令用家作互動探索。繪製大型三維模型及避免觀測者與三維摸型的碰撞是一個極耗時的過程。更需利用特別技術才能加強系統效能。除此之外，操縱大型三維模型時更需精確的數字運算，否則物體及圖像會出現不穩定及震動。

根據景觀模型的空間計算，開發高效可視性及重疊檢測技術可改善系統的性能。開發特殊空間分割技術更可減少在操縱大型三維模型時可能出現的數值誤差。

虛擬香港令用家可在不同地區作互動探索。虛擬環境包括城市和郊野。系統更可與其他科學計算軟件結合達到可視化目的，例如將噪音及空氣污染等數據可視化。

Economics and Finance

經濟與金融

Cognitive Radio Communications and Networking

認知無線電通訊與網路技術

Hong Kong Frequency Allocation Chart
香港頻率劃分圖表
*Allocation Chart retrieved from http://www.ofta.gov.hk
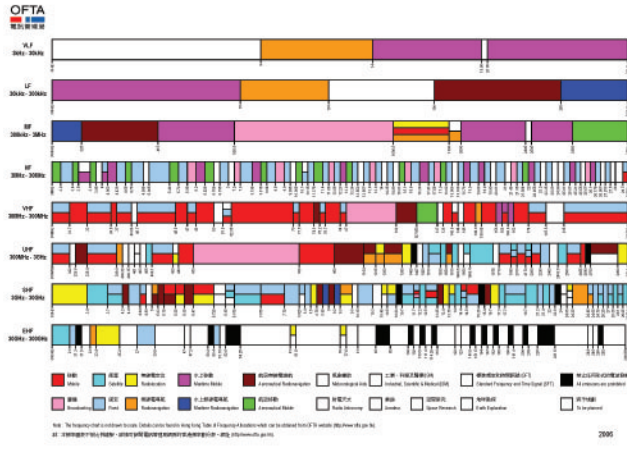
Prof. Huang Jianwei (second from left of the first row) and his research team
黃建偉教授（第一排左二）及其研究小組

Prof. HUANG Jianwei
Department of Information Engineering

訊息工程學系
黃建偉教授

The wireless spectrum resource today is scarce and yet severely underutilized. Cognitive radio technology enables wireless networks and secondary users to exploit the spectrum resource dynamically and opportunistically. This can significantly improve the spectrum efficiency without violating the rights of the existing licensees (primary users).

There are four key aspects of cognitive radio technology: spectrum sensing, spectrum decision, spectrum mobility, and spectrum sharing. We focus on advancing the state-of-the-art technology for the latter two cases.

Spectrum mobility: we enable secondary users to identify the most suitable current available spectrum opportunities according to its Quality of Service requirements. In particular, we utilize the channel statistical information to differentiate and predict the qualities of various spectrum bands and match the need of the secondary users.

Spectrum sharing: we design efficient auction mechanisms that are able to achieve efficient resource allocation or revenue maximization, depending on the primary user's objective. We also allow secondary users to fairly access the resource in a completely distributed fashion.

無線頻譜是一種極度稀缺而目前使用率嚴重不足的資源。認知無線電技術通過允許無線網絡及非授權用戶動態地、伺機地利用頻譜資源，能夠在無礙授權用戶權利的情況下大幅度提高頻譜的使用率。

認知無線電技術有以下四個關鍵的組成部份：頻譜感知、頻譜決策、頻譜移動及頻譜共享。我們著重推動後面兩部份的尖端技術。

頻譜移動：非授權用戶將根據其服務質素要求來決定當前最合適的可用頻譜機會。我們將使用統計信息來辨別及預測不同頻段的通訊質素，然後配對非授權用戶的需求。

頻譜共享：我們將設計能根據授權用戶的目標，同時實現高效資源分配或收入最大化的高效拍賣機制。該機制也將允許非授權用戶以完全分佈的方式來公平使用頻譜資源。

If you are interested in any of the projects listed, please contact

Centre for Innovation and Technology
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如閣下對目錄內任何科研項目有興趣

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