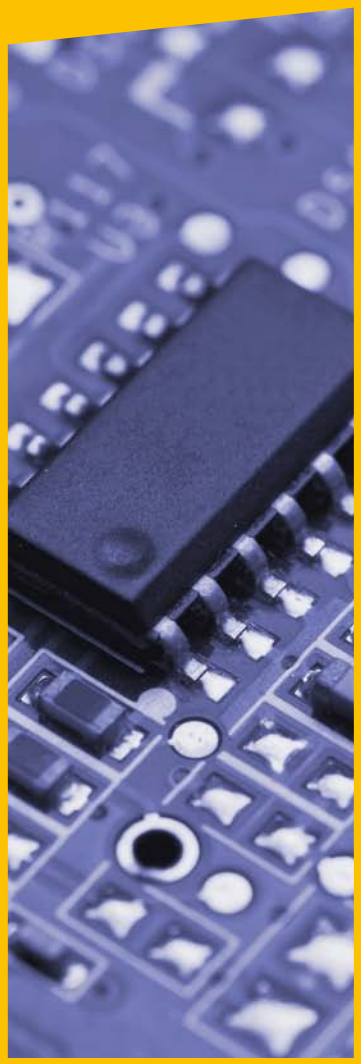
香港中文大學
The Chinese University of Hong Kong

Embrace our Culture Empower our Future
傳承・開創
香港中文大學五十周年
50th Anniversary of CUHK

Innovation for Better Life

2013-2014






Preface 序言

"Embrace our Culture; Empower our Future" is the theme of celebration for the Golden Jubilee of The Chinese University of Hong Kong (CUHK). Being a forward-looking comprehensive research university, CUHK has been embracing the culture of innovativeness since it was founded in 1963. Our leading-edge research empowers our future.

As a technology transfer arm of CUHK under the Faculty of Engineering, Centre for Innovation and Technology (CINTEC) serves as a bridge between the university and the industry and facilitates communications and collaboration between them. CINTEC promotes CUHK innovation through active technology transfer. To achieve this goal, CINTEC would like to share with you some of the latest CUHK research results through this booklet.

Herein we provide the abstracts of the projects. For detailed information, please visit the website: www.cintec.cuhk.edu.hk/exhibition, or contact us at:
Tel: (852) 3943 8221 Email: enquiry@cintec.cuhk.edu.hk

Thank you for your interest in the innovations of CUHK.

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

「中大五十 ▪ 傳承開創」是香港中文大學（中大）金禧校慶的主題。作為一所具有前瞻性的研究型綜合大學，中大傳承自1963年創校以來的創新文化，透過研發走在時代尖端的項目，開創未來。

創新科技中心隸屬於中大工程學院，為學院提供技術轉移服務，是連繫大學與業界的橋樑，促進中大研究團隊與業界的交流與合作，推動創新。為達成此目標，創新科技中心製作此刊物與您分享中大最新的科研成果。

本刊主要提供項目摘要，有關項目詳細資料，請瀏覽網頁：www.cintec.cuhk.edu.hk/exhibition，或與我們聯繫：
電話：(852) 3943 8221　電郵：enquiry@cintec.cuhk.edu.hk

謹此感謝您對中大創意發明的興趣。

香港中文大學
創新科技中心主任
黃錦輝教授

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傳承・開創

Embrace our Culture
Empower our Future

香港中文大學五十周年
50th Anniversary of CUHK

In celebration of its Golden Jubilee, CUHK is pleased to showcase its recent research achievements and introduce to the public how the University's researches contribute to the society.

今年適逢香港中文大學金禧校慶，我們除透過此書介紹中大最新的科研項目與技術外，還特別製作五十周年專頁，讓業界及公眾人士了解中大的研究如何貢獻社會。

Embrace our Culture Empower our Future

On 17 October, 1963, The Chinese University of Hong Kong was established. Founded on the basis of the earnest scholarship and modest resources of three tertiary institutions, the Chinese University began with three colleges, 1,395 students, and about 100 teachers and staff members. Embracing the mission "To combine tradition and modernity, and to bring together China and the West", the Chinese University works hard, strives for excellence, and never hesitates to reinvent itself to meet new challenges. Today, the Chinese University is a top higher education institution in Hong Kong. It has grown into a vibrant teaching, learning and research community with nine colleges, eight faculties, a student population of more than 20,000, undergraduate and postgraduate students included, and a staff of over 6,000 full-time teaching, research and administrative members. CUHK takes great pride in its achievements.

中大五十・傳承開創

1963年10月17日，以三所專上學院的篤實學風和簡約規模為基礎的香港中文大學宣告成立。由書院三間、學生一千三百九十五人、教職員約一百人，以「結合傳統與現代，融會中國與西方」為使命，奮發自強，日新又新到今日書院九所、學院八間，本科生與研究生逾二萬人、全職教研行政人員六千多人，凝聚成一個蓬勃活潑的學研群體，成為本港首屈一指的高等學府，成就實足自豪。

香港中文大學
The Chinese University of Hong Kong

University Research Contributions to Community

Apart from teaching and research, the "third mission" of CUHK is to apply its research outcomes to the benefit of the community, as a repayment for community support. From 2009 onwards, the University Grant Committee has allocated funding to the eight institutions for knowledge transfer on the basis of their size and research strengths. CUHK was pleased to receive additional support from the Committee, and in October of the same year it set up the Knowledge Transfer Unit. In March 2011, the Technology Licensing Office and the Knowledge Transfer Unit were reorganized and became the Knowledge Transfer Office. The new office is responsible for the development of technology and community initiatives, as well as related contract issues and legal matters.

Between 2011 and 2012, the University supported 23 projects with the Knowledge Transfer Project Fund. During the vetting process, "impressing the community and caring for the people" became one of the requirements for approval. These projects applied the University's research outcomes to improvements in social, cultural, environmental and economic areas.

大學研究 • 貢獻社會

除了教學和研究，中大的第三使命是將科研成果應用在社會各階層，肩負取之社會、用之社會的責任。2009年起，大學教育資助委員會按照院校的規模及研究優勢分配撥款予八大院校，用於推動知識轉移的發展。中大樂見教資會提供額外資助，同年10月成立了知識轉移辦公室處理相關工作，繼而於2011年3月，重組科技授權處和知識轉移辦公室為知識轉移處，負責技術開發，開展社區為本項目，以及處理合約與法律事務。

在2011至12年，大學共推動了二十三項知識轉移項目計劃，在批核過程中，「感動社區、關愛社群」成為撥款要求之一。這些項目把校內各學科的研究成果，應用於改善社會、文化、環境和經濟各領域。

Areas of Excellence

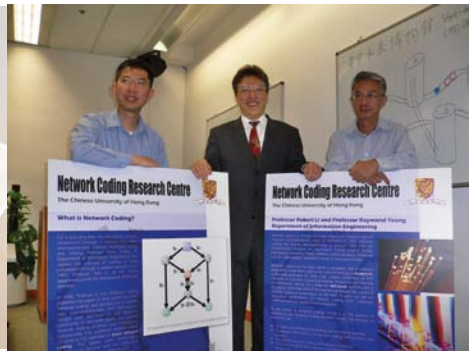
The University Grants Committee has provided special funding to the local tertiary institutions to conduct research into selected Areas of Excellence. Out of a total of 15 such projects, six are led by CUHK researchers.

- Chinese Medicine Research and Further Development
- Centre for Research into Circulating Fetal Nucleic Acids
- Centre for Plant and Agricultural Biotechnology
- Information Technology
- Institute of Network Coding
- The Historical Anthropology of Chinese Society

大學教育資助委員會卓越學科領域

大學教育資助委員會選出了十五個卓越學科領域，為本港大專院校提供專項撥款，進行有關研究。大學教育資助委員甄選及資助的十五個項目中，由中大研究人員領導的共佔六項。

- 中醫中藥研究與發展研究
- 母體血漿胎兒核酸研究中心
- 植物及農業生物科技中心
- 資訊科技
- 網絡編碼研究所
- 中國社會的歷史人類學研究



香港中文大學
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State Key Laboratories

CUHK has actively maintained research collaborations with institutes on the mainland, resulting in the establishment of more than 30 joint research centres, research institutes and laboratories. In 1984, China introduced the State-funded Key Laboratory Scheme to conduct pioneering research on specific areas to further support the country's technological and economic development. These laboratories are of great significance and the institutes to which they are attached must have demonstrated the highest international-level research and possess the resources and technology to accomplish the tasks assigned by the country. With the approval of the Ministry of Science and Technology of China, CUHK has established the following four state key laboratories:

State Key Laboratory of Oncology in South China (Partner Laboratory in CUHK)

Established in 2006, this Laboratory aims at, on the foundation of a strong clinical base, developing early detection techniques and novel therapeutics for cancers that are of high prevalence in Asia.

State Key Laboratory of Agrobiotechnology (Partner Laboratory in CUHK)

Established in 2008, this Laboratory aims at combining modern biotechnology with the traditional wisdom of farmers and growers to increase agricultural productivity, safeguard food security, and improve people's nutrition in China.

State Key Laboratory of Phytochemistry and Plant Resources in West China (Partner Laboratory in CUHK)

The Laboratory will draw on the expertise of CUHK and the Kunming Institute of Botany in Yunnan province to conduct research into the modernization of traditional Chinese medicine and the application of biotechnology in medical science.

State Key Laboratory of Synthetic Chemistry

The Laboratory was established in partnership with the University of Hong Kong and the State Key Laboratory of Organometallic Chemistry located in the Shanghai Institute of Organic Chemistry, the Chinese Academy of Sciences, to create and identify novel chemical compounds with important structural and bonding features or with notable potential for practical applications.

國家重點實驗室

本校積極與內地院校開展科研合作，至今已建立超過三十個聯合研究中心、研究所和實驗室。中國在1984年推行國家重點實驗室計劃，針對特定領域，設立由國家資助的實驗室，從事創新的基礎和應用研究，以促進國家科技和經濟發展。這些實驗室的重要性非比尋常，因此它們所屬的院校，必須具備國際一流水平的研究能力，並且有資源和技術完成國家交付的科研重任。中大成功獲國家科學技術部批准，成立四所國家級重點實驗室：

華南腫瘤學國家重點實驗室（香港中文大學夥伴實驗室）

實驗室於2006年成立，在大量臨床病例的實證支持下，針對亞洲人常患的癌症，發展早階段檢測確診技術，並開發診治方案。

農業生物技術國家重點實驗室（香港中文大學夥伴實驗室）

實驗室成立於2008年，以現代生物科技加上農民及育種家的傳統智慧，開發新技術，提高中國農業生產力，保障糧食安全和改善人民營養。

植物化學與西部植物資源持續利用國家重點實驗室（香港中文大學夥伴實驗室）

實驗室結合中大與昆明植物研究所的研究優勢，發展有關傳統中醫藥現代化及應用生物科技於藥用植物上的研究。

合成化學國家重點實驗室

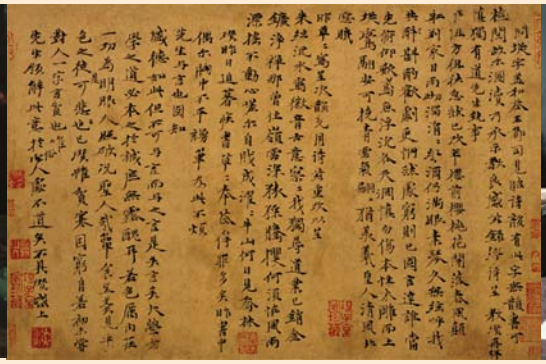
實驗室由中大、香港大學和中國科學院上海有機化學研究所金屬有機化學國家重點實驗室共同建立，主要研究新穎合成物的設計、合成與應用。

Focused Areas of Research

To maximize impact and benefit to society, CUHK has adopted in its Strategic Plan 2006 the strategy of focusing its research investments in five already distinguished fields of academic enquiry within the University.

重點研究領域

為增強大學的研究和學術實力，發揮深遠影響，造福社會，香港中文大學在2006年的策略計劃中，選定五個重點學術領域，調配充足資源協助其開展研究。


Chinese Studies

As China takes centre stage in the world's economic, cultural and political arenas, the bilingual and multi-disciplinary field of Chinese Studies becomes an international hub of teaching and research on China and an essential source of understanding for all things Chinese.

中國研究

中國在國際經濟、文化、政治舞台的地位日益重要，跨學科的中國研究，也逐漸變成理解所有中國事物的基礎。



Biomedical Sciences

Biomedical research in CUHK straddles the conventional boundaries of various academic disciplines and addresses health issues from the molecular to the societal level, contributing to progress in medicine, public health, and bioscience.

生物醫學科學

中大的生物醫學研究跨越了傳統的學術範疇，從微小的分子單位出發，廣涉社會、公共衛生、生物科學等不同層面的健康課題。

Focused Areas of Research

重點研究領域

Information Sciences

On the basis of its significant presence in Information Sciences, CUHK, being the major internet hub for the region, will continue to create and disseminate cutting-edge knowledge and technologies that have profound impact on academia, industry, and society.

信息科學

中大對信息科學的發展影響深廣，是區內的重點互聯網樞紐，我們將繼往開來，創造和傳播信息科學的新知，為該學科的研究方向、業界和社會帶來深遠影響。

Economics and Finance

Economics and Finance builds strategically on the existing strengths of CUHK as a leading Asian institution to develop the Institute of Economics and Finance. The focus of the Institute will be the Chinese economy and corporate finance and the emerging financial markets of China and Asia.

經濟與金融

中大在探討經濟與金融方面，於亞洲處領先地位。中大利用這一優勢成立了經濟金融研究所。該所以中國經濟、企業財務及中國和亞洲新興金融市場等為研究重點。



Geoinformation and Earth Sciences

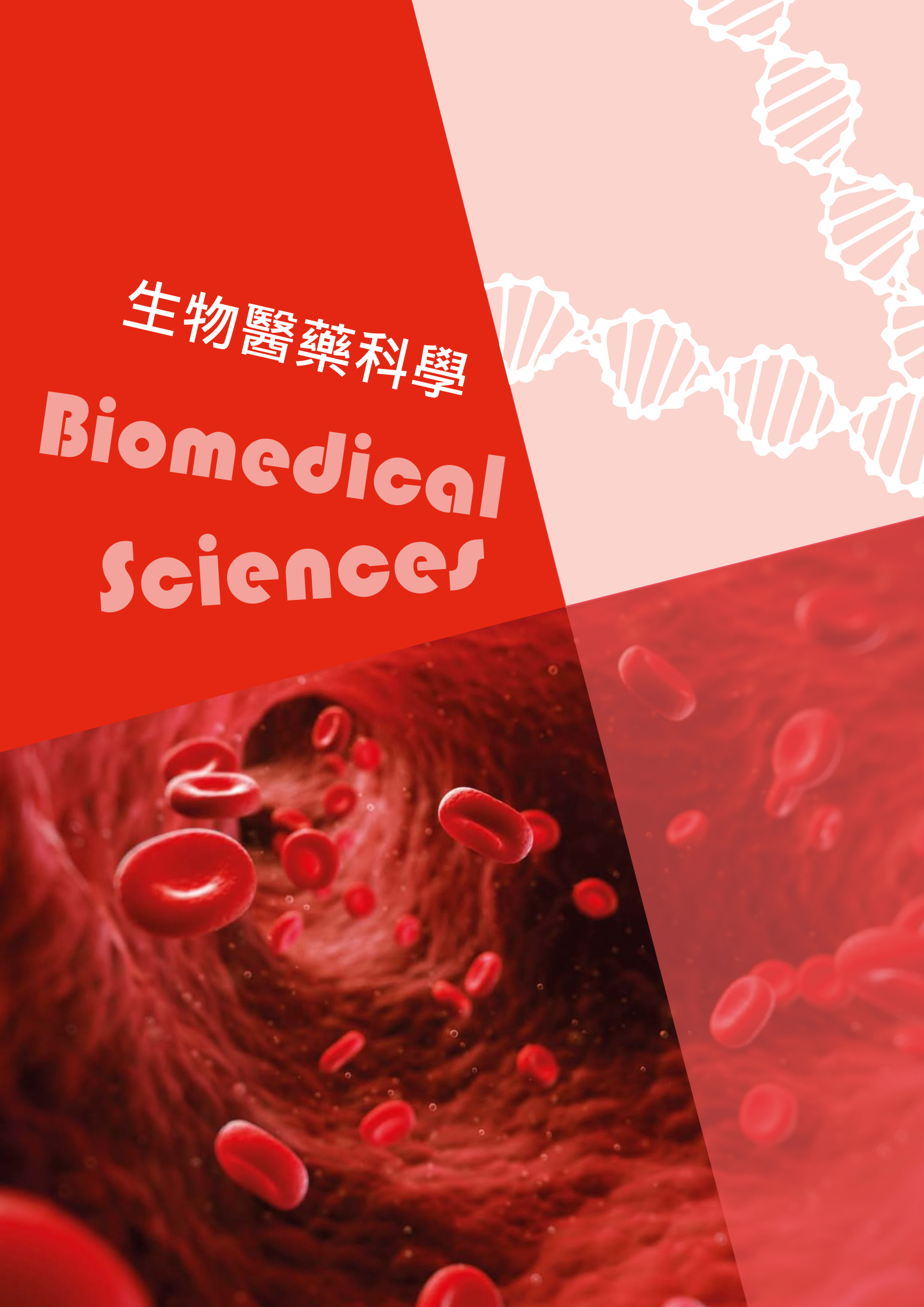
The Institute of Space and Earth Information Science (ISEIS) is the only national base for satellite remote sensing in Hong Kong. The Institute's major initiative, a Laboratory for Tropical Monsoon Environmental Remote Sensing, is a groundbreaking, state-of-the-art, comprehensive laboratory in Geoinformation and Earth Science. The strategic development of this Laboratory through education, cutting-edge research, providing scientific solutions and technology transfer will greatly assist in the enhancement of life, the environment, and the economy in the region.

地球信息與地球科學

太空與地球信息科學研究所是香港唯一的國家級衛星遙感基地。由該所建議設立的熱帶季風環境遙感實驗室，更是一所創新突破、科技尖新的地球信息與地球科學綜合實驗室。該實驗室的發展方向是推行教育、從事前沿研究，以科學解決問題，並提供技術轉移，藉此提升區內人們生活品質、改善環境和推動經濟發展。

生物醫藥科學

Biomedical Sciences



Wide Dynamic Range Phase-sensitive Surface Plasmon Resonance Sensor
寬動態範圍相位敏感表面等離子體共振傳感器

Prof. HO Ho Pui Aaron
Department of Electronic Engineering
電子工程學系
何浩培教授

Supported by CUHK Technology Transfer Fund and Innovation and Technology Commission
由香港中文大學技術轉移基金和創新科技署資助

Collaboration with City University of Hong Kong, Shenzhen University and Shenzhen Entry-exit Inspection and Quarantine Bureau
合作夥伴為香港城市大學、深圳大學、深圳出入境檢驗檢疫局

Wide dynamic range phase-sensitive surface plasmon resonance sensor
寬動態範圍相位敏感表面等離子體共振傳感器

Surface Plasmon Resonance (SPR) is a new optical technology for performing real-time, label-free (i.e. no need of any fluorescent probe molecules) detection of bio-related agents. SPR sensors are commonly used as a laboratory tool for measuring bio-molecular interaction properties such as DNA hybridization and antibody-antigen binding. Current SPR technology also aims at the development of point-of-care quantitative immunoassays.

表面等離子體共振（SPR）是一種實時、免標籤(即無需螢光顯影分子)的光學生物傳感技術。SPR傳感器是常用的化驗所工具，經常應用於測量生物分子相互作用，例如DNA混合體和抗體抗原連結等。SPR技術的發展亦有邁向於臨床就地測量病毒抗體的應用。

In a typical SPR sensor, the signal is generated through one of the following techniques: (i) wavelength interrogation, (ii) angular interrogation or (iii) intensity measurement. However, they have the drawback of lacking detection sensitivity required by the target application. Our work has demonstrated that the optical phase detection approach offers up to 10 times improvement in sensitivity level.

傳統的SPR傳感器透過測量 (i) 波長、(ii) 角度或 (iii) 光亮度去產生信號，但它們的檢測靈敏度往往未能附合應用所需。我們的研究展示了光學相位檢測方法可將靈敏度提升達10倍。

Despite its better detection performance, the phase-sensitive SPR sensor has one major weakness because of its narrow dynamic range. To address this problem, we have incorporated a white light source in our phase-sensitive SPR. Spectral information is captured simultaneously while we measure the phase. In the new design, we practically have a large number of interferometers working in tandem within a range of optical wavelengths. Hence dynamic range is no longer an issue. The final outcome is a highly sensitive SPR bio-detection system that operates for a wide range of concentration limits.

雖然相敏SPR的檢測表現較好，但動態範圍較窄是其主要缺點。針對此問題，我們在相敏SPR中加入白色光源，在相位測量的同時獲取光譜資訊。新設計實際上將多個光譜分析儀串聯起來，於不同光波長範圍下運作，解決了動態範圍的問題，最後得出具極高靈敏度的SPR生物檢測系統，可於不同濃度範圍下運作。

Practical application areas of our sensor include measurement of dielectric properties of fluidic samples, molecular adsorption monitoring and surface degradation. Typical applications are real-time label-free monitoring of bio-molecular interactions involving DNAs, proteins and viruses, quantitative immunoassays, drug residue testing and drug screening. This sensor is also being explored for various detection applications in medical laboratories, pollution monitoring agencies and biochemistry laboratories.

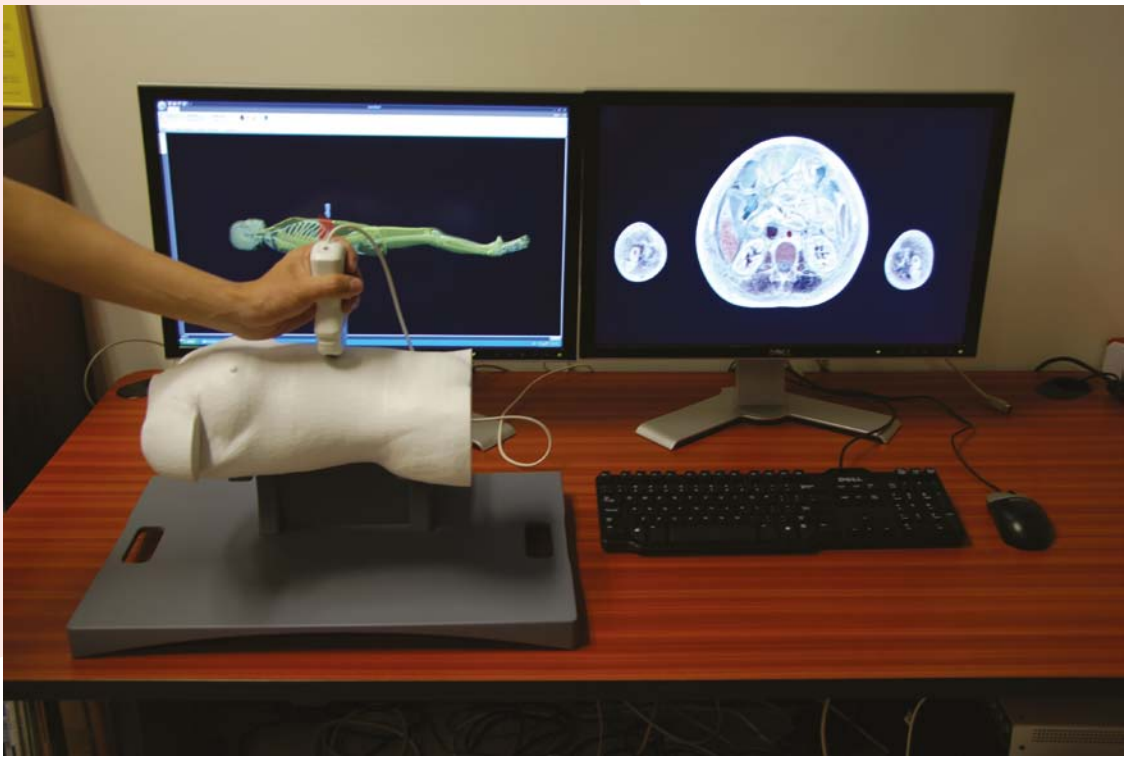
傳感器可應用於測量液體介電性能、監測分子吸附過程以及表面變化。典型的應用包括涉及DNA、蛋白質和病毒的實時免標籤生物分子相互作用監測、測量病毒與抗體、藥物殘留檢測和藥物篩選。我們亦正探究將技術應用於醫學實驗室、生化實驗室和污染監測機構之檢測用途上。

Website 網址： www.cintec.cuhk.edu.hk/exhibition/project.php?pid=313

Chinese Visible Human Slicer
中國可視人切片系統

Prof. HENG Pheng Ann
Department of Computer Science and Engineering
計算機科學與工程學系
王平安教授

Funded by the Research Grants Council of Hong Kong and Innovation and Technology Commission
由香港研究資助局及創新科技署資助



Human – machine interface
人機介面

Chinese Visible Human (CVH) data is a big dataset with more than 3000 cross-sectional slices of a human body. It is a valuable and useful education and training resource for students and professionals majored in medicine or related disciplines. However, it is often tedious and inefficient to browse through such a big database to find the slices we are interested in. A human-computer interaction process simply via mouse and keyboard is also an unnatural manipulation for those who want to find the corresponding position of certain slices on the human body.

We develop an interactive system for the navigation of cross-sectional anatomy based on Chinese Visible Human (CVH) data, named CVHSlicer. This system is featured in real-time computation and rendering of high-resolution anatomical images on standard personal computers (PCs) equipped with commodity Graphics Processing Units (GPUs). Besides, we provide users with a 3D printing model equipped with a sensor and a transducer to help them easily and interactively locate their interested region on the human body. We can navigate the cross-sectional anatomy in arbitrary directions, by simply turning around and moving the transducer.

中國可視人數據是一個含有超過3000張人體切片圖的數據庫。這是對醫科學生和醫療專家非常有用的教育和培訓資源。然而，在如此巨大的數據庫中尋找所需的解剖切片，是一項枯燥和低效的工作。而且要找出解剖切片於人體上的位置，僅利用滑鼠和鍵盤的人體互動過程亦有欠流暢。

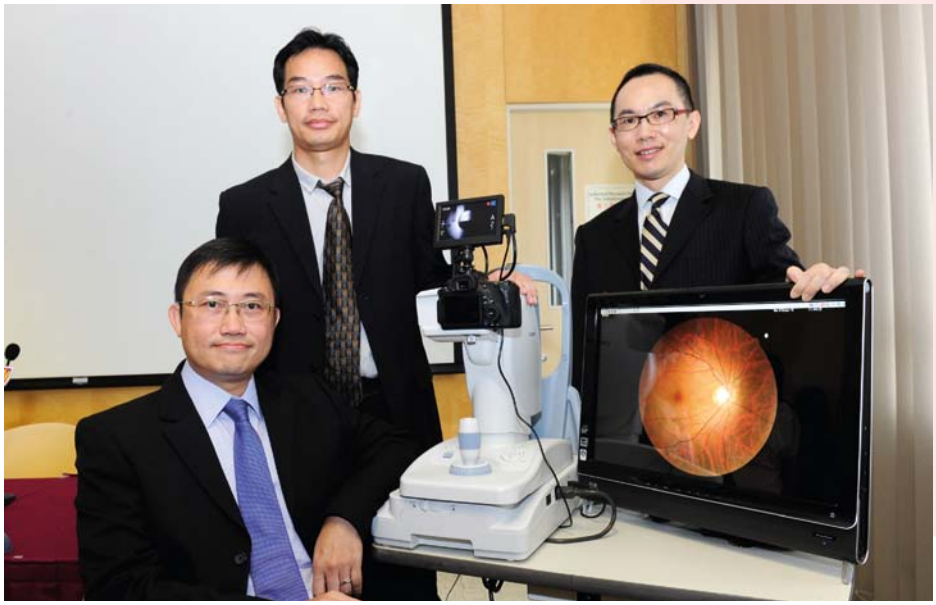
我們建立了一套名為「CVHSlicer」的互動系統，以瀏覽可視人數據的解剖橫切面圖。這個系統的特點是可以在設有圖像處理器(GPU)的個人電腦上，即時計算和顯示高解像度的解剖切片。另外，該系統配備人體模型、感應器和導航器，以協助用戶簡單並交互式地定位所需的人體區域。用戶只需簡單地移動傳感器，便可從不同方向隨意觀察人體的內部解剖切片圖。

Website 網址： www.cintec.cuhk.edu.hk/exhibition/project.php?pid=314

Automatic Retinal Image Analysis System to Help Diabetes Patients Prevent Stroke
有助糖尿病患者預防中風的全自動化視網膜圖像分析系統

Prof. ZEE Chung Ying Benny
Dr. LEE Jock Wai Jack
Division of Biostatistics,
The Jockey Club School of Public Health and Primary Care
賽馬會公共衞生及基層醫療學院生物統計學學部
徐仲錡教授
李作為博士

Prof. MOK Chung Tong Vincent
Division of Neurology,
Department of Medicine and Therapeutics
內科及藥物治療學系腦神經科
莫仲棠教授



(From left) Prof. ZEE Chung Ying Benny, Dr. LEE Jock Wai Jack and Prof. MOK Chung Tong Vincent show the automatic retinal image analysis system.
（左起）徐仲錡教授、李作為博士及莫仲棠教授展示全自動化視網膜圖像分析系統。

Stroke is the fourth leading cause of death in Hong Kong. Diabetic retinopathies (DR) and hypertensive retinopathies are associated with stroke. Retinal vessels are the only visible vessels and accessible by retinal imaging technique. They have the same embryo origin, histological structure and pathological change caused by diabetes and hypertension with cerebral vessels, providing us a convenient way to assess cerebral vessels condition. CUHK have developed an automatic retinal image analysis system to assess cerebral vessel condition to evaluate the risk of stroke.

In order to study stroke using retinal images, it is logical to study DR first and expand the methodology further to cover new information for stroke. However, there are problems with current manual screening process, such as variability between different observers, difficulty in outpatient clinics on image interpretation, etc.

Standard retinal images can be transmitted through internet to server installed with the computer algorithm using advanced biostatistics method to read pixel-by-pixel in the retinal images and analyze these pixels to come up with measurements on exudates, hemorrhages, new vessels and finally the overall rating of retinopathy. The method will decrease bias due to human perceptions, reduce cost and save time.

With this technology, the CUHK research team has expanded the application for stroke detection and determined important retinal vessel characteristics specifically for stroke. The technology is now being expanded to detect stroke for both diabetes patients and non-diabetic individuals.

中風是香港第四大死亡殺手，而糖尿病視網膜病變和高血壓視網膜病變都與中風有關。視網膜血管是唯一可直接以肉眼看見的血管，它和腦血管都有相同的胚胎起源、組織結構以及因糖尿病和高血壓所引起的病理變化，故檢測視網膜血管亦有助檢視腦血管的情況。中大成功研發一種全自動的視網膜圖像分析系統，有助糖尿病患者檢視腦血管狀況，評估中風風險。

利用視網膜圖像分析來研究中風，必須先處理糖尿病視網膜病變的問題和檢測方法。然而，現時透過人工檢測糖尿病視網膜病變受到不少限制，包括不同驗光師的檢測結果差異、門診對於圖像解讀有困難等。

中大研發的全自動視網膜圖像分析系統，透過互聯網將一般的視網膜圖像傳送到伺服器，程式會自動分析每點的像素，並以嶄新計算程式和先進的生物統計學評估是否有分泌物、視網膜出血量和新生血管，最後計算出患糖尿病視網膜病變的機會。此系統不單能在幾秒鐘內提供精確診斷，亦可大大降低成本。

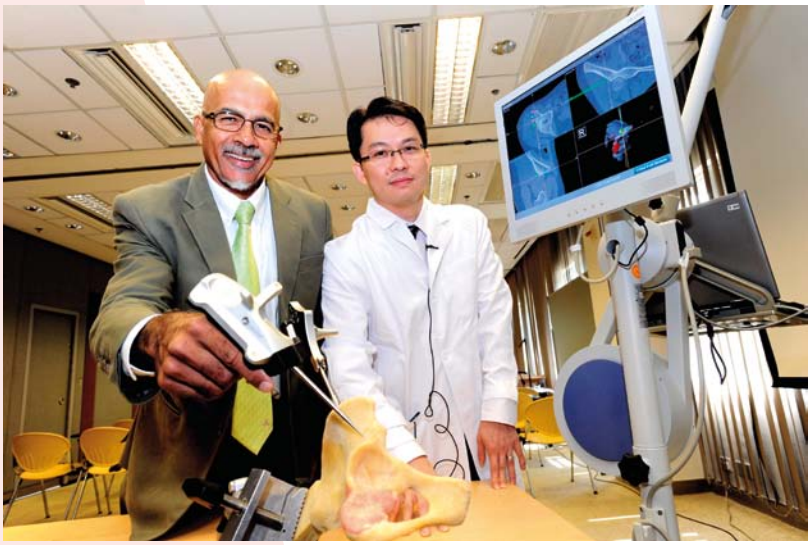
研究團隊把這項技術延伸到中風患者上，並確定了與中風相關的視網膜微細血管之重要特徵，現正研究把應用擴展到糖尿病患者上來預防中風。

Website 網址： www.cintec.cuhk.edu.hk/exhibition/project.php?pid=315

Innovative Computer Assisted Tumor Surgery for Bone Cancer Patients
嶄新電腦輔助治療骨腫瘤手術

Prof. KUMTA Shekhar Madhukar
Dr. WONG Kwok Chuen
Department of Orthopaedics and Traumatology
矯形外科及創傷學系
古明達教授
黃國全醫生

Funded by Research Grants Council of Hong Kong
由香港研究資助局資助



Prof. KUMTA (left) and Dr. WONG demonstrate the simulation of bone tumor removal surgery.
古明達教授（左）及黃國全醫生示範模擬切割骨腫瘤手術。

CUHK pioneers an innovative technology - Computer Assisted Tumor Surgery (CATS) to assist in complicated tumor surgery, such as pelvic / sacral tumors removal and paediatric bone cancers. CATS has been successfully applied to 32 bone cancer patients.

In the conventional management of bone tumor surgery, surgeons have to integrate two-dimensional (2D) preoperative images to simulate a three-dimensional (3D) surgical plan. Surgeons often have difficulties in accurately executing the virtual surgical plan. Inaccurate tumor resection may lead to local tumor recurrence and death.

The integration of all preoperative information by image fusion not only allows detailed analysis of patients' anatomy and tumor position, but also enables construction of 3D models and hence precise virtual surgical simulation and resection planning. The surgical plan can be executed with the help of a computer navigation system to achieve a high level of precision and accuracy, ensuring clear resection margins and reducing the error in bone resection from 10 mm by using conventional methods to less than 2 mm. This technology helps increase the chance of total tumor resection and preserve normal bone tissues and joints. CATS is widely recognized and accepted worldwide in the treatment of bone cancer. CUHK is the only orthopaedic tumor centre in the world that provides systematic and structural training courses for CATS.

中大率先研發嶄新的電腦輔助腫瘤手術(CATS)以輔助複雜而困難的腫瘤手術，例如盤骨腫瘤、骶骨腫瘤和兒童骨癌等手術，至今已成功應用於32位骨腫瘤病人上。

傳統的骨腫瘤手術中，醫生需拼合平面掃描影像，以模擬骨腫瘤的立體圖像並制定手術計劃。然而，由於模擬與現實情況會有偏差，醫生執行手術時往往遇到很大困難。醫生可能因「手術切口邊界」不足，需要犧牲患者部分正常組織，導致病人手術後肢體功能欠佳；或未能準確切除腫瘤，引致病情復發甚至死亡。

CATS具備多層掃描影像融合技術，能更詳盡和仔細地分析影像和建立三維透視模型，讓醫生可準確掌握病人的解剖圖像和腫瘤位置，以模擬和制定手術計劃，並透過電腦導航系統執行手術。新技術大大提高手術的精確度，並能確保有足夠的「手術切口邊界」，將骨切口誤差減至少於2毫米，比傳統的一厘米誤差大幅減少。同時，它亦改善了骨骼重組接合不對等的問題，增加把腫瘤完全切除的機會，並有助保留正常組織以改善肢體功能。CATS技術現已得到國際醫學界認可，各國亦開始採用此技術進行切割骨腫瘤手術。中大更是現時全球唯一提供一站式CATS技術培訓的骨腫瘤中心。

Honours :
Eight related articles have been published in international journals, including the *Journal of Bone and Joint Surgery*, *Clinical Orthopaedics* and related research.

CUHK orthopaedic surgeons also won two poster awards
at the International Society of Limb Salvage Surgery meeting in 2007 and 2011 respectively
and the best clinical paper award at International Computer-Assisted Orthopaedic Surgery meeting in 2008.

榮譽：
CATS技術的研究成果曾先後八次刊登於國際醫學期刊，包括《骨和關節外科期刊》、《臨床骨科》和相關研究期刊。

中大矯形外科及創傷學系更憑這嶄新技術，分別於2007和2011年國際保肢手術會議中獲得海報論文獎，
並於2008年國際電腦輔助骨科手術會議上榮獲最佳臨床論文獎。

Website 網址： www.cintec.cuhk.edu.hk/exhibition/project.php?pid=316

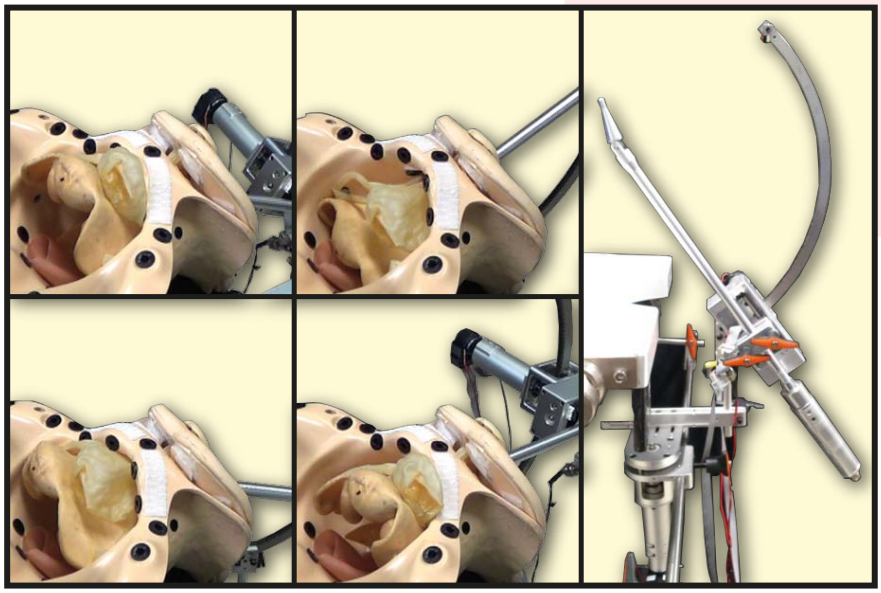
Robotic Assistant in Hysterectomy
子宮切除手術輔助機械人

Prof. LIU Yun Hui
Dr. TONG Hang
Dr. LI Peng
Department of Mechanical and Automation Engineering
機械與自動化工程學系
劉雲輝教授
唐珩博士
李鵬博士

Dr. CHEUNG Tak Hong
Department of Obstetrics and Gynaecology
婦產科學系
張德康醫生

Funded by Innovation and Technology Commission
由創新科技署資助

Collaboration with Soon Luck Industrial Limited
and Unistar Industries (Hong Kong) Company Limited
合作夥伴包括生祥實業有限公司及聯星實業(香港)有限公司



Prototype of the Robotic Assistant in Hysterectomy
子宮切除手術輔助機械人原型

Hysterectomy is the most commonly performed gynecological surgical procedure. In laparoscopic hysterectomy, an assistant has to position and deform the uterus with a tool throughout the procedure, which lasts more than 90 minutes, to expose the anatomical structures in the surgical field. The task is tedious and labour-intensive, and very often the assistant cannot manipulate the uterus into an optimal position that meets the surgeon's need. This not only slows down the surgical procedure but also increases the risk of injury to adjacent organ structures. It is highly demanded to replace the assistant with a robot in order to improve quality and efficiency and to reduce workload and manpower.

In this project, we will develop a compact and low-cost robotic assistant for the above mentioned purpose. Surgery safety is highly guaranteed by both a uniquely designed passive mechanisms as well as an energy-based motion/force controller. This customized design demostrates the elegant combination of the actively and passively controlled joints, while is of low cost. It also provides a friendly foot-controlled interface for the hand-busy surgeon to directly manipulate the uterus.

子宮切除是最常見的婦科手術。進行微創子宮切除手術時，助手往往需於逾90分鐘的手術過程中，以儀器控制子宮的位置及形狀，將周邊生理組織結構顯露出來以進行手術。這項工作既乏味且費人手，而助手亦經常未能按醫生要求控制子宮位置。這不但影響手術進度，還很可能傷及其他器官。為了提高手術質素和效率並降低工作量和人力成本，以機械人代替助手去執行這項工作，實在有逼切的需求。

本項目將研發一台簡單而低成本的子宮切除手術輔助機械人。專門設計的被動式保護機制和能量定限運動操作器，確保了手術的安全性。主動和被動控制的關節巧妙地組合，且成本便宜。醫生更可用腳操控簡單易用的介面，以控制子宮的位置和形狀，而不影響雙手同時進行手術。

Website 網址： www.cintec.cuhk.edu.hk/exhibition/project.php?pid=321

Multi-modality High-speed Microscope System for Volumetric Imaging
多模式高速立體成像光學顯微鏡系統

Prof. CHEN Shih Chi
Department of Mechanical and Automation Engineering
機械與自動化工程學系
陳世祈教授

Funded by Innovation and Technology Commission
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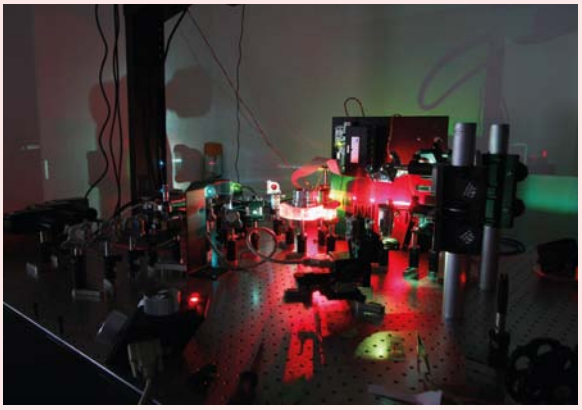
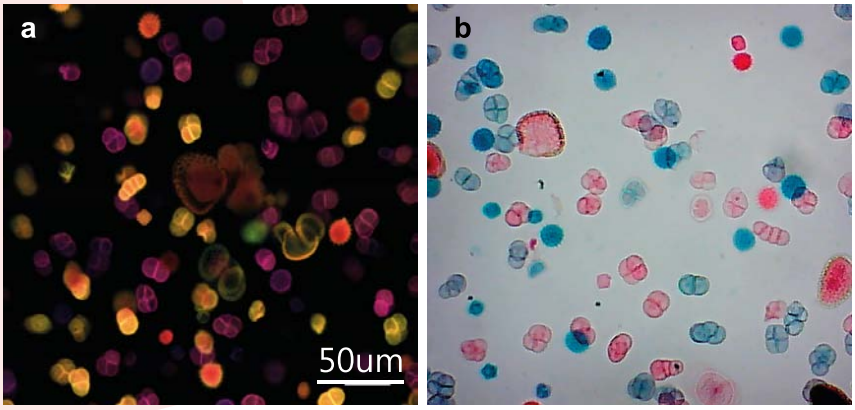
Collaboration with RF Tech Limited and ITE Engineering Limited
合作夥伴包括 RF Tech Limited及ITE Engineering Limited



Multi-modality High-speed Microscope System
多模式高速立體成像光學顯微鏡系統



Mixed pollens images generated by (a) Multi-modality High-speed Microscope System and (b) conventional widefield microscope respectively.
(a) 多模式高速立體成像光學顯微鏡系統和 (b) 傳統顯微鏡所獲取之花粉影像。

Many breakthroughs in biology and medicine are driven by the advancement of new diagnostic tools. This project aims to develop a multi-modality high-speed microscope system for generating high-frame-rate volumetric images for the advancement in biological and medical research.

The system comprises of three modules:
1) a combined video-rate confocal and multi-photon excitation fluorescence microscope;
2) a high-density fiber bundle-based nonlinear endomicroscope;
3) an ultra-high-speed volumetric imaging module achieved via the 3D temporal focusing technique.

Through different modules, this novel system can generate images of resolution as high as 200nm or at a speed of up to 1000 frame per second (FPS).

The system enables various vivo biological studies that cannot be realized in the past. For example, in order to observe and study biological events with short time constants, e.g. cell trafficking (immune cells or cancer cells) or neural cell signaling process, it will require a frame rate much higher than video rate (30 FPS). With our system, high-quality optical cross-sectional images, e.g. 512 x 512 pixels for up to 1000 FPS, can be generated.

Besides, the nonlinear endomicroscope module can generate video-rate optical cross-sectional images at subcellular resolution, realizing the concept of optical biopsy. Accordingly, we can perform in vivo biological studies not only on the exterior of the animal, e.g. skin, eye, or skull etc., but also various internal organs, e.g. spleen, liver or even deep brain.

診症儀器的進步，為生物與醫學領域帶來許多的突破。本項目研發的多模式高速立體成像光學顯微鏡系統，將有助生物及醫學研究再向前邁進。

本系統可以在以下三種主要模式間切換：
1)視頻幀頻的多光子及共聚焦顯微成像模式；
2)基於高密度光纖束的非線性內窺顯微成像模式；
3)通過三維時間聚焦技術實現的超高速立體顯微成像模式。

透過不同模式，這款新型系統可獲得最高200nm解像度或最高每秒1000幀(FPS)的影像。

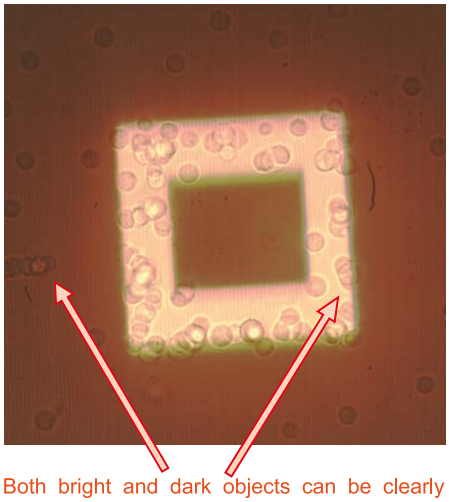
本系統令多種過去由於儀器性能所限而不能進行的生物醫學研究能夠實現。例如研究瞬態生物學現象(包括免疫細胞和癌細胞追踪、神經細胞信號傳遞等)時，需求的顯微鏡獲取圖像速度遠高於視頻幀頻(30FPS)。有了這系統，研究人員就可獲得高質量的光學層析圖像，如在1000FPS的幀頻下獲得512×512像素的共聚焦影像。

另外，在非線性內窺顯微鏡模式下，本系統可以視頻幀頻的速度獲得具亞細胞解像度的光學層析影像，實現了光學活檢的概念。有了這項技術，我們可以將活體生物醫學研究從生物器官表面(如皮膚、眼睛、頭骨內骨髓腔等)擴展到多種器官內部(如脾臟、肝臟甚至大腦內部)。

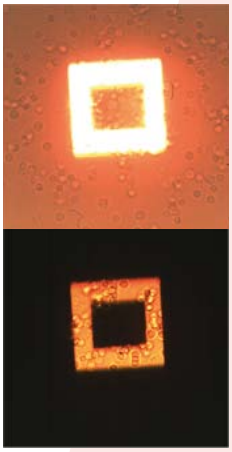
Website 網址： www.cintec.cuhk.edu.hk/exhibition/project.php?pid=317

High-speed High-resolution Imaging Systems for Health Care and Medical Industries
高速高解像度拍攝系統

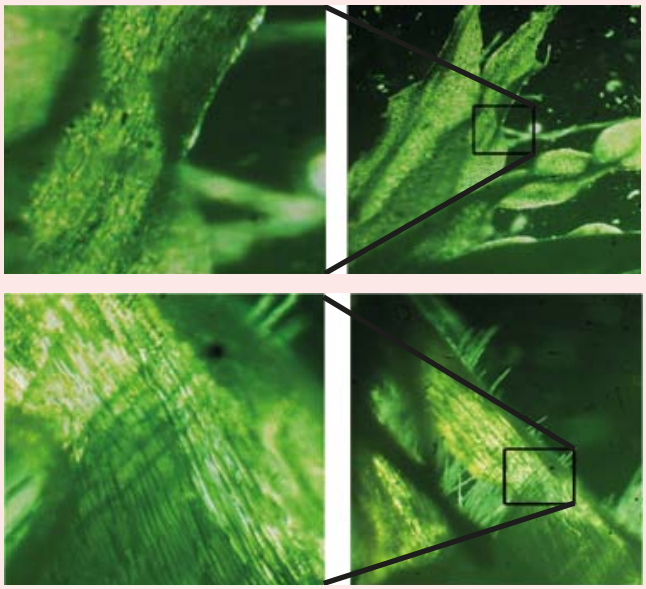
Dr. LAU Tak Kit
Department of Mechanical and Automation Engineering
機械與自動化工程學系
劉德傑博士



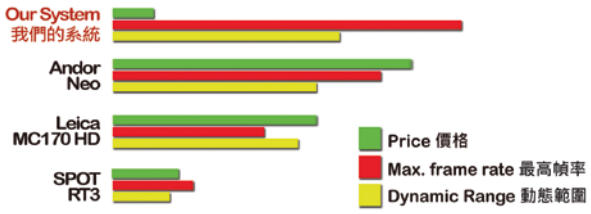
Both bright and dark objects can be clearly imaged under our HDR mode.
極端光暗物體皆能清晰分辨



Without HDR mode, images are either over-exposured or under-exposured.
缺乏HDR, 相片不能同時呈現極端光暗物體。



250% larger in image size than conventional microscopic cameras, and hence an extremely large field-of-view. But still, images are crystal clear after zooming in.
比一般顯微鏡相機大2.5倍的畫幅面積，令可視範圍倍增；但同時，當圖像放大時每個細節仍能清晰盡現。



Comparison between different imaging systems
不同拍攝系統之比較

Digital image acquisition and processing facilitate a wide range of development in pathology, dental medicine, dermatology and ophthalmology. Imaging devices are not only used in diagnosis and patient treatment, but also used in production process of medical devices and components. To keep pace with the ever-evolving medical applications, accurate and highly reliable imaging systems are continuously demanded by the professional personnel in the medical fields. Our imaging systems are designed to meet the needs of all mainstream medical applications. Particularly, our imaging systems offer:

- +90dB high dynamic range
- 4MP to 60MP resolutions
- 160 to 1,150 FPS maximum imaging rates
- +60% quantum efficiency
- Up to ±1ps of sampling accuracy
- +2 hours recording @ full-res full-speed
- -50°C cooling for low-light imaging

Applications include:
- Ophthalmology
  e.g. cornea and the retina measurement
- Dental Medicine
  e.g. prosthetics, dental scanning
- Microscopy
  e.g. in vivo cell imaging, stem cell studies

數碼拍攝現正廣泛應用在病理學、牙科、皮膚科及眼科上。除了用於斷症及治療，數碼拍攝系統亦用於生產醫療設備及用品上。因應高質量醫療產品的需求，以及臨床及科研層面上對觀察及分析的需要，在拍攝質素、通量及成本考慮上長期有著未被滿足的需求。我們開發的拍攝系統正正是針對以上種種需要而設計。其中特點如下：

- +90dB 動態範圍
- 4MP to 60MP 解像度
- 160 to 1,150 FPS 最高幀率
- +60% 量效
- 達±1ps 取幀準確度
- +2 小時記錄時間(使用最高解像度及速度)
- -50°C 低温低照拍攝

應用範疇:
- 眼科
  例如: 角膜及視網膜檢查
- 牙科
  例如: 矯形、掃描
- 顯微觀察
  例如: 活胞觀察

Website 網址： www.cintec.cuhk.edu.hk/exhibition/project.php?pid=318

環境和綠色科技

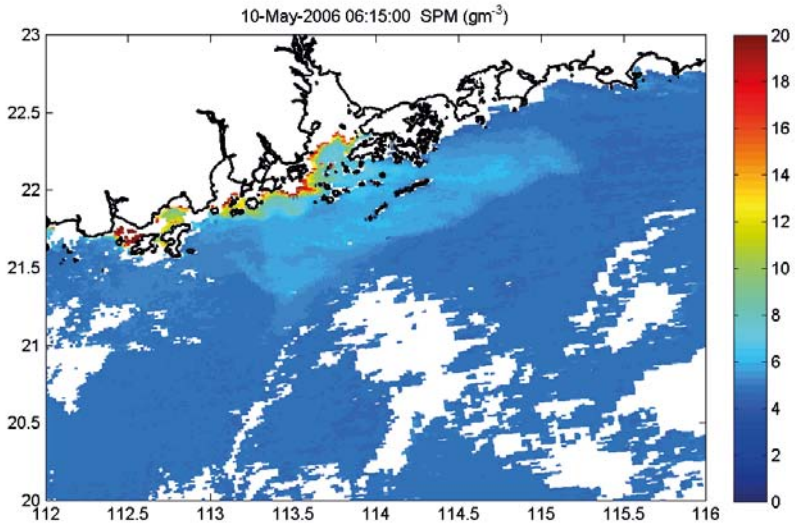
Environment and Green Technologies

Real-time Monitoring System for Hong Kong Offshore Dynamic Characteristics Based on Satellite Remote Sensing
基於衛星遙感的香港近海動態海洋實時監測系統

Prof. PAN Jiayi
Institute of Space and Earth Information Science
太空與地球信息科學研究所
潘家禕教授

Funded by Innovation and Technology Commission
由創新科技署資助

Collaboration with Hong Kong Observatory, Hong Kong Marine Department, Laurel Technologies Company Limited and National Space Science Center, Chinese Academy of Sciences
合作夥伴包括香港天文台、香港海事處、香港勞雷工業有限公司及中國科學院國家空間科學中心



The suspended sediment matter in the Hong Kong coastal water observed by satellite Moderate Resolution Imaging Spectroradiometer (MODIS)
利用中等解像度成像光譜儀(MODIS)觀測的香港水域懸浮物濃度分佈圖

The marine environment has significant impacts on the economy and society of Hong Kong. Coastal marine hazards and pollution greatly threaten its living and ecological environment. The project aims at establishing a satellite remote sensing-based system for monitoring the dynamic marine environment of Hong Kong.

海洋環境對香港的經濟及社會有重大影響，近海的海洋災害及污染，嚴重威脅香港居住及生態環境。本項目希望利用衛星遙感技術建立香港近海的海洋動態環境實時監測系統。

The project will focus on developing precise satellite data algorithms and computing software for the retrieval of accurate ocean dynamic parameters, generating real-time monitoring data to improve the accuracy of marine environmental forecast, assisting the marine ecological environment protection and disaster mitigation, and helping to build a sustainable marine environment for Hong Kong.

研究團隊將開發高精度海洋動態參數衛星算法及軟件，提供更準確的即時近岸海洋監測數據，提高香港近海海洋災害預報的準確度，並更有效地保護海洋生態環境、減災防災、營造可持續發展的海洋生態結構。

The technology innovations of the project include:
1) a novel technology to monitor ocean surface currents
2) new satellite algorithms applicable for Hong Kong waters
3) high-resolution models for sea surface waves and winds from satellite imagery
4) new ocean surface mode recognition technology

本項目的創新點在於四方面：
1）嶄新的衛星監測海流方法
2）新的香港海域衛星算法
3）高分辨率的海洋表面風場及波浪模型
4）海洋表面特徵識別新技術

The project results support the government operational services. Hong Kong Observatory can use real-time observations of coastal ocean and meteorological parameters from the project for marine and weather forecasting. Marine Department can monitor the seaway navigation status based on real-time sea state and current data distributed by the project. Ocean pollution can be also monitored by using chlorophyll, turbidity, and temperature data provided in the project.

本研究的成果可用於政府部門，例如香港天文台可把香港近海的海洋和氣象實時監測資料應用於預報系統；香港海事處可利用衛星數據提取海況、流場監測數據，及時提供高危區域的航道狀況。本項目利用衛星資料提供高精度的海水葉綠素濃度、濁度和溫度的實時數據，有助監測海洋污染和模擬香港的近海環境。

Website 網址： www.cintec.cuhk.edu.hk/exhibition/project.php?pid=319

High-efficiency Photon Energy Upconversion
高效率光子能量上轉換

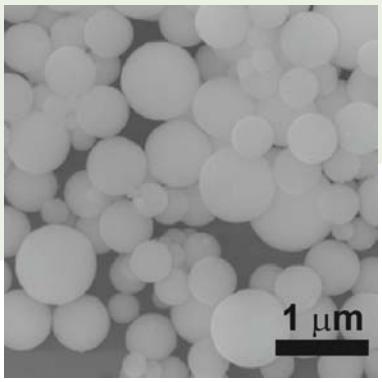
Prof. WANG Jian Fang
Department of Physics
物理系
王建方教授

Collaboration with Peking University
合作夥伴為北京大學

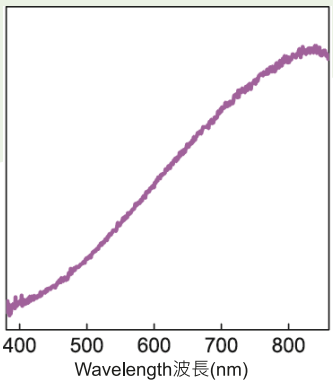
Upconversion material
上轉換材料

Radiated by infrared light
受紅外光照射

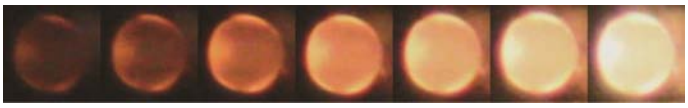
Emission of visible light
釋出可見光



SEM images of Microspheres
掃描式電子顯微鏡下的微球



Emission spectrum
發射光譜



Emission image of Microsphere (diameter = 30μm)
微球釋放可見光時的影像 (直徑 = 30μm)

Solar energy is an important renewable source and could be the solution for energy crisis. Yet, currently available silicon-based solar cells cannot absorb light with wavelength longer than 1,100 nm (e.g. infrared light), wasting approximately 30 % of the sun's radiation for electricity generation.

To tackle this problem, we develop novel solid-state materials that upconvert infrared light into visible light. The cations in the materials absorb infrared radiation and convert the photon energy into phonon energy (heat). The rapid accumulation of heat results in an abruptly increased temperature, which gives incandescent radiation with a significant visible fraction. The upconversion efficiency is more than 10%, which is much higher than that of the state-of-the-art NaYF4-based upconversion materials (<4%) and might be able to overcome the Shockley-Queisser limit. Our materials avoid photon induced quenching effect and have a wider excitation window and emission band. Moreover, it is highly stable.

A new set of apparatus, which can effectively couple our materials with a photovoltaic system, is also designed in our project. With this apparatus, infrared solar radiation, which is not absorbed by the solar panel, is converted into visible light. The visible infrared light feeds back to the solar cell for increasing its efficiency.

太陽能是解決能源危機的重要再生能源，然而目前市面上的矽系太陽能電池不能吸收波長大於1100納米的光(例如紅外光)，浪費了約30%的太陽光輻射能源。

針對這個問題，我們研發出一種能使紅外光轉化為可見光的新型固態材料。這材料中的陽離子將紅外光子吸收，並把光子能量轉化成聲子能量(產生熱)，熱量高速聚集令溫度驟升，釋放出主要為可見光的熾熱輻射。它的能量上轉換效率可達10%，遠高於傳統的上轉換材料NaYF4(低於4%)，有助突破被視為太陽能電池轉化效率瓶頸的「肖克利-奎伊瑟極限」。另外，這種材料能避免熱猝滅現象，並可廣譜吸收及發射連續光譜，而且穩定性高。

我們亦設計了一個裝置將這種材料和薄膜太陽能電池板有效地結合，把太陽能電池板不能吸收的紅外光子轉化為可見光，再傳輸至太陽能電池，從而提升電池的效率。

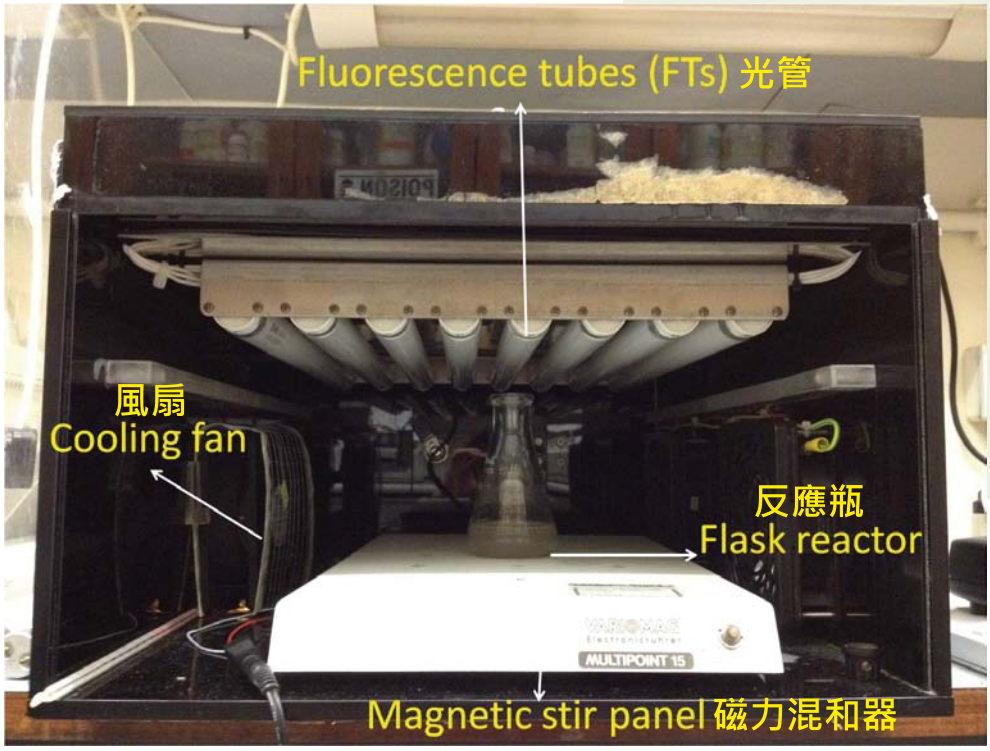
Website 網址： www.cintec.cuhk.edu.hk/exhibition/project.php?pid=322

Advances in Photocatalytic Disinfection
光催化殺菌技術前瞻

Prof. WONG Po Keung
School of Life Sciences
生命科學學院
王保強教授

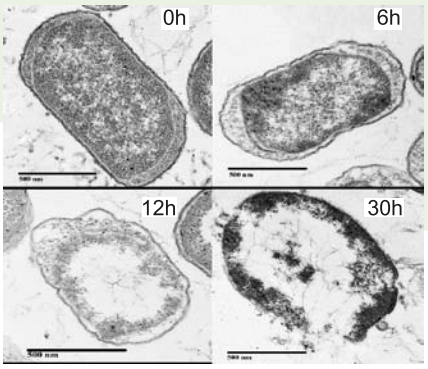
Supported by General Research Fund,
Research Grants Council of Hong Kong
由香港研究資助局優配研究金資助

Collaboration with Peking University,
Guangzhou Institute of Geochemistry, Chinese Academy of Sciences
合作夥伴包括北京大學、中國科學院廣州地球化學研究所



Set-up for photocatalytic disinfection
光催化殺菌設備

Photocatalysts
光催化劑



TEM images of E. coli K-12 photocatalytically treated under fluorescent tube irradiation.
大腸桿菌K-12在光管照射下進行光催化作用的透視電子顯微鏡影像。

By using visible light, natural and synthetic materials, CUHK research team developed a cost-effective, safe and efficient photocatalytic disinfection technology, as well as selecting photocatalysts that can effectively kill bacteria in water. This kind of photocatalysts, which is inexpensive and available in large quantity in nature, is efficient to inactivate bacterial cells under fluorescent tubes, a common and safe indoor lighting source. It works well in large-scale operations.

Based on experimental evidences, bacterial disinfection can be carried out by inputting the photocatalysts to sewage (i.e. water containing bacteria and other microbes) with visible light irradiation and for photocatalytic oxidation treatment. In general, the bacterial content of domestic sewage is approximately 10^4 cfu/mL, while the photocatalysts can disinfect a solution with bacterial content up to 10^7 cfu/mL in 30 minutes. Experiments show that the photocatalysis can be applied to all indoor premises with regular lighting systems without direct contacts between the catalysts and bacterial cells. After the disinfection process, the amount of effective photocatalysts remains unchanged. Because of the ferromagnetic properties, the photocatalysts can be easily collected for recycling and reuse by electromagnetic method.

中大研究團隊利用可見光、天然及合成物料，成功研發一項具成本效益、安全和高效的光催化殺菌技術，選出有效殺菌的光催化劑。這種催化劑在大自然的現存量大、成本低，而且能在光管這種普遍和安全的光源下有效抑制細菌活動，在大規模操作時亦表現理想。

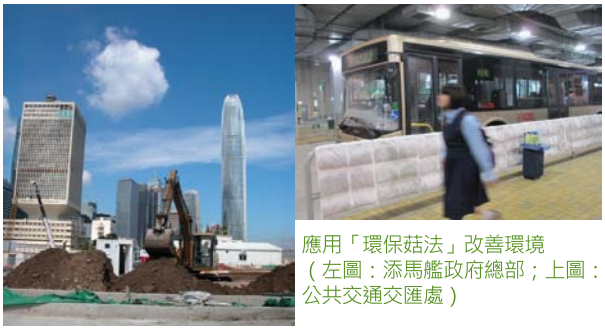
研究團隊的實驗證明，把這種天然光催化劑加入污水中(即含有細菌和其他微生物的水)，加上可見光的照射和進行光催化氧化處理，便可達致殺菌效果。一般家居污水的含菌量為10^4 cfu/mL (菌落形成單位/毫升)，這種天然光催化劑則可於在30分鐘內，殺滅10^7cfu/mL的細菌，它適用於設有一般照明系統如光管等的室內環境。實驗亦顯示光催化劑無需與細菌直接接觸，仍然可起殺菌作用，而在促進殺菌過程後，數量亦不會減少，而且這種天然光催化劑屬磁性物料，很容易以電磁吸引方法回收再用。

Website 網址： www.cintec.cuhk.edu.hk/exhibition/project.php?pid=323

Recycling of Spent Mushroom Compost for Protecting Air, Water and Soil Environment
以廢治廢：環保菇法防治空氣、水和土壤污染

Prof. CHIU Siu Wai
School of Life Sciences
生命科學學院
趙紹惠教授

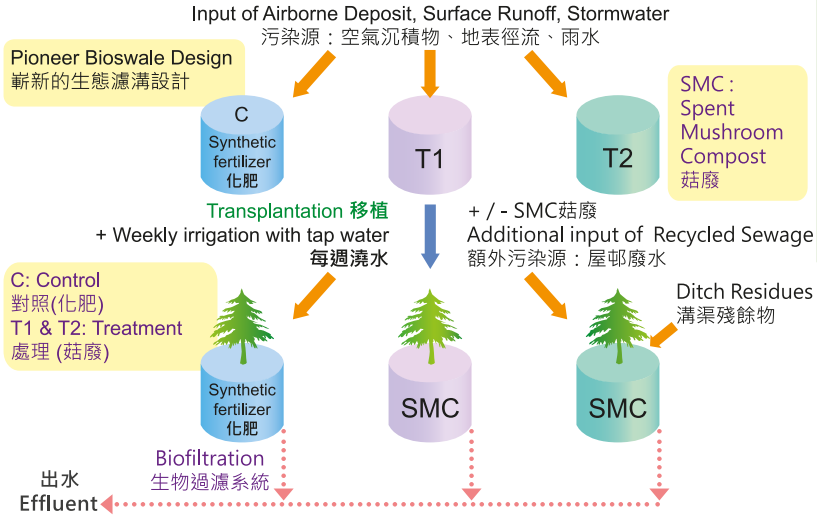
Funded by Hong Kong Housing Authority
由香港房屋委員會資助



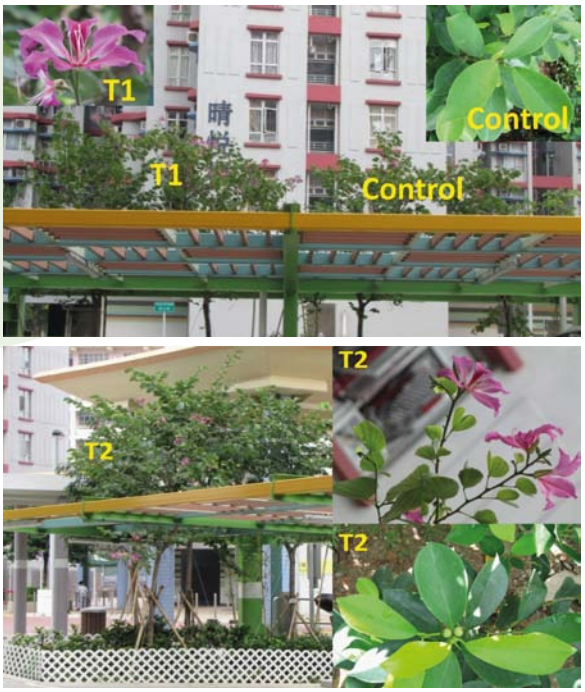
應用「環保菇法」改善環境
（左圖：添馬艦政府總部；上圖：公共交通交匯處）

Mushroom bioremediation applied in improving environments. (Left, Tamar Government Headquarter; Above, public transport interchange)

Bioswale is a biofiltration system composed of soil and vegetation to do filtration for protecting the water quality of the effluent and ultimately underground water for environmental protection. Vegetation provides greening to improve the environment.
生態濾溝是由土壤和植被組成的生物過濾系統，用於保障出水和地下水的水質及保護環境，而植被有助綠化及改善環境。



Compost-based bioswales (T1 and T2) perform better in filtering effluent over the control. There are significant reductions in alkaline pH, electrical conductivity, biodegradable organics, total organics and suspended solids.
加入菇廢的生態濾溝 (T1 及 T2) 的淨化效果比對照的生態濾溝好；出水的鹼性pH值、導電率、可生物降解的有機物、總有機物和水體懸浮顆粒物均明顯下降。



T1 and T2 (with SMC amended) perform better than the control (with conventional synthetic fertilizer) in urban greening; T1 and T2 cultivate larger and healthy plants with early and longer flowering. SMC serves as an organic fertilizer and a soil conditioner.
加入菇廢培植的T1及T2植物生長表現較加入常規化肥的對照植物優勝; T1及T2培植出來的植物生長健康，花期更早和長。菇廢是有機肥料和土壤改良劑，發揮城市美化的功能。

Wastes are unavoidably generated in every life system. Environmental quality is enhanced when pollutants are removed or eliminated. Recycling is an economic way of waste treatment in providing job opportunities and generating novel products. This project aims at designing a low-cost and effective means to abate pollution. The research team converts solid wastes (e.g. kitchen waste, garden waste, waste paper) into edible mushrooms. After mushroom harvest, the solid waste called spent mushroom compost (SMC) is further recycled as a bioremediating agent to improve air, water and soil quality.

The competitive advantages of this innovative “mushroom remediation” system include:
1) Low construction and maintenance cost, 2) High removal efficiencies of pollutants from air, water and soil environment, 3) Zero waste is generated.

The technology involved in this pioneer compost-based bioswale system project can be applied to:
1) Eco-friendly soft landscape practice, 2) Enhance vegetation health for aesthetic value and ecological functions, 3) Roadside, carpark and highways to protect the underground water from contamination.

每個生命系統都無可避免地產生廢物，回收廢物不但可以將污染物消除以提高環境質素，更可提供就業機會和製造新穎產品，是一種符合經濟效益的處理廢物方法。本項目旨在設計價廉和有效的控制污染方法。研究團隊把固體廢物，如廚餘、園藝廢料及廢紙，轉化為可食用的菇類，而且進一步將食用菇收成後餘下的「菇廢」用作生物修復劑，以治理空氣、水和土壤污染。

本項目的創新「環保菇法」有三方面的優勢：
1)建設和保養管理成本低；2)生物修復淨化能力強，高效率去除空氣、水和土壤中的污染物；3)零廢製造。

以廢治廢的生態濾溝技術可應用於：
1)環保的綠化工程；2)優化植被健康，以完善景觀的品質和生態功能；3)過濾馬路、停車場及公路的污染物以保護地下水質。

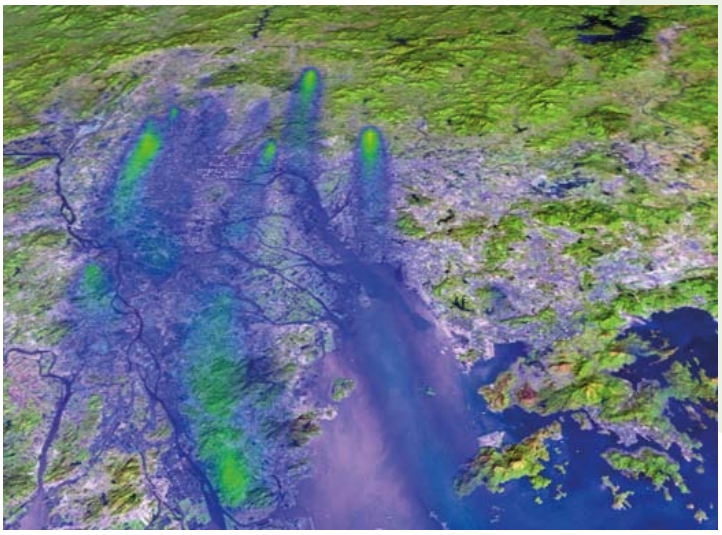
Award : Champion Innovation Award by Gammon Construction Ltd on ‘mushroom remediation’ technology
獎項：金門建築有限公司創新獎冠軍

Website 網址： www.cintec.cuhk.edu.hk/exhibition/project.php?pid=324

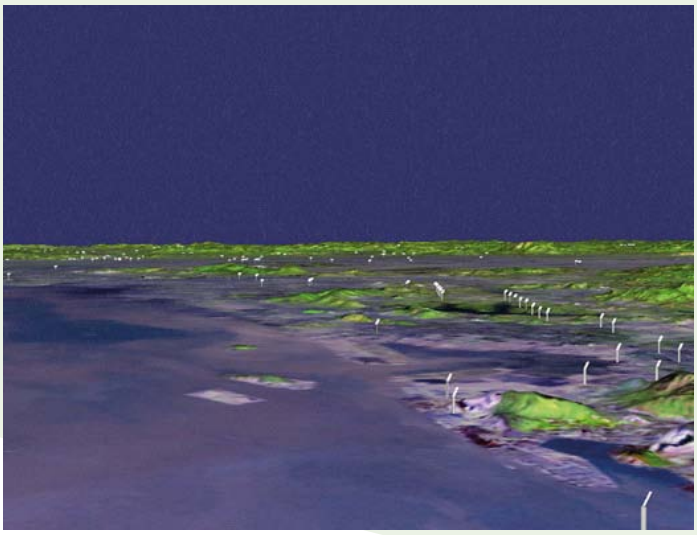
Evaluation Technology and Demonstrative Platform for Cross-boundary Air Pollution in the Pearl River Delta Region
珠三角地區城市群空氣污染跨境評估技術與示範平台

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

Funded by Innovation and Technology Commission
由創新科技署資助



This figure demonstrates the diffusion of sulphur dioxide concentration in the Pearl River Delta region starting from 18:00 on 18 July, 2005.
上圖展示2005年7月18日18:00開始的珠三角區域二氧化硫濃度動態擴散過程



Rainfall scenario in a virtual geographic environment
降雨情況下的虛擬地理情景

This project will develop a computerized platform for air quality evaluation for Pearl River Delta (PRD) Urban Agglomeration, and facilitate the knowledge sharing and collaboration in air pollution monitoring and management among cities. The products will contribute to air pollution control and environmental sustainability in the PRD region.

本項目將實現大珠三角地區城市群之空氣污染跨境評估與示範應用，促進城市間在空氣品質評估方面的知識共享與異地協同，為有效治理區域內的空氣污染提供決策支持。

This project will build a Collaborative Virtual Geographic Environment (CVGE) platform; establish the list of emission pollutant in the region; achieve an effective integration of multi-source data and models; and design high-performance algorithms for 3D spatial-temporal representation and visualization of air pollutant in urban agglomeration. The integrated system of CVGE with numerical meteorological and air pollution modeling will enable cross-boundary evaluation and high-resolution prediction of air pollution for the PRD region.

項目將構建協同虛擬地理環境的基本框架；完成珠三角地區空氣污染物排放清單；實現珠江三角洲城市群虛擬地理環境中多源數據與模型的有效集成；並研發城市群空氣污染體三維時空組織與可視化表達的算法與技術。建基於廣域網的分布式協同虛擬地理環境系統，將創建空氣污染跨境評估的示範平臺。

Implementation of the project will not only strengthen the collaboration among the governments of Guangdong, Hong Kong and Macao in air quality monitoring, but also enhance the capability of integrated coping with air pollution with low cost.

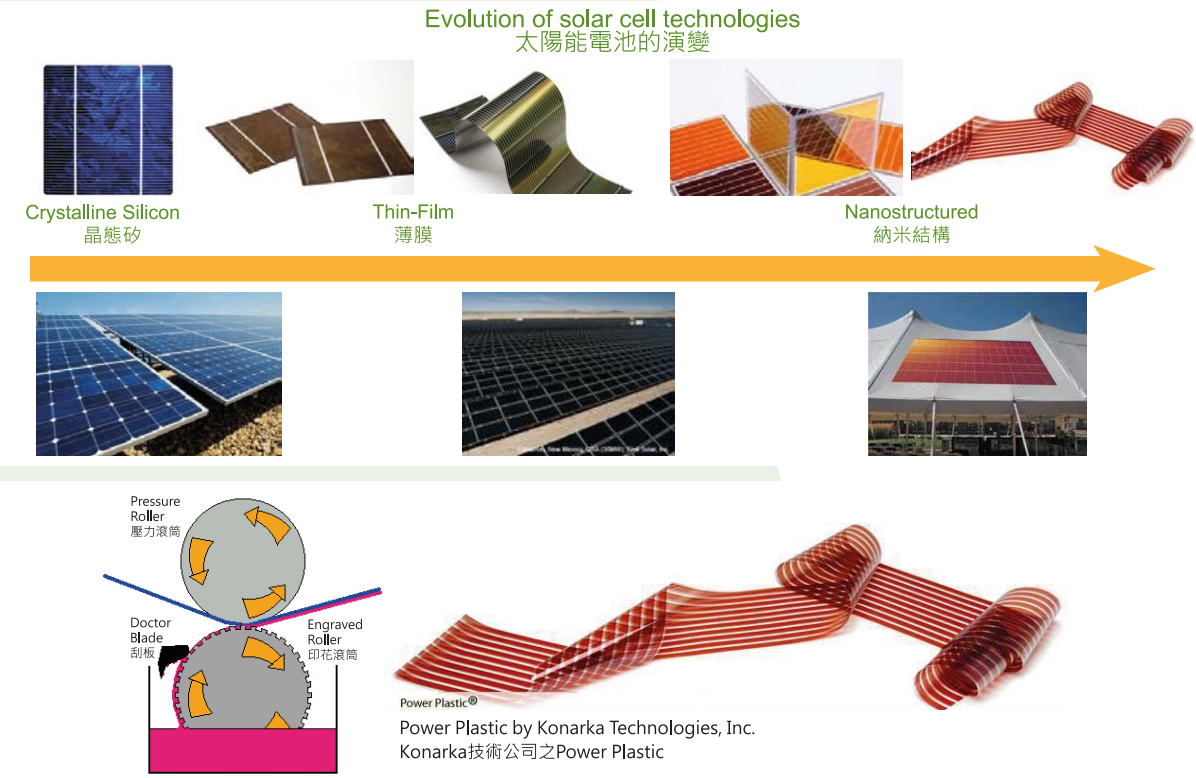
項目的實施將加強大珠三角地區的協同合作與知識共享，並提高綜合應對城市群空氣污染問題的能力，及降低應對問題的成本。

Website 網址： www.cintec.cuhk.edu.hk/exhibition/project.php?pid=320

Nanostructured Organic Solar Cells
納米結構有機太陽能電池

Prof. ZHAO Ni
Department of Electronic Engineering
電子工程學系
趙鈮教授

Funded by Research Grants Council of Hong Kong and Shun Hing Institute of Advanced Engineering
由香港研究資助局及信興高等工程研究所資助



Power Plastic by Konarka Technologies, Inc.
Konarka技術公司之Power Plastic

Nanostructured solar cells can be fabricated in low cost using high-throughput roll-to-roll printing and coating technologies.
納米結構太陽能電池可利用卷對卷印刷及塗層技術低成本大量生產。

Nanostructured organic solar cells offer great opportunity towards the widespread use of solar energy because:

1) They can be low-temperature solution processed, hence allowing inexpensive high-throughput fabrication by means of roll-to-roll printing and coating technologies.

2) They have a high power-to-weight ratio and are mechanically flexible. This makes them useful for building-integrated applications, e.g. rooftops and windows of residential and commercial buildings; as well as portable applications, e.g. battery chargers for handheld devices.

Yet, the energy conversion efficiency of organic solar cells is relatively low when compared with that of conventional silicon-based solar cells. Researchers are working on various methods to improve the photovoltaic (PV) efficiency of nanostructured organic solar cells. “Bulk HeteroJunction” (BHJ) is one of the promising approaches. CUHK research team has probed into the use of nanowires and the corresponding special coating on enhancing the performance of hybrid BHJ solar cell. Research focusing on material design and processing of BHJ has been conducted to increase the device performance. With the hybrid organic-inorganic nature, the mechanical flexibility of organic materials and the morphological tunability of inorganic nanostructures are combined. By making use of the tandem cell design, solar cells of different bandgaps are stacked on top of each other and interconnected in series with each cell absorbing at a range of wavelengths, hence the energy harvested from the broad spectrum of solar radiation can be maximized.

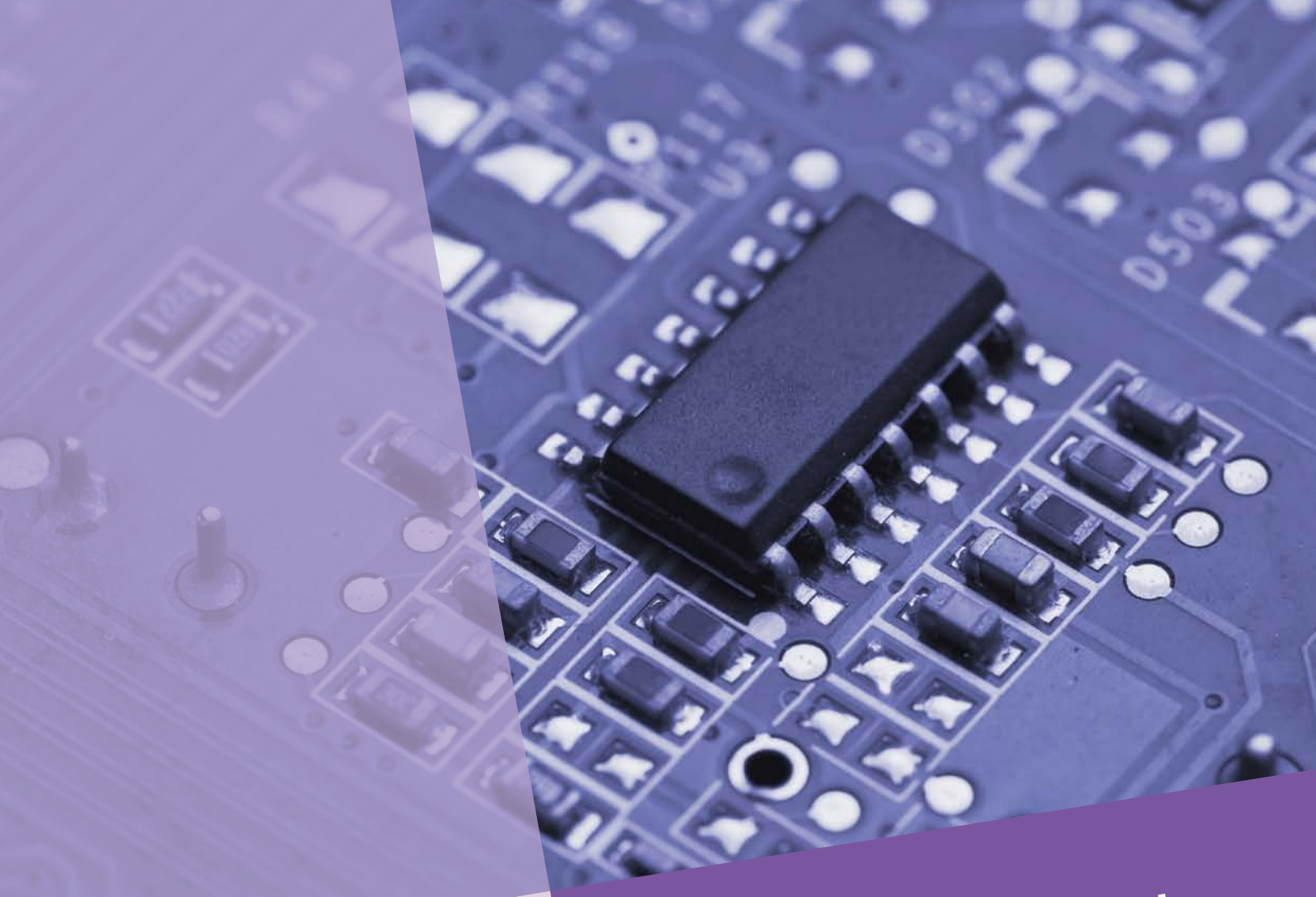
納米結構有機太陽能電池可大大促進太陽能的廣泛使用，因為：

1) 它可以低溫溶液處理，因此可透過卷對卷印刷及塗層技術以低成本大量生產；

2) 它的功率重量比率高，而且具機械柔韌性，使它能夠容易融入建築當中，例如應用在住宅和商業建築的樓頂和窗戶上，另外亦適合用來製造充電器等手提設備。

不過，與傳統的矽系太陽能電池相比，有機太陽能電池的能量轉換效率較低，故研究人員正探究不同方法以提高納米結構有機太陽能電池的光伏（PV）效率。「塊材異質接面」（BHJ）是其中有效可取的方法之一。香港中文大學研究出使用納米線和相應之特別塗層可提高混合BHJ太陽能電池的性能，並循材料的設計和加工方面進行重點研究。而有機和無機材料的混合使用，可令電池同時擁有有機物的機械柔韌性和無機納米結構的可調性。此外，通過利用疊層電池的設計，不同帶隙的太陽能電池交疊和串聯在一起，吸收不同波長範圍的能源，可於太陽輻射光譜中獲取最大的能量。

Website 網址：www.cintec.cuhk.edu.hk/exhibition/project.php?pid=330



信息和通訊科技

Information and Communication Technologies

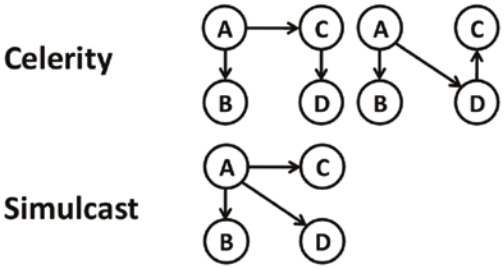
Celerity:
Towards Low-delay Multi-party Video Conferencing
實時網絡上的低延遲多方視像會議

Prof. CHEN Minghua
Department of Information Engineering
信息工程學系
陳名華教授

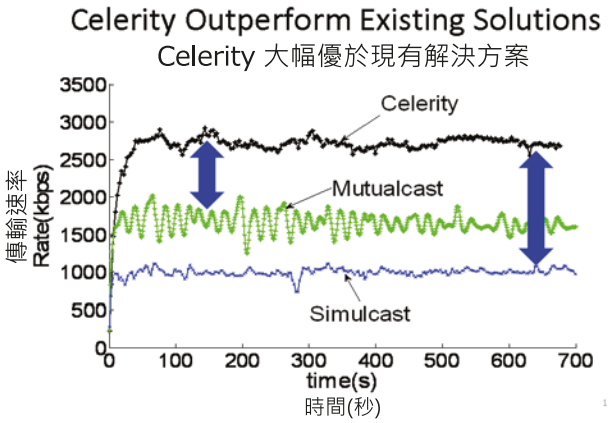
Collaboration with Microsoft Research
合作夥伴為微軟研究院

Funded by Hong Kong University Grants Committee and Microsoft Corporation
由香港大學教育資助委員會及微軟公司資助

Interface of Celerity on smartphones
智能手機上的Celerity 介面



Comparison between the transmission paths of Celerity and traditional method Simulcast
Celerity 與傳統方法 Simulcast 在視像傳輸路徑上的對比



Results show that Celerity quickly ramps to near-stable values. Upon stabilization, Celerity achieves the best throughput performance among the three systems while Simulcast performs the worst.
結果顯示，Celerity視像傳輸速度迅速提升至接近穩定值。穩定後，Celerity處理視訊的表現是三個系統中最好的，Simulcast的表現則最差。

Multi-party video conferencing is increasingly popular in day-to-day communications and entertainments. It is also a core technology of online education and medical treatment. However, delays are common in the current technology for video conferencing. To solve this problem, we present “Celerity”- Towards Low-delay Multi-party Conferencing.

This system can be applied to personal computers or even low-end smartphones. Its competitive advantage is totally peer-to-peer operation (P2P), and as such eliminating the cost of purchasing and maintaining centrally administered servers. Rather than commonly assumed scenarios where the delays only appeared at the edge of the network, bottlenecks can be anywhere over the network. Therefore, Celerity is designed with a distributed and adaptive rate control protocol. The protocol can discover bottlenecks and adapt quickly to the latest network topologies and conditions, as well as providing the most effective transmission path and methods. Source video encoding rates are also dynamically controlled to optimize video quality to provide a better user experience. We apply network coding to allow flexible and opportunistic local loss recovery, without incurring additional retransmission delay which deteriorates conferencing experience.

多方視像通訊在日常交流和娛樂當中日漸流行，也是網上教育和醫療的核心技術。目前的系統多存在視訊延遲或不流暢等問題。有見及此，我們提出「Celerity」—實時網絡上的低延遲多方視像會議系統。

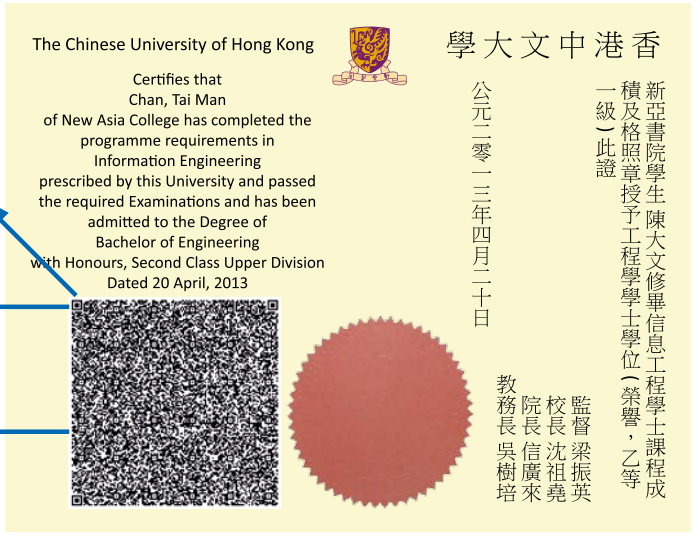
這個系統可應用於電腦甚至低端的智能手機上。它的優勢是完全點對點(P2P)運作，可以省卻購買和維護伺服器的成本。由於資料傳輸上的瓶頸實際上可以出現在網絡上的任何地方，而並非如普遍假設般，只出現在網絡邊緣，所以這個系統的設計特別採用一個分佈式和自我適應的速率控制協議。該協議可以迅速發現瓶頸並適應最新的網絡結構及其特殊情況，提供最有效的傳輸路徑和方法。在視訊來源上的編碼率會根據最新的情況，自動優化視頻質量，以提供更佳的用戶體驗。我們應用網絡編碼技術，靈活地修復有機會出現的損失，而不會因額外的重新傳送而產生視訊延遲。

Website 網址： www.cintec.cuhk.edu.hk/exhibition/project.php?pid=312

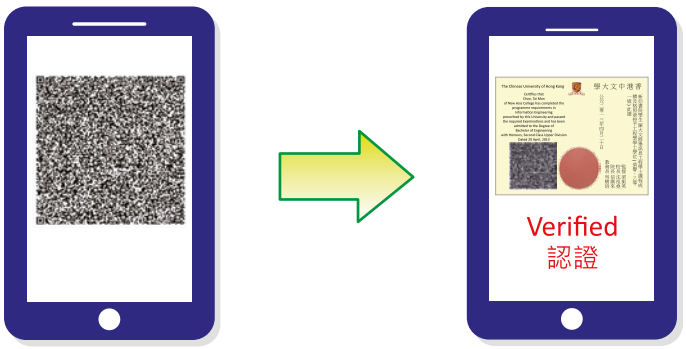
Offline Authentication Code: Protecting Documents/Credentials Offline Using 2D Barcode

離線認證碼：藉二維條碼給予文件或證件離線認證的防偽技術

Mr. LI Chak Man
Supervised by Prof. LAU Wing Cheong
Department of Information Engineering
信息工程學系
李澤民先生
由劉永昌教授指導



Example of graduation certificate with 2D barcode carrying authenticated digital copy
載有防偽數碼副本二維條碼的畢業證書範例



Hand-held scanning device displays the digital content embedded in the authenticated 2D barcode
手提掃描裝置顯示證書上的防偽二維條碼所載有之電子內容

All printed documents/credentials are potentially subject to counterfeiting and forgery. Conventional counterfeiting solutions such as watermarking or printing using special-quality paper are not cost-effective. Other widespread low-cost solutions such as certification via authorized stamps only provide a false sense of authenticity. We propose a low-cost, secure solution for authenticating paper-based documents/credentials using off-the-shelf handheld devices such as smartphones and tablets.

The key idea is to extend standard 2D barcodes, e.g. the QR-code, to carry heterogeneous self-describing authenticated data. The authenticity of the document can be readily verified by comparing its content with the corresponding digitally-signed content embedded in the extended 2D barcode.

One unique feature of our solution is that no online network-access is required during the verification process, thus privacy is increased. Authenticated Papers can also be duplicated readily by the users without losing its authenticity or verifiability. Practical applications of this technology include: low-cost, self-authenticating paper-based credentials such as education diplomas, bank-statements, utility bills as well as low-cost, deposable ID cards. Our system can also be applied to other non-paper-based media, e.g. in the form of semi-permanent tattoos on skin. Besides, we can apply the same idea to create paper-based archives of critical electronic documents which are immune from electronic-warfare but can be accurately and readily converted back to electronic format when needed.

所有紙質文件/證件均有可能被偽造。浮水印、特殊紙質等現行的防偽特徵造價不菲，而其他常用的低成本防偽方法如印章等，實際上並不具防偽功能。離線認證碼提供一個低成本且安全有效的防偽技術，利用智能手機或平板電腦等離線認證文件/證件的真偽。

本項目擴展如QR-code的現有二維條碼技術，將得到數碼簽名認證的數碼副本資料載於條碼中。透過掃描文件上的二維條碼讀取數碼副本，並和打印出來的文件作比較，以辨別其真偽。

這防偽方法其中一項優勢在於整個文件驗證過程無需使用任何網路資源或資料庫，令私隱度得以提高。它所提供的防偽特徵更可連同文件一同複印而無損其可信性和可核實性。這技術可用於製作低成本的防偽文件或證書，例如學術文憑、銀行結單和繳費單等，更可用作廉宜且可複印的身份證明文件。此技術也可應用於非紙質的媒介上，例如以非永久紋身形式於皮膚上儲存資料。另外，我們亦可將重要的電子資料以印本形式存檔，免受電子攻擊侵害，而需要時亦可簡單而準確地將資料轉回電子格式。

Award: Second runner-up of Postgraduate Individual Entry, Prof. Charles K. Kao Student Creativity Awards 2013

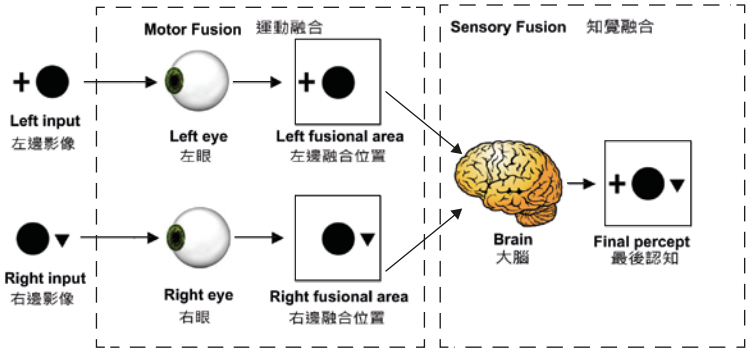
獎項: 高錕教授學生創意獎2013研究生個人組季軍

Website 網址： www.cintec.cuhk.edu.hk/exhibition/project.php?pid=325

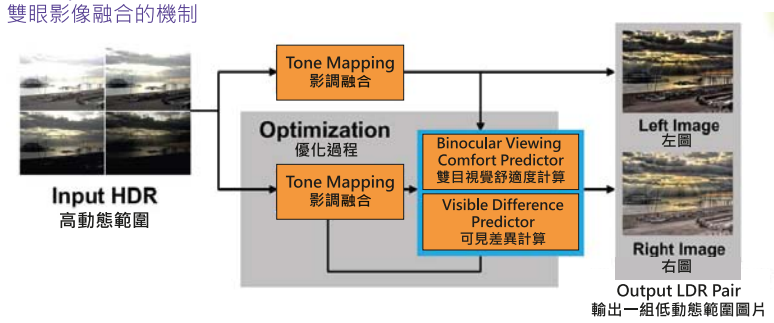
Binocular Tone Mapping
雙目立體影調融合

Prof. WONG Tien Tsin
Dr. YANG Xuan
Department of Computer Science and Engineering
計算機科學與工程學系
黃田津教授
楊軒博士

Funded by Research Grants Council of Hong Kong
由香港研究資助局資助



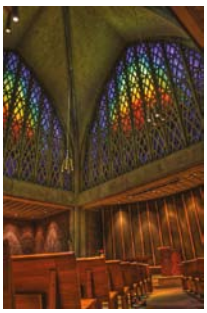
Concept of binocular fusion
雙眼影像融合的機制



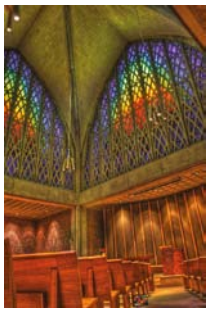
Overview of Binocular Tone Mapping framework
雙目立體影調融合框架

Left 左

Right 右



Left 左



Right 右

The left view presents more global contrast while the right view presents more local details. By utilizing the binocular fusion property of human vision system and the dual displays of stereoscopic devices, the binocular LDR pair can collectively present more visual content to human observers than just a single LDR image.
左邊的圖片顯示更多的全局對比，而右邊的圖片則顯示更多的局部細節。利用人類雙眼視覺的自然融合能力和3D立體設備所提供的雙顯示，用家看了一組兩幅低動態範圍圖片，可感受到比單幅圖片更多的視覺信息和內容。

With the wide popularity of 3D movies, more and more filmmakers produce movies in 3D. However, the dynamic range of current display devices is quite limited and can only present a much smaller range of intensity as compared with our daily visual experiences. Current display technology lacks the ability to accurately show high dynamic range outputs. To tackle the problem, we developed a low-cost innovative technology called “Binocular Tone Mapping”

Human vision system can tolerate certain degree of differences between our left and right views, e.g. disparity, differences in color, contrast, and even fine content. Our brain can naturally fuse the differences from both views without any visual discomfort. Our team is the first to make use of this human vision phenomenon for synthesizing enriched binocular vision content. Via an optimization process, the new technology synthesizes a pair of images, one exhibits high contrast, while the other preserves the fine details. With a pair of 3D glasses and a 3D display device, a user can simultaneously visualize the image pair. These images are optimally synthesized in a way such that the user's brain can naturally fuse the two views, and perceive both the high contrast as well as the rich texture details at both dark and bright regions, so as to gain an enriched visual experience.

Our technology can combine with existing stereoscopic (disparity based) movies without hurting the existing stereoscopic experience. It can also virtually compensate the luminance attenuation due to the wearing of 3D glasses. The technology can be generally applied to 3D movie production, 3D games, 3D visualization as well as other digital visual entertainment applications, without paying extra cost for additional equipment.

3D電影近年非常流行，製作具高質素畫面的3D影片乃大勢所趨。傳統顯示設備受最大亮度和灰階級別所限，不能全面展現畫面中最陰暗至最光亮的所有亮度，像真度大減。以現時的3D技術，強烈的光暗對比和豐富的紋理細節往往無法並存。針對以上情況，我們研發了低成本的「雙目立體影調融合」技術。

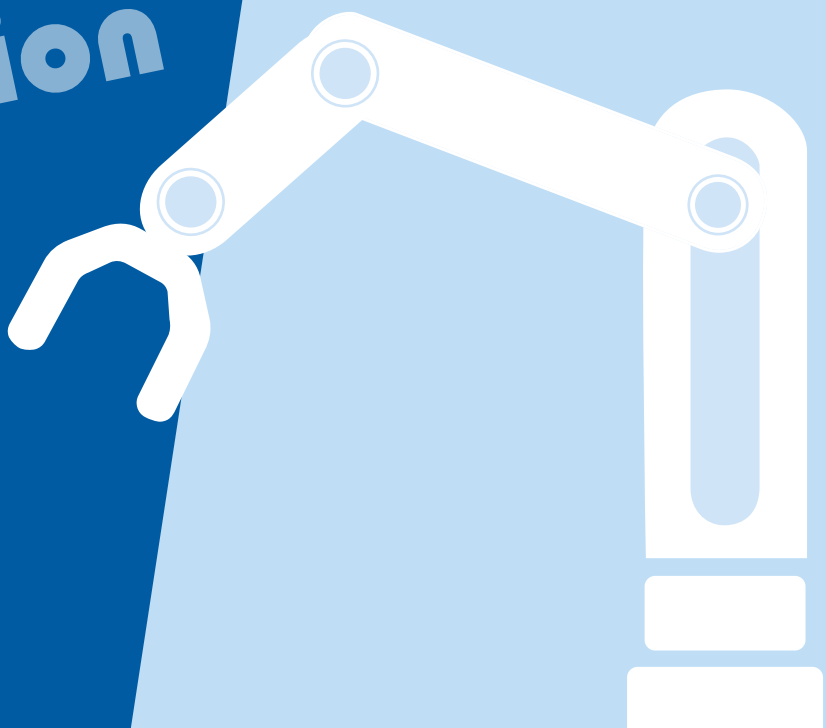
人類的視覺系統容許左眼和右眼看到的影像有所差異，例如由距離所產生的位移、一定程度的顏色、對比度、甚至內容的差異等。大腦會在我們不察覺的情況下，自然地把兩個存在差異的影像合併。我們率先利用人類雙眼視覺這種自然融合能力，合成更豐富的雙目視覺內容。新技術透過優化過程，產生一對左右圖像，其中一幅圖像顯示光暗變化產生的對比，另一幅則顯示明暗處的紋理細節。觀眾戴上3D眼鏡，可透過3D顯示設備同時看到這兩幅存在差異的圖像，它們會在觀眾的大腦中自動融合，讓觀眾清楚看到畫面中強烈的光暗對比和豐富的圖像紋理細節，畫面更具層次感和衝擊力。

這項技術可與3D立體影視良好結合，不會影響影片的立體感覺。由於增強了亮度和對比度，此技術更可解決觀看3D電影時，因配戴眼鏡造成的亮度下降和昏暗感。此技術可廣泛應用於3D電影、3D 遊戲、3D可視化以及其他數碼影像和娛樂行業，並無需額外花錢安裝新設備。

Website 網址：www.cintec.cuhk.edu.hk/exhibition/project.php?pid=311

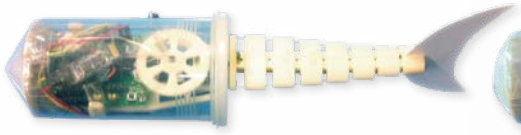
機械人及自動化技術

Robotics and Automation

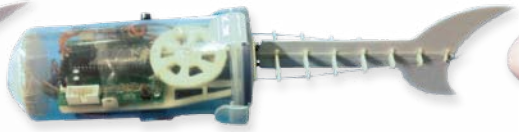


Biomimetic Wire-driven Mechanism and its Application in Robot Fish
仿生拉線機構及其在機械魚上的應用

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



1) Oscillatory Wire-driven Serpentine Robot Fish
擺動式蛇形拉線機械魚



2) Oscillatory Wire-driven Continuum Robot Fish
擺動式連續型拉線機械魚

3) Undulatory Wire-driven Serpentine Robot Fish
波動式蛇形拉線機械魚

4) Wire-driven Vector Propelled Robot Fish
向量推進拉線機械魚

5) Wire-driven Robot Fish with Twisting Tail
扭動式拉線機械魚

Inspired by nature, we designed the biomimetic wire-driven mechanism (WDM). It is a highly underactuated flexible system. The backbone structure is snake-like, while the actuation is done by several pairs of wires. Using this mechanism, we designed and built several novel robot fishes:

1) Oscillatory Wire-driven Serpentine Robot Fish
2) Oscillatory Wire-driven Continuum Robot Fish
3) Undulatory Wire-driven Serpentine Robot Fish
4) Wire-driven Vector Propelled Robot Fish
5) Wire-driven Robot Fish with Twisting Tail

The robot fishes are composed of the streamlined fish body and the wire-driven tail. The body encloses the actuators, control board, power supply etc. The wire-driven tail design is different from existing counterparts. It can better resemble the bodycurve of the fish swimming. Also the number of actuator used is reduced to the minimum. An oscillatory robot fish and an undulatory robot fish uses one and two actuators respectively.

With the WDM, brand-new robot fishes, such as the vector propelled robot fish, can also be built. It can mimic shark swimming as well as dolphin swimming. The vectored thrust can improve the robot's agility a lot. Another example is a robot fish with twisting tail which can swim by twisting its tail only. From the experiments, the maximum Froude efficiency of these robot fishes is 92.85%; the maximum forward speed is 0.673 BL(body length)/s; the minimum turning radius is 0.24 BL; the maximum turning speed is 51.4°/s.

我們在大自然的啟發下設計了仿生拉線機構，它是一個高度欠驅動的柔性系統，其結構類似蛇的骨架，利用若干對拉線來驅動。我們利用這個機構設計了一系列新型機械魚：

1) 擺動式蛇形拉線機械魚
2) 擺動式連續型拉線機械魚
3) 波動式蛇形拉線機械魚
4) 向量推進拉線機械魚
5) 扭動式拉線機械魚

這些機械魚由一個流線型魚身和一條拉線驅動魚尾組成。魚身內包括驅動器，控制器和電源等。有別於傳統方法，魚尾是基於拉線機構設計，令機械魚更相似地模擬魚類游動，而所需之驅動器數目亦同時減至最少，擺動式機械魚和波動式機械魚分別只需一個及兩個驅動器。

通過拉線機構，我們設計了多款嶄新的機械魚。向量推進拉線機械魚可模擬鯊魚和海豚游動，向量推力大大提高機械魚的機動性。而扭動式拉線機械魚前所未有地單憑尾部的扭動前進。實驗中，這些機械魚的最高推進效率達92.85%；最高游速達每秒0.673體長；最低轉彎半徑為0.24體長；最快轉速為每秒51.4°。

Awards : Champion of Postgraduate Individual Entry, Prof. Charles K. Kao Student Creativity Awards 2013
Best paper finalist of IEEE International Conference on Robotics and Biomimetics (Robio), 2012

獎項：高錕教授學生創意獎2013研究生個人組冠軍
2012年 IEEE 機器人及仿生學國際會議 (Robio)最優秀論文入圍獎

Website 網址： www.cintec.cuhk.edu.hk/exhibition/project.php?pid=326

Enhanced Micro Hybrid Powertrain Systems
增强型微混合動力總成系統

Prof. XU Yangsheng
Prof. XU Guoqing
Department of Mechanical and Automation Engineering
機械與自動化工程學系
徐揚生教授
徐國卿教授

Funded by Innovation and Technology Commission
由創新科技署資助

Sponsored by Smart China (Holdings) Ltd., Chongqing Ruiteli Technology Ltd, and Grandmark Industrial Ltd
由智慧中國（控股）有限公司、重慶銳特力科技有限公司及天徽實業有限公司贊助

Vehicle incorporating the micro hybrid system
改裝後的微型混合動力樣車

Micro hybrid powertrain
微型混合動力總成

This project targets to reduce fuel consumption and emission, and aims to assist the stop idling engines policy. We further develop to solve the key problems in micro hybrid powertrain in the performance perspectives of speed, comfort, and convenience. Compared with other hybrid systems and pure electric systems, the installation cost of our micro hybrid powertrain systems is relatively low. The cost can be recouped within a short period of time, due to about 10% saving in fuel consumption.

Research aspects of this project include:

1) Develop system integration solutions for power electronics conversion, intelligent control of energy conversion, thermal management and intelligent protection for the integrated power control unit. The target is to develop an integrated power control unit (IPCU) with high power density, so as to start the engine faster.

2) Develop a compact ratio-variable Belt-driven Starter Generator (BSG) gearbox to solve the confliction between motor mode and starter mode, so as to shorten the startup process.

3) Develop intelligent control and automatic mode selection of automatic manual transmission (AMT) in the idling stop and start process. No shift lever action will be required to stop/restart the engine, so as to improve the convenience.

4) Develop an intelligent and user friendly graphic user interface, in order to estimate the performance in fuel saving and emission reduction, and meanwhile attract the user to consistently adopt the system.

為了節能減排，並配合停車熄匙計劃，中大研究團隊從速度、舒適、方便三方面，改良了微混合動力車輛總成系統，解決了現存系統的關鍵問題。與其他混合動力及電動車輛相比，新系統的安裝成本較低，同時可令汽油使用量減少達10%，讓用戶在短期內收回成本。

本項目的研究包括四大方面：

1）提出電力電子變換單元的系統集成解決方案，針對系統效率、可靠性、能量變換智能控制、熱管理與智能保護等共性關鍵核心技術，開發高能量密度的集成功率控制單元，提高啓動速度。

2）開發小型BSG變速箱，從根本上解決BSG電機在電動機和發電機兩種工作狀態下，轉矩轉速要求之矛盾，進一步減少啓動時間。

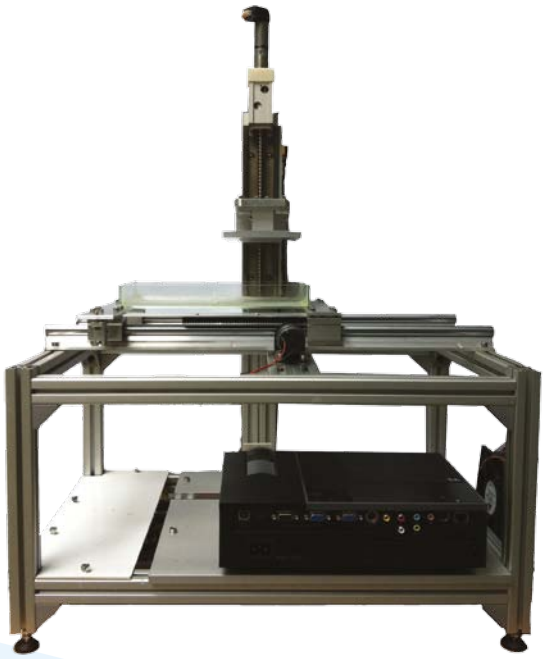
3）研究在微混汽車怠速啓停之條件下，手動/自動一體式變速器的智能控制和自動模式選擇，使司機無需切換檔位和操作離合器便能啓動或暫停引擎，令操作變得更方便。

4）開發一個容易使用的智能顯示介面，讓使用者知道節省汽油和減排的效果，從而吸引他們持續使用系統。

Website 網址： www.cintec.cuhk.edu.hk/exhibition/project.php?pid=327

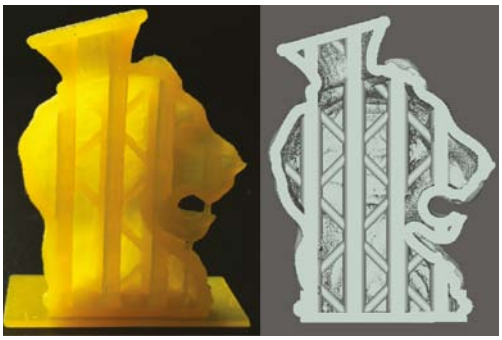
Fast 3D Printer
快速立體打印機

Prof. WANG Chang Ling Charlie
Mr. CHAN Ka Chun
Department of Mechanical and Automation Engineering
機械與自動化工程學系
王昌凌教授
陳嘉駿先生

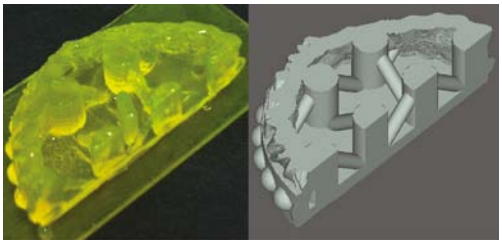


Fast 3D Printer
快速立體打印機

Solid model printed
by the Fast 3D Printer
快速立體打印機打印的實心模型



Hollow model printed by the Fast 3D Printer
快速立體打印機打印的空心模型



Inner supporting structure of hollow model
空心模型的內部支撐結構

This Fast 3D Printer uses a photo reactive resin which will solidify upon contacting with visible light. By utilizing a computer-controlled projector to display accurate horizontal cross sections of the model on the resin, a 3D model with fine details can be fabricated.

The printing technology used in traditional 3D printing machines is similar to raster scan-printing a single layer of model using numerous lines of material, which is time consuming. In this project, a projector is used to solidify a layer of model at a time according to the model structure, which increases the printing speed dramatically.

The printing speed of this 3D printer is faster than traditional ones for at least a few times. For instance, printing a 87x87x103 mm model using traditional 3D printer uPrintSE takes 21 hours but only 3 hours by using this 3D printer. The design of this 3D printer is simple, the projector is the only major equipment. Thus, the cost and the power consumption of this printer are very low. This printer can benefit all types of companies that need to fabricate product prototype. For example, in jewelry industry, a designer can fabricate a ring by our printer and then use it for casting the real rings efficiently.

我們研發的「快速立體打印機」採用一種受可見光照射時會固化的感光塑材(photo reactive resin)，通過電腦控制投影機精確地投射模型的橫切面到感光塑材上，一層一層的橫切面組成細緻的立體模型。

傳統立體打印機使用類似光柵掃描方式的打印技術，以線組成面，故相當費時。而我們的立體打印機，改而採用投影機一層一層的把感光塑材按模型結構固化，大大提高打印速度。

這部打印機的打印速度較其他傳統立體打印機快數倍以上，例如打印一個87x87x103毫米的模型，傳統立體打印機uPrintSE需要21小時，而此項目只需3小時。它的設計簡單，主要設備只是一部普通投影機，所以其成本和耗電量十分之低。它可為各行各業打印產品的原型，以珠寶首飾業為例，珠寶設計師可利用這部打印機快速打印戒指的原型，然後用其原型直接鑄造金屬戒指，過程方便快捷。

Award : Merit of Postgraduate Individual Entry, Prof. Charles K. Kao Student Creativity Awards 2013

獎項：高錕教授學生創意獎2013研究生個人組優異獎

Website 網址： www.cintec.cuhk.edu.hk/exhibition/project.php?pid=328

A Flexure-based High-throughput Roll-to-roll Printing System
卷對卷柔性量化印刷系統

Prof. CHEN Shih Chi
Department of Mechanical and Automation Engineering
機械與自動化工程學系
陳世祈教授

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由創新科技署資助

Collaboration with C.K. Yeung Worldwide Limited
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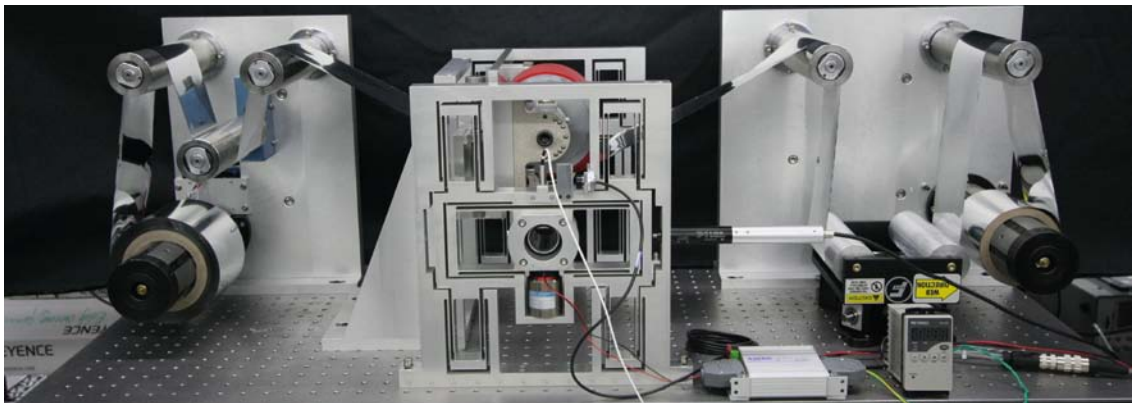
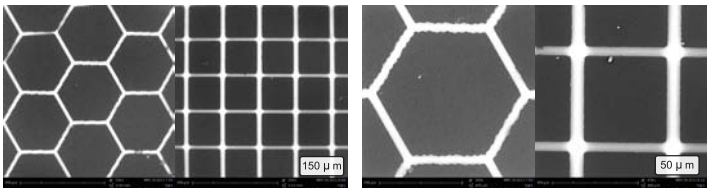
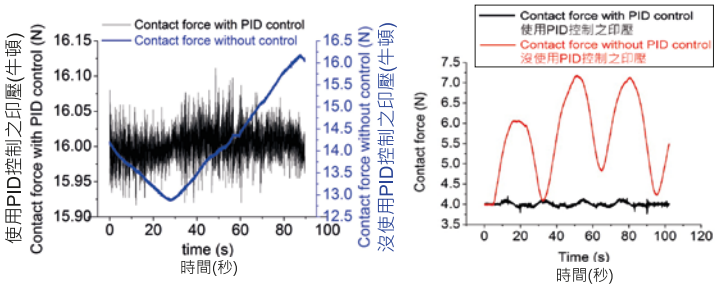


Prototype of Flexure-based High-throughput Roll-to-roll Printing System
卷對卷柔性量化印刷系統的原型



SEM image of gold mesh electrodes and gold mesh preliminary samples
掃描式電子顯微鏡下的金屬網格電極及金屬網格樣本初型



Position control and force control capability of the R2R system at 1 ft/min.
卷對卷系統於每分鐘一尺速度下的印壓及位置誤差控制表現

This project aims to develop a fully automated flexure-based high-throughput roll-to-roll (R2R) printing system with multiple degrees of freedom (DOF) misalignment correction capability for implementing nanometer resolution contact printing techniques e.g. Microcontact Printing (μCP).

μCP is a promising high resolution fabrication method developed to overcome the limitation of optical diffraction and can print submicron patterns. Yet, it remains primarily a lab-based technique for academic research and has not been utilized for practical manufacturing. To adapt the μCP technology for high-throughput R2R manufacturing, we developed a modified μCP process and a new molecular ink formulation that are compatible with the R2R printing process. We also constructed a flexure-based prototype precision R2R printing system that demonstrates multi-axis submicron level precision and repeatability. Experiments indicated the R2R system can control the printing force within ±0.05N and system position within ±0.5μm.

The developed technology could be widely adapted to manufacture low cost submicron-level resolution photonic devices e.g. optical gratings and transparent metal grids as electrodes for organic photovoltaic cells.

本項目旨在開發一個具多自由度對準誤差修正功能的全自動卷對卷柔性量化印刷系統，並結合具納米級解像度的接觸印刷技術，如微接觸印刷(μCP)。

μCP是一種軟光刻技術，其印刷精度不受光學衍射極限的限制，可達到納米級的解像度。目前這技術僅用於學術研究，並未應用於實際生產。為了將μCP技術應用於卷對卷量化印刷系統，我們改良了μCP的製程，並研製出可與高速滾筒印刷製程相容的新式分子油墨配方，而且製造了以柔性結構為主體，並具有納米級準確度及多軸修正功能的高精度滾筒印刷系統。實驗證明此系統可將印壓控制於±0.05N之內，以及將位置誤差控制於±0.5μm之內。

此技術可廣泛應用於製造低成本、達納米級精度的光電儀器，例如光柵以及有機太陽能光伏電池的透明金屬網格電極。

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項目資料已上載於以下網頁
Project information is also available at
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Telephone 電話: (852) 3943 8221
Facsimile 傳真: (852) 2603 7327
Email 電郵: enquiry@cintec.cuhk.edu.hk
URL 網址: www.cintec.cuhk.edu.hk/newcintec

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