Innovation for Better Life
2009-2010
Preface

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.

Prof. WONG Kam Fai
Director, Centre for Innovation and Technology
The Chinese University of Hong Kong

香港中文大學創科中心四十多年來一向致力追求卓越的學術研究，亦積極探索能夠載用於社會的新知識、新技術，從而推動香港以及區內邁入知識型經濟體系發展。

創科中心作為大學與業界之間的橋樑，在過去十年間一直積極與業界連結及溝通，促進產學合作。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所需的龐大開支，故此利用大學的研發資源突破本身於創新的限制，成為這些企業的出路之一。

創科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對接，共同發掘合作空間與機會。我們亦會協助本校畢業生創建創新科技概念創業，希望為香港培育更多具實力及創新的年輕企業家。
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.

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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，我們特別編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系統及應用環保教育之用的軟件。研究方向可謂極之多元。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興趣，歡迎獲取更多詳盡的資料，或有意與我們的研究隊伍見面，了解合作的可能性，歡迎以下列方法與我們聯絡。
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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

癌症是人類疾病中的第二大殺手。致癌因素有多種，包括化學物質和微生物、病毒感染、基因突變等。TBX2和TBX3蛋白質失調可能會導致癌症。CUHK研究團隊發現了一種小分子抑制劑，它可以特異性地抑制TBX2和TBX3的轉錄活性，抑制腫瘤細胞增殖和誘導癌細胞凋亡。
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腫瘤並無治療效果。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模型進行驗證。
Cancer Epigenetics Identifies Novel Tumor Suppressor Genes and Epigenetic Tumor Markers

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 earlier therapeutic options.

At the molecular level, carcinogenesis is a multi-step process involving both 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 therapy.

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.

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Development of Safe and Effective Drugs from Traditional Chinese Medicine

以傳統中藥開發安全有效新藥

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 Synthèse selective organique et produits naturels de Centre national de la Recherche Scientifique (CNRS) and École 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 resistance 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 Chinese 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，研究和發抗感染及其抗耐藥機制的藥物是當務之急。

中大傳統藥物聯合實驗室旨在找出傳統中藥內潛在的新有效成份，以及展現出有效及安全的藥物，治療有多種抗藥性的金黃葡萄球菌、耐藥型細菌及其他與人類健康息息相關的細菌。實驗室將由香港中文大學中醫藥研究所、法國國家實驗室及法國國立巴黎高等化工學校共同管理。

香港中文大學中醫藥研究所對中藥有效成份的研究，分離、構築和改良有豐富的經驗。而法國國家實驗室則對細菌抗菌藥研究，尤其是金黃葡萄球菌、耐藥性細菌病的治療經驗，並發展出不同針對細菌抗菌機理的細菌治療及篩選高通量篩選方法。

兩所之合作期望對中藥提供一個有效、安全的科研基礎應用於抗藥性金黃葡萄球菌的臨床治療。

三十三種中藥當中，有九種中藥在抗菌測試中，對普通及抗藥性金黃葡萄球菌的生長抑菌呈陽性反應。
Treatment of Experimental Ulcerative Colitis with Scutellariae Radix (Huangqin)

以黃芩治療實驗性潰瘍性結腸炎

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.

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).

經蘇木酚和伊紅染色的結腸組織切片取自：(A) 細菌性結腸炎鼠顯示廣泛性的潰瘍及嚴重的炎性細胞浸潤；(B) 治療組顯示出康復的現象，結腸組織的潰瘍比較輕微；(C) 維持組顯示出康復的結腸 (100倍)。

潰瘍性結腸炎（UC）及克隆氏症（CD）兩類發炎性腸道疾病（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，只副作用亦一直備爭議，所以用傳統中醫藥（TCM）為另類或補充治療的做法，吸引了愈來愈多人注意。其中，最常使用的中藥便是傳統中醫藥黃連解毒湯，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最有強的藥用效果，但黃芩或其成份的生物學基礎及確證作用機制仍然未明。

在實驗中，患有 UC 的老鼠連續八天被喂食黃芩。結果顯示，它們的臨床疾病指標、宏觀及組織損傷評量改善，結腸分泌電解質的功能也顯著恢復，顯示黃芩的萃取物能有效治療 UC。

本研究除確認黃芩對實驗性腸炎的療效效果外，也是首次有實驗顯示，它的療效與大腸醣類的電解質輸送功能再增有關。同時，研究也說明 TCM 的有效有科學及生物學根據，能為未來以黃芩及其活潑成分治療 IBD 的進一步評估打下基礎。

Funded by Direct Grant for Research, Faculty of Medicine, CUHK
Collaboration with National University of Singapore

由香港中文大學醫學院直接撥款資助
合作機構為新加坡國立大學
Auriculotherapy for Hypertension

針對高血壓的耳穴療法治療

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.

有些病人服藥時服用降血壓藥，但仍未能持續及有效地控制血壓。在有對照組的臨床實驗中，研究將刺激七個與血壓控制有關的穴位，配對受試者使用西藥，療程為四星期。實驗組之受試者接受治療後，於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治療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.

The SERS spectrum of BRCA1 breast cancer gene monolayer on 2-D Ag hole arrays.

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。將分子放在構造金屬表面附近，拉曼信號的幅度可增加數量級。所以，表面增強拉曼感測器具有良好的靈敏性和特異性。

用納米工程可改進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，對應的拉曼信號以波譜的形式表示。

表面拉曼感測器特性

- 高分子敏感性及特異性
- 實時檢測
- 可大量生產的經濟便攜式感測器
- 無需標記標記

Funded by Research Grants Council and Shun Hing Institute of Advanced Engineering
Collaboration with Department of Physics, Imperial College, London

由研究资助局及順恆高等工程研究所資助
合作夥伴為倫敦帝國學院物理學系
Femtosecond Laser for DNA and RNA Transfection
利用飛秒激光導入DNA或RNA細胞技術

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, i.e. 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 transfected 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.
Non-contact Monitoring of Cardiovascular Signals on Sleeping Bed

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，檢測期間往往會對使用者不適宜，進而影響睡眠。

項目研發一套能夠在不影響使用者睡眠的情況下，連續監測心電及血壓的家用裝置。本裝置採用了電子織物、紅外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）
Vascular Intervention Simulation System

血管介入治療模擬系統

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，如血管堵塞、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，醫生便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穿針引線將藥物直接注入病變組織，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，近年在本地的需要亦迅速增加。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。傳統訓練需利用動物或實習模擬，極具限制，若能通過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，現時歐美等地已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編製，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，重建血管泵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血管所承受的阻力及壓力，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培訓護理人員的實務評估。
A researcher examines the skin by using the terahertz imaging device.

"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^{18} 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「赫茲」(10^{12} Hz)則是測試成像技術中所用的頻率單位。對比X光成像中所用的10^{18} Hz頻率,兆赫要低頻得多,因此兆赫成像不會對人體帶來任何已知的麻煩。它是完全非破壞性及非離子化的成像方式。在過去很長一段時間,產生兆赫波的技術是非常困難的事,但隨著半導體物理學及奈米技術的提升,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,相較於X光波長長,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。兆赫波長極容易被水份吸收,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條件下獲得軟組織。我們正在發展一項技術,以將兆赫成像用於活體機體上,希望令乳腺及皮膚癌等癌症的診斷結果更為準確。
Structured ASIC\(^1\) is an intermediate technology between ASIC\(^1\) and FPGA\(^2\). It offers high performance (characteristics of ASIC\(^1\)) and low NRE\(^2\) 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\(^2\) costs (about 1/6 of full mask set cost)\(^3\)
- Lower design risk because of proven silicon and regular fabrication structure
- Fast turn-around-time (about 1/3 of ASIC\(^1\) fabrication time)\(^3\)
- 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\(^1\)是介於ASIC\(^1\)與FPGA\(^2\)之間的集成電路技術。它具有ASIC\(^1\)的高性能特性，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容易，從而更快以合理成本推出市場。它亦對可編程邏輯器件市場帶來新機遇。

為支援發展結構化ASIC\(^1\)，本中心研製了(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)一款具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（光罩定片成本約是傳統方法成本的六分之一）
- 由於先導設計的結構與組合已經確認可靠，設計風險因此降低
- 開發時間短（大約是製造ASIC\(^1\)的三分之一）
- 邏輯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 可編改門陣列
3. 0.13umCMOS生產程序下之估計

Funded by Innovation and Technology Commission
Collaboration with Applied Science and Technology Research Institute and Peking University

China-UK Technology Innovation Centre
合資科技創新中心及北京大學
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.

射頻標簽的應用相當廣泛，但由於構建中的射頻模塊要按應用需求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改變，射頻模塊更要重新設計，工序繁瑣又昂貴。

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

利用這個硬體開發平台，可將構建設計放至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需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、門禁識別控制及生物醫學監測等。
Building Recognition System

自拍功能已普遍出现在電子產品中，大部分手提電話都具備自拍功能。若在街道上拍照發現新型建築物，只要把建築物外形拍下，透過系統對建築物圖像的分析、分類及辨識，系統便能精確及有效地自動識別圖片中的建築物。若連接到全球定位系統及相關資料庫，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

建築物識別系統的用戶界面

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.
Fast Image/Video Upsampling

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 of 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 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 upsampling 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:

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Video demonstration can be found at:
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）

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，相機無法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動態模糊的新演算法，憑單一照片就能復原最多的視覺資訊。這種技術比簡單地以數學化功能處理模糊照片所得的效果好得多。它以一個同時估計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率的優化方案得出結果。這種技術已通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處理的晶片中。
Computational Manga System

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 handrawn 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.

Funded by Innovation and Technology Commission

The system can automatically fill up colors by identifying similar hand-drawn hatching and printed screening patterns. The system can prevent color leakage and ensure consistency. The system can prevent color leakage and ensure consistency.
System for Animating Animal Motion from a Still Picture

单一圖片合成動物動畫系統

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.

![Diagram of the system](source image)

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Farmtasia 2

農場狂想曲 2

Screenshots of Farmtasia 2 and the research team
「農場狂想曲 2」的遊戲截圖及其研究小組

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.

商貿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人，著重評估而不是學習。而「農場狂想曲 2」則是一個精巧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，它有一個非常接近真實的農場環境，能模擬世界各地11種氣候、256個城市及60,000個農場。其中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
- 快速反應時間（延遲少於0.3秒）
- 動態遊戲內容，無須更新程式

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控工具，適用於專題研究及通識課程上。
Crystal: Text-to-Audiovisual-Speech Synthesis in Putonghua and Cantonese

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

嵌入式版本的晶晶

我们開發的實時的漢語文本文到語音合成器，名為『晶晶』。它通過一個虛擬人物的形象，將漢語的文本文入以視聽兼備的方式表示出來。「晶晶」可以用漢語文本文入進行語音合成，並同時做出虛擬的動作，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
  - 結果可以以MP3或MP4的格式下載
- 嵌入式版本– WinCE平台上運作
  - 支持手提和多式聯通軟件，如：閱讀短信
Building Multilingual Meta-search Engine over the Web

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就無法被找到，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就是要建立搜索引擎和頁面內容之間的語言橋梁，通過找到不同種語言的相關網頁而無需母體查詢時所使用的語言。然而，這項技術非常挑戰性，在以下各方面均會遇到困難：細節查詢到語，搜索過程自身，不同語言結果的合併，以及搜索者要判斷結果是否是他們需要的語言。我們的任務是如何解決這些困難。

基於以上目標，我們創建了一個在跨語言搜索系統稱為搜索，即多語言環境下的搜索優化的英文首字母縮寫。搜索採用的技術是在現有的單語言搜索引擎（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，對於查詢翻譯，我們就採用了先進的語義基礎語義匹配技術自動地從搜索結果集中輸入的查詢請求查找最好的翻譯。對於結果合併，我們就使用借改進的方法在不同的排列中，根據語境結果的相關性來重新排列搜索結果，最後，為了方便用戶的閱讀和瀏覽，我們是利用在線語音翻譯工具按照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 DJX system consists 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 DJX 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 DJX 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.

DJX系統是一個運行在用戶電腦上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系統專注於中文流行音樂的推薦，其受眾將數以億計。
- 系統主要基於音樂的音頻信號本身，最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為一個音樂管理器使用。

Funded by Innovation and Technology Commission, and
Wiselify Limited
Collaboration with Tsinghua University
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.
Indoor Ionic Propulsion Technology

室内離子噴射技術

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.

蔵歓空氣動力學發行系統中一個難以克服的複雜性問題，就是機械運轉零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，往往會大幅降低監察飛行系統的即時視覺監視系統的穩定性。因此，配備傳感器和攝影機的智能控制

飛行系統也難以應用於這些飛行系統上。

為了解決上述問題，本項目小組研發了一項新穎的離子噴射技術，此技術將高壓電直接轉化為機械動力以產生推進力，完全

無需任何機械配件，因此操作時不會產生噪音。利用這項技術，我們研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，我們進一步開發了類似室內飛行系統——離子噴射飛艇，來示範離子噴射技術的實用

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

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.

The system for assessing SAR by using head simulating liquid使用人頭部模擬液體進行電磁波能量比吸收率測試之系統

The high-resolution CEMHM head model高解像度中國電磁人頭部模型

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

The new development of high-resolution human head model for SAR calculation increases the accuracy of the results. It also provides valuable insights into the understanding of electromagnetic fields and their interaction with biological tissues.

2008 Asia-Pacific Microwave Conference (APMC) prize

2008亞太微波學術會議獎
“VeriGuide” Text Similarity Detection System

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.

Champion, CUHK Vice-Chancellor’s Cup of Student Innovation 2007
The Third Prize, the 5th Challenge Cup

2007年香港中文大學校長一學生創新比賽冠軍
第九屆「挑戰杯」全國大學生創業靈感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

合作夥伴香港特別行政區政府教育局，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

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, non-magnetic 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.

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Fund by Innovation and Technology Commission
Collaboration with the Beijing Institute of Technology

由創新科技委員會資助
合作夥伴為北京理工大學
Traffic Accelerator for Mobile Networks

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.
Geoinformation and Earth Sciences
Development of Industrial Standards for Ground Deformation Monitoring in Transportation Infrastructures Constructions Using A-PSI-Based Satellite Measurements

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 transferred 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. landslides) 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).

Funded by Innovation and Technology Commission
Collaboration with MTR Corporation Limited and Airport Authority Hong Kong
Automatic Space Debris Identification and Tracking System

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.

太空碎片的碰撞是造成航天器损毁甚至爆炸的主要原因。为防止航天器因太空碎片撞击而造成损坏，目前各国在制造航天器时往往需要为航天器铺设特殊保护层材料，并对其实行部分或全部防弹设计，这些额外措施不但提高了制造成本，更会增加航天器的重量及缩短航天器的工作寿命，大大影响航天器的性能。

因此，如果能利用经济简单又有效的手段对太空碎片位置和运动轨迹进行准确观测和预测，并据此提供有效的碰撞预警机制，制定航天器的运行路线，避免与太空碎片相撞，我们就能有效降低航天器损坏的风险，提升航天器的性能及降低研制成本。

本研究利用天文光学探测方法获取太空碎片(CD)图象序列，并采用自动图象处理、图象识别与分析、图象识别和人工智能等技术，自动识别出每帧CD图象中的太空碎片以及背景恒星等空间目标，并定量计算其矢量参数（表示空间目标的位置）、面积、长、宽和中心等空间特征。

根据太空碎片移动较快的特点，在CD图象序列中结合主动图象追踪和被动图象追踪两种方法，对其中出现的太空碎片目标进行自动识别和追踪，并根据自动追踪的结果，得出其在空间中的运动轨迹，建立可追踪的太空碎片目标位置数据库。

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
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.

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 panoramic 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.

A sample of CBERS-02B High Resolution Image: The Macau Stadium and the Venetian Resort.

Funded by Innovation and Technology Commission.
Energy Harvesting Device Based on Knudsen Effect

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 create a self-sufficient heating system useful for many applications.
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
製造太陽能電池設備

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 it 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

The CIGS based thin-film solar cell has a high efficiency and low cost. However, the large-area fabrication technology is still in development.

Features
1. High efficiency and low cost
2. Large-area fabrication technology still in development

Fund by Innovation and Technology Commission
Collaboration with JV Technology Development Company Limited, and Shenzhen Topray Solar Company Limited

由創新暨科技資助
合作夥伴港深科技開發有限公司及深圳拓日新能源科技股份有限公司
Solar-Driven Photocatalytic Formation of Hydrogen from Water

太陽光解水製氫

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 (TiO₂) 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 TiO₂ are much needed.

CdS embedded TiO₂ 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 TiO₂ framework can extend its photo-response to the visible-light region by accelerating the photo-generated electron transfer from the inorganic sensitizer to TiO₂.

This research may revolutionize clean energy production.

Fundied by Centre of Novel Functional Molecules
( Strategic Research Investments Scheme of CUHK)

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

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 the long run. Aiming at an innovative and effective solution, we propose to develop a lake cleaning robot for clearing 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.

Proin lacinia lacinia lacinia. Proin lacinia lacinia lacinia.

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 the long run. Aiming at an innovative and effective solution, we propose to develop a lake cleaning robot for clearing 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.

此清潔機械人配備有超級媒體的遙控介面，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，我們更會引入能清潔湖面油污的機能。
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.
Virtual countryside of Hong Kong - Understanding Local Flora & Fauna

"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。

此應用程式開設時需結合不同的三維建模及利用多種互動渲染技術。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佈在香港不同區域獨有的動植物如：中國白海豚、豬籠草、小白鷺等。
Interactive Virtual Hong Kong Landscape

3D models of the city

A 3D model of Hong Kong is to be constructed providing sufficient details for interactive exploration. Rendering of large 3D models 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. Beside, finite precision in numerical computation is often a problem in the manipulation of large scale 3D models. 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，細緻度更是夠令用家作互動探索。繪製大型三維模型及避免數測者與三維模型的碰撞是一個極耗時的過程。更需利用特別技術才能加速系統效能。除此之外，操縱大型三維模型時更需精确的數學運算，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測量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。
Cognitive Radio Communications and Networking

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.

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