



香港中文大學
The Chinese University of Hong Kong

Innovation for Better Life 2014 - 2015



Preface 序言

Innovation For Better Life 2014 -15

Being a forward-looking comprehensive research university, the Chinese University of Hong Kong (CUHK) conducts extensive innovative research projects. In this booklet, we compiled some of the latest CUHK research results, which are the contributions of various faculties, namely Faculty of Education, Faculty of Engineering, Faculty of Medicine, Faculty of Science, Faculty of Social Science as well as research units, such as Centre for Soybean Research of the State Key Laboratory of Agrobiotechnology, Centre for Learning Enhancement and Research, Institute of Chinese Medicine, Institute of Network Coding, Institute of Space and Earth Information Science, etc.

Centre for Innovation and Technology (CINTEC) is pleased to share these excellent research results with you. As a technology transfer arm of CUHK under the Faculty of Engineering, CINTEC serves as a bridge between the University and the industry. It facilitates communications and collaboration between CUHK research teams and the industry, as well as promoting innovation through technology transfer to the society.

If you would like to read an electronic version of the projects listed, please visit the website: www.cintec.cuhk.edu.hk/exhibition. Moreover, if you have any enquiries, please contact us by phone: (852) 3943 8221 or 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

作為一所具前瞻性的研究型綜合大學，香港中文大學（中大）進行大量創新科學研究。我們編修部份中大最新的科研成果於本刊物內，這些研究來自中大多個不同學院及研究單位，包括教育學院、工程學院、醫學院、理學院、社會科學學院，以及農業生物技術國家重點實驗室大豆研究中心、學能提升研究中心、中醫中藥研究所、網絡編碼研究所、太空與地球資訊科學研究所等。

創新科技中心樂意與您分享這些卓越的科研成果。作為隸屬於中大工程學院的技術轉移部門，創新科技中心是連繫大學與業界的橋樑，以促進中大研究團隊與業界的交流與合作為己任，同時亦透過向社會和業界的技術轉移，推動創新。

如您想參閱本刊項目的電子版本，請瀏覽網頁：www.cintec.cuhk.edu.hk/exhibition
此外，如您有任何查詢，請與我們聯繫：
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

Table of Contents 目錄

Innovation For Better Life 2014 -15

Biomedical Sciences 生物醫藥科學

碟片實驗室(LOAD) - 醫療診斷設備的選擇 Lab-on-a-disc (LOAD) - A Possible Choice for Health Diagnostic Device Platforms	05
低成本高通量流動大腸桿菌立體成像系統 High-throughput Low-cost 3D Imaging System for Flowing Escherichia Coli	06
內鏡手術機械人 Endoscopic Surgical Robotic System	07
應用於助聽器植入手術的電腦輔助系統 A Computer-assisted Platform for Hearing Aid Implantation Surgery	08
綠茶提取物及其前藥作為血管增生抑制劑以治療子宮內膜異位症 Green Tea Extracts and Pro-EGCG as a Novel Anti-angiogenesis Agent for Endometriosis Treatment	09
循證研發的止痛消腫外用中藥 Evidence-based Topical Herbal Application for Pain Relief and Swelling Control	10

Environmental and Green Technologies 環境和綠色科技

12	基於壓縮感知演算法的SAR層析成像技術研發 Research and Development of SAR Tomography based on Compressed Sensing
13	智能化太陽能技術 – 採集、儲存和應用 Smart Solar Energy Harvesting, Storage and Utilization
14	野生大豆的耐鹽基因 Salt Tolerance Gene in Wild Soybean
15	防止樹木盜竊的護樹監控系統 Tree Guard Monitoring System against Tree Thefts

Information and Communication Technologies

信息和通訊科技

- 17 手繪動畫立體化
Stereoscopizing Cel Animations
- 18 分批稀疏編碼
Batched Sparse Code (BATS Code)
- 19 物理層網絡編碼
Physical-layer Network Coding
- 20 CodFS: 具備高效率更新及快速修復功能的糾刪碼分佈式儲存系統
CodFS: An Erasure-Coded Clustered File System with Efficient Updates and Fast Recovery
- 21 RevDedup: 高效混合在線及逆向重覆數據刪除儲存系統
RevDedup: Efficient Hybrid Inline and Out-of-line Deduplication for Backup Storage
- 22 室內空白頻譜無線通信網絡
Indoor White Space Communication System
- 23 用於4G無線TD-LTE的超高速模擬前端芯片的關鍵技術研發和產業化
Research and Development on High-speed Analog Front-end for 4G TD-LTE
- 24 謠言檢測研究及發展
Rumor Detection Research & Development
- 25 實時環境監測及風險管理傳感網絡系統
Real-time Environmental Monitoring and Risk Management Sensing Network System
- 26 研發用於太赫茲高速成像系統的液晶儀器
Liquid Crystal Device Development for High Speed Terahertz Imaging System
- 27 LATIA: 移動資訊錢包開發庫
LATIA: Mobile Information Wallet Development Library
- 28 uReply: 互動移動學習
uReply: Interactive Mobile Learning
- 29 透過大型開放式線上課程進行教師專業發展
Teacher Professional Development through MOOC

Robotics and Automation

機械人及自動化技術

移動式微漩渦鉗：用於細胞操作和納米醫療的低成本非侵入式工具
Mobile Microvortex Tweezers: Noninvasive, Low-cost Tools for Cell Manipulation and Nanomedicine

31

用於車輛懸架的可再生能源磁流變阻尼器
Regenerative Magnetorheological Dampers for Vehicle Suspensions

32



Biomedical Sciences

生物醫藥科學





碟片實驗室(LOAD) - 醫療診斷設備的選擇

Lab-on-a-disc (LOAD) - A Possible Choice for Health Diagnostic Device Platforms

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

Funded by
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

Collaboration with Nanjing University
合作夥伴為南京大學

Bioassay 生物檢測



Traditional 傳統



Automated 自動化
Simple 簡單
Low Cost 低成本



Lab-on-a-disc 碟片實驗室

Bioassays are scientific experiments conducted to provide assessment of the effects of a substance on a living organism. They are commonly used in medical diagnostics, pharmaceutical analysis, environment and food safety tests. A conventional bioassay involves many procedures undertaken by trained personnel. They tend to be tedious and labour-intensive, hence time-consuming and costly. In this work, we have developed an integrated biomedical testing platform called Lab-On-A-Disc (LOAD). The LOAD system executes all steps of a bioassay within a single automated disc device, therefore offering true sample-to-answer operation.

The concept is based on the use centrifugal force, which occurs naturally in a spinning disc, to actuate movement of aqueous samples and reagents within a spinning microfluidic device under highly controlled manner. Reactions are programmed to take place in designated chambers in a desired sequence. Another unique yet simple feature is the introduction of electricity coupling capability to the rotating disc, which has enabled a multitude of bio-detection functionalities that were previously not possible. LOAD offers an open platform, users can design their customized discs according to their bioassay requirements. Power-enabled LOAD platform acts as an all-in-one system where all bioassay steps including sample actuation, heating and cooling, signal excitation and capture are performed with full automation. By eliminating tedious manual operations, LOAD significantly reduces time and costs.

LOAD can be used in point-of-care healthcare detection instrument and high-throughput screening of biomolecules. We have successfully used a LOAD system for DNA amplification through polymerase chain reaction (PCR) and loop-mediated amplification (LAMP) protocols.

生物檢測是指以科學測試去檢定某種物質對生物的影響，常用於醫學診斷、藥物分析以及環境和食物安全測試等。傳統的生物檢測方法，需要由受訓人員進行多重的實驗工序，既繁複又涉及大量人手，因而十分費時且成本高昂。在此項目中，我們研發了命名為「碟片實驗室」(LOAD)的綜合生物醫學測試平台，將生物檢測步驟整合在一個單一自動化設備上，真正從樣本直接得出檢測結果。

我們利用碟片旋轉時自然形成的離心力，精確地控制帶水樣本和試劑在微流裝置上的移動。碟片的設計使實驗反應得以循指定的次序在指定的反應室發生。另外，我們將電耦結合到旋轉碟片上，此簡單而獨特的設計令許多過去不可能做到的生物檢測能夠實現。LOAD提供開放式的平台，使用者可根據需要自訂碟片設計。引入電能的LOAD平台是一個一體化的設備，全自動地進行生物檢測中的所有步驟，包括樣本驅動、加熱和冷卻，以及信號激發和收集等。LOAD免卻了繁複的人手程序，大大減低了生物檢測所需的時間及成本。

技術可應用在床邊看護檢測設備、高效篩選生物分子等範疇。另外，我們已成功利用LOAD透過聚合酶鏈反應和環介導等溫擴增反應實現DNA擴增。

Demonstrated Applications 應用範例

Cell-based Allergy Test 以細胞為基礎的過敏測試

Non-invasive And Low Cost
非侵入性及低成本

Real-Time DNA Amplification by PCR 實時DNA擴增 - 聚合酶鏈反應

Fast and Simple
快速簡單

Whole Blood DNA Screening 全血DNA篩選

Fully Automated One-step Operation
全自動化單步操作



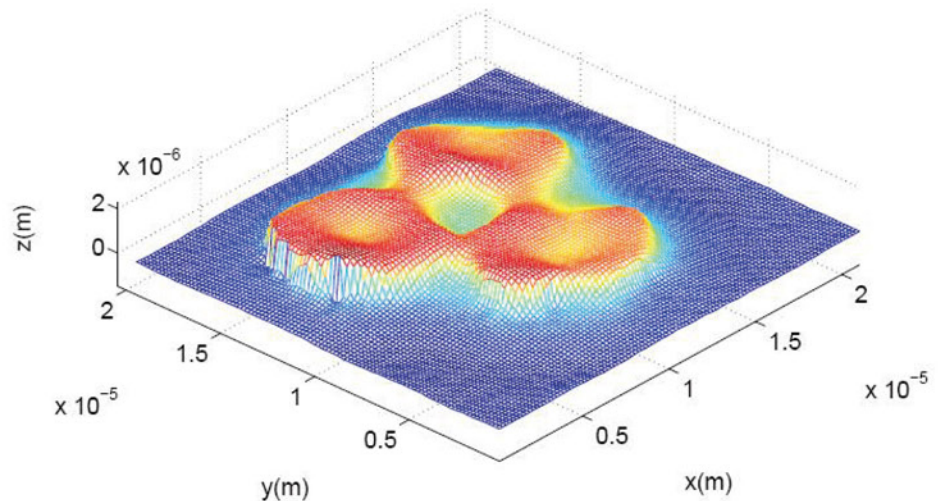
低成本高通量流動大腸桿菌立體成像系統 High-throughput Low-cost 3D Imaging System for Flowing Escherichia Coli

Prof. LIU Yunhui
Dr. LAU Tak Kit
Mr. LU Yujie
Department of Mechanical and Automation Engineering
機械與自動化工程學系
劉雲輝教授
劉德傑博士
魯豫杰先生

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



Multi-pinholes digital holographic microscopy system
多孔數字全息顯微成像系統



A 3D structure of blood cells
血細胞三維重構圖

The objective of this project is to develop a low-cost, high-throughput hologram-based 3D imaging system for the detection of Escherichia coli (E. coli). This focusing-free system will capture image of food samples flowing in a transparent micro-channel under illumination of RGB lasers, and yield their 3D chromatic structures in real-time using hologram-based reconstruction algorithms.

Two key technical problems have been solved to realize the system:

- (1) modification on a high-speed (200fps) imaging system for capturing full-frame holograms of the flowing cells;
- (2) reconstruction of 3D chromatic structure of E. coli by characterizing the holograms under low-cost incoherent light sources.

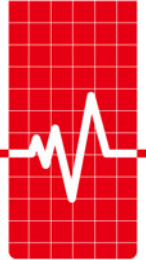
The proposed system is over 1,000 times faster than existing methods. It can serve to safeguard food safety in our society against the virulent and ever-evolving serogroups of E. coli and fecal contamination. The technology also fulfills the demand of food industry and point-of-care testing (POCT) for rapid and low-cost E. coli detection. Additionally, the system can be adapted to other applications such as detection of circulating tumor cells in blood.

本項目的目標是開發一種低成本、高通量的全息立體成像系統，以檢測大腸桿菌。系統能夠在全彩激光照明下採用免光學調焦的技術，獲取在微米管導裡流動的食物細胞圖像，並利用全息重建演算法實時重塑出它們的三維彩色結構。

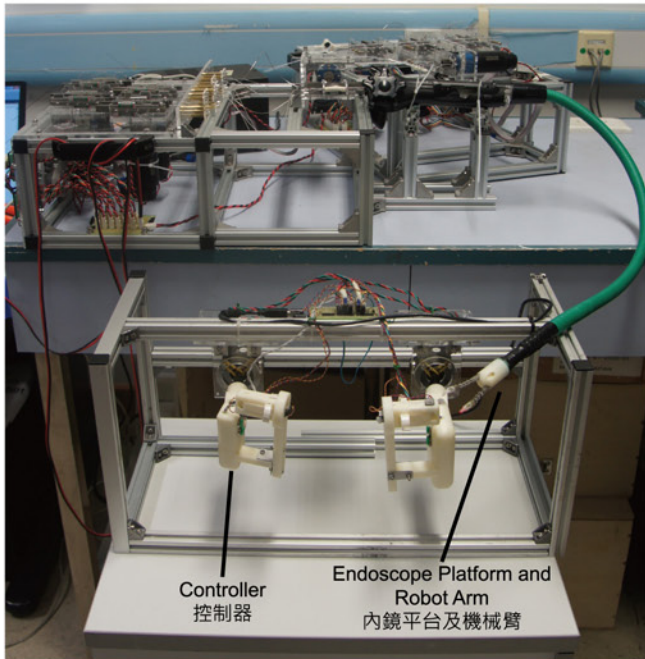
我們解決了開發系統的兩個關鍵技術問題：

- (1) 改進高速成像系統（每秒200幀），以獲取流動細胞的全息全幀；
- (2) 使用低成本的非同調激光全息成像技術，重建大腸桿菌的三維彩色結構。

系統的檢測速度比現有方法高1,000倍以上，有助確保食物沒有受到劇毒且不斷演化的血清型大腸桿菌或動物糞便的污染，保障社會食品安全。技術提供快速、低成本的大腸桿菌檢測，正正解決食品行業和醫護點檢驗的需求問題。此外，系統還可應用到其他測試，例如檢測血液中的循環腫瘤細胞。



內鏡手術機械人 Endoscopic Surgical Robotic System



First prototype of endoscopic surgical robot
內鏡手術機械人之首個原型

Prof. CHIU Wai Yan Philip
Prof. LAU Yun Wong
Dr. POON Chung Yan Carmen
Department of Surgery
外科學系
趙偉仁教授
劉潤皇教授
潘頌欣博士

Prof. YAM Yeung
Dr. TONG Hang
Department of Mechanical and Automation Engineering
機械與自動化工程學系
任揚教授
唐珩博士

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

Collaboration with Imperial College London,
National University of Singapore, Olympus HK and China Ltd.,
Soon Luck Industrial Ltd. and MediConcepts Limited
合作夥伴為英國倫敦帝國學院、
新加坡國立大學、奧林巴斯香港中國有限公司、
生祥實業有限公司及醫科創建有限公司

The therapeutic management of early gastrointestinal cancer and many other digestive diseases has changed in recent years by minimally invasive surgeries (MIS). Flexible endoscopy is an emerging technique to inspect and treat gastrointestinal (GI) tract disorders. Surgical procedures can be performed by introducing flexible tools through the working channel of an endoscope to reach the site of interest without the need for creating an opening in the patients' body, greatly reducing the pain and speeding up recovery. However, the lack of maneuverability of endoscopic platforms and tools makes complex surgical procedures, such as dissection and suturing, technically challenging to perform. In view of this problem, CUHK is developing a high maneuverability two-arm endoscopic surgical robotic system for digestive diseases, which will enable surgeons to perform sophisticated surgical procedures with high accuracy and thus increase surgical safety and success rate.

CUHK research team has already developed a robotic system consisting of two arms with a total of 9 degree-of-freedom (DOF), which is able to complete simpler surgical procedures such as tissue retraction. Yet, the limited size of the working channel of conventional endoscope, which is of 3mm diameter, is a bottleneck for further increasing the DOF of the robotic arms.

To overcome the above inadequacy, we proposed in this project to develop smart and flexible technologies in three technical areas: 1) smart sensors and actuators for flexible robots; 2) intelligent robotic control systems; and 3) bio-inspired suturing protocols. Making use of a hollow overtube, which provides a larger channel for surgical tools to pass through, the developed robotic arms will couple with the latest ultrathin endoscope to set out the basic working platform for endoscopic surgeries. The freed space allows improvements in the DOF and sensing functions of the robotic arms. Together with our control system with high maneuverability, the accuracy of surgeries will be further enhanced.

近年，微創手術成為治療早期消化道癌症和其他消化系統疾病的主流，而消化道的內鏡檢查和治療亦日益普及。內鏡治療經由內鏡的工作管道把手術工具伸進體內患處進行手術，無需開刀，大大減輕病人痛楚和加速康復。惟現時內鏡手術的操作平台和工具有欠靈活，要進行剝離和縫合等複雜的手術步驟，在技術上非常困難。有見及此，中大研發具有高靈活性的消化道疾病內鏡兩臂機械人手術系統，讓醫生可以更精準地進行複雜的手術程序，增加手術的安全性及成功率。

中大的研究團隊早前已開發了具有9個自由度 (DOF) 的內鏡兩臂機械人手術系統，能夠完成簡單的外科手術步驟，例如把器官組織拉高。但一般內鏡的工作管道十分狹小，平均只有3毫米直徑，要進一步增加內鏡機械人手臂的自由度，必需突破此瓶頸問題。

在這個項目中，我們將會從三個技術層面解決上述問題：1) 內鏡機械人的智能感應器和執行器；2) 智能內鏡機械人的操作系統；3) 仿生物啟發的機械人內鏡縫合器。我們將利用管道較闊的內鏡套管，配合嶄新的纖細內鏡和項目中研發的機械臂，作為內鏡手術的基本工作平台。增加了的空間讓機械臂的靈活度和感測能力得以提升，而我們的操作平台亦將便於醫生控制，進一步提升手術的精準度。



應用於助聽器植入手術的電腦輔助系統 A Computer-assisted Platform for Hearing Aid Implantation Surgery

Prof. SHI Lin
Department of Medicine and Therapeutics
內科及藥物治療學系
石林教授

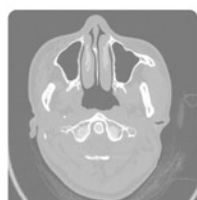
Prof. BHATIA Kunwar Suryaveer Singh
Prof. WANG Defeng
Department of Imaging and Interventional Radiology
影像及介入放射學系
BHATIA Kunwar Suryaveer Singh教授
王德峰教授

Prof TONG Chi Fai Michael
Department of Otorhinolaryngology, Head and Neck Surgery
耳鼻咽喉 - 頭頸外科學系
唐志輝教授

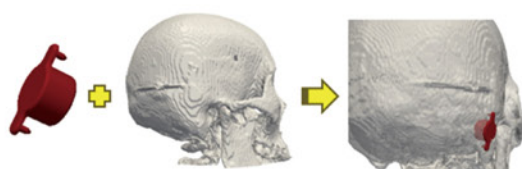
Funded by Innovation and Technology Commission
由創新科技署資助



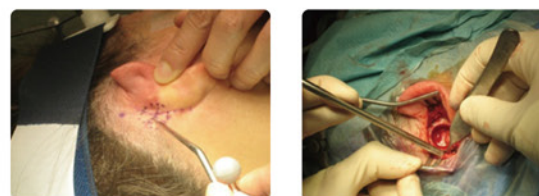
(Fig. 1) Implantable hearing aid system
(圖一) 植入式助聽器



(Fig. 2) CT image of skull
(圖二) 顱骨斷層掃描



(Fig. 3) Surgical plan displayed in 3D view
(圖三) 三維場景下設計的手術計劃



(Fig. 4) Hearing aid implantation surgery
(圖四) 助聽器植入手術

Implantable active bone conduction hearing aid (Fig. 1) is designed to help patients suffering from conductive hearing loss, mixed hearing loss or unilateral hearing loss, as they cannot benefit from traditional hearing aids. However, implantation of hearing aids to patients' skulls leads to high risk and surgery complexity. Effective and reliable surgical assistance is therefore essential. In view of this problem, CUHK developed a pioneer computer-assisted platform for the planning and navigation of implantation surgery. The system helps to reduce surgical risk, shorten operation time, avoid secondary surgery and minimize the cost.

Using patient-specific pre-operative CT data (Fig. 2), the skull in 3D view (Fig. 3) is constructed by core algorithms consisting of efficient 3D skull segmentation and modeling operations. The skull thickness is calculated and color-coded, and then mapped to the outer skull surface in order to assist the operator to select the optimal position to accommodate the implant. To ensure operation safety, alerting signals will be given if the operation is detected inappropriate. The 3D planning result will then be converted to DICOM images and sent to the intra-operative navigation system (Fig. 4).

With the user-friendly interface and the smooth and efficient 3D surface manipulation function, surgeons can easily operate the system. In addition, the system can be conveniently modified to apply to implantation surgeries of other skull implants.

植入型骨導式助聽器 (圖一) 為患有傳導性聽力缺失、混合性聽力缺失或單側聽力缺失這類不能使用傳統助聽器的病人而設計。但是，要將這種助聽器植入病人的顱骨，手術的複雜性和風險性都很高。因此，一個準確可靠的手術輔助工具是不可或缺的。有見及此，我們研發了首個專為助聽器植入手術設計的規劃及導航系統，能幫助縮短手術時間、降低手術風險、避免二次手術及減低手術成本。

系統以電腦斷層掃描獲取病人的術前頭部影像 (圖二)，然後透過準確的圖像分割與重建技術，建立出顱骨的立體模型 (圖三)。系統計算出顱骨的厚度並編定彩色區域編碼，然後在顱骨表面影像顯示相應顏色以標示厚度，幫助醫生決定植入助聽器的最佳位置。為確保手術安全，系統會於偵測到錯誤操作時顯示警告信息。三維場景下設計的手術計劃將轉化為DICOM圖像，並傳送到手術導航系統 (圖四)。

系統提供簡潔易明的控制介面及高效流暢的三維操作功能，讓醫生能輕易使用。此外，技術還可以延伸應用於其他顱骨內置器植入手術。



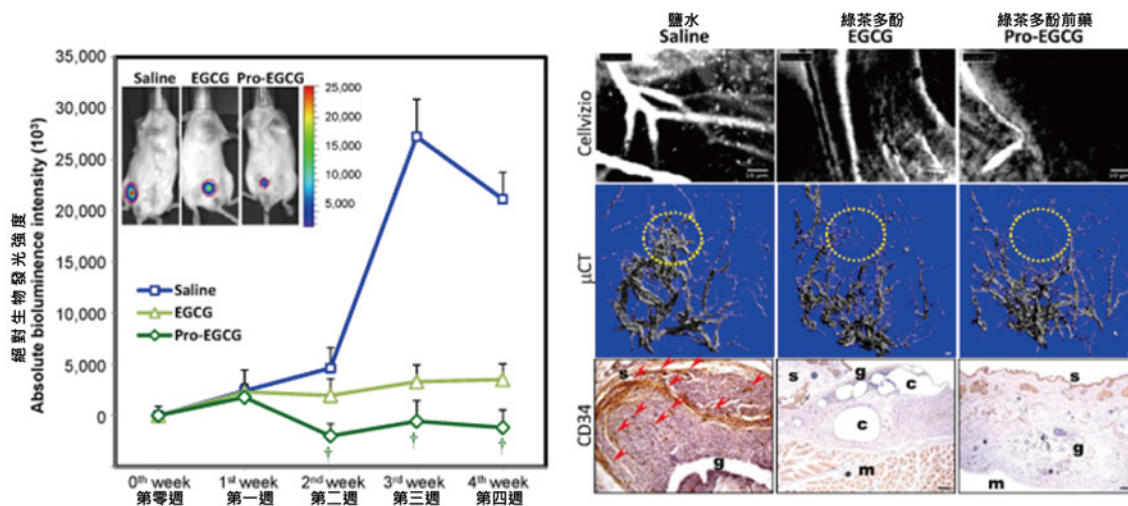


綠茶提取物及其前藥作為血管增生抑制劑 以治療子宮內膜異位症 Green Tea Extracts and Pro-EGCG as a Novel Anti-angiogenesis Agent for Endometriosis Treatment

Prof. WANG Chi Chiu, Ronald
Department of Obstetrics & Gynaecology
婦產科學系
黃志超教授

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

Collaboration with The Hong Kong Polytechnic University
合作夥伴為香港理工大學



Pro-EGCG significantly inhibited the development, growth and angiogenesis of experimental endometriosis.
實驗結果顯示，EGCG前藥能顯著抑制子宮內膜異位症的發展及血管生成。

One of the substances found in green tea, epigallocatechin-3-gallate (EGCG), is a potent antioxidant that has therapeutic applications. While there are many health products derived from green tea available on the market, we are the very first research team to study the use of EGCG in endometriosis treatment.

Endometriosis is a common chronic disorder characterized by implantation of endometrium outside the uterine cavity. The condition leads to chronic pelvic pain, infertility and menstrual problems in women during reproductive age and millions of women in the world are suffering from it. Current hormonal treatment will lead to undesired endocrine side effects while the chances for disease recurrence after surgical treatments are high. Thus, there is an urgent need in seeking better therapeutic approaches.

Anti-angiogenesis therapy offers a new opportunity for endometriosis treatment. Studies show that small anti-angiogenic molecules derived from natural products have great potential and advantages over synthetic inhibitors. EGCG is one natural anti-angiogenic agent. However, it suffers from instability and poor bioavailability. In this project, a prodrug of EGCG (Pro-EGCG) is utilized to enhance the stability and bioavailability. Laboratory test results show that EGCG and Pro-EGCG have potent antioxidant-independent inhibitory effects on the endothelial proliferation, migration, invasion and tube formation in vitro; and also significantly inhibit the growth of endometrial implants. Pro-EGCG has even greater potent than EGCG, with better anti-oxidation and anti-angiogenesis capacities.

Furthermore, Pro-EGCG also has promising potentials for treatments of other angiogenesis-dependent disorders such as diabetic retinopathy and cancers.

綠茶多酚(EGCG)是綠茶中的一種物質，能抗氧化且具治療效用。坊間雖有不少以EGCG提煉的健康產品，但我們是首個研究以EGCG治療子宮內膜異位症的團隊。

子宮內膜異位症是生育期婦女常見的婦科慢性疾病，患者的子宮內膜組織生長到子宮以外，導致慢性盆腔痛、不孕以及痛經。全球數以百萬計婦女正受此症的煎熬，但目前的激素藥物治療會產生無可避免的副作用，而手術治療後的復發率則非常高。因此，研發更有效的治療方案實有迫切需要。

抗血管生成治療為子宮內膜異位症提供嶄新的治療方向。研究顯示，自然物中提取的抗血管生成分子較人工合成的抑制劑具有更多優點。EGCG是一種天然的抗血管生成分子，但其穩定性和身體可用率都很低。在這個項目裡，我們使用改良過、具更高穩定性和身體可用率的EGCG前藥。實驗結果顯示，EGCG及其前藥對血管上皮細胞增生、遷移和血管形成具顯著的抑制作用，並能有效抑制子宮內膜異位組織的生長。而EGCG前藥則具有更高的抗氧化和抗血管生成效用，療效更佳。

EGCG前藥同時具有潛力成為其他血管生成相關疾病（例如糖尿病視網膜病變和癌症）的治療方向。



循證研發的止痛消腫外用中藥 Evidence-based Topical Herbal Application for Pain Relief and Swelling Control

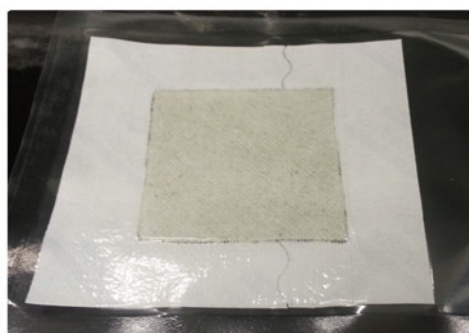
Prof. HUNG Leung Kim
Department of Orthopaedics and Traumatology
矯形外科及創傷學系
熊良儉教授

Prof. LEUNG Ping Chung
Institute of Chinese Medicine
中醫中藥研究所
梁秉中教授

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



Herbal bath
消腫止痛泡浸液



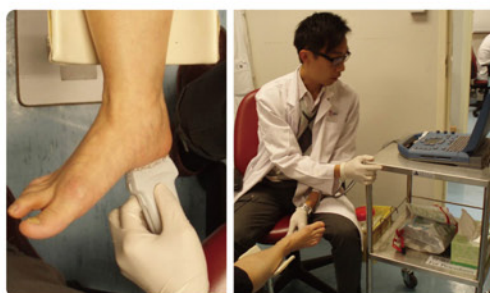
Herbal paste for acute ankle sprain injury
腳踝扭傷消炎止痛外敷貼



Herbal paste for plantar fasciitis
足底筋膜炎消炎止痛外敷貼



3D measurement of feet
三維足型掃描測量



Ultrasound imaging
超聲波影像測量

Musculo-skeletal pain and swellings are very common illnesses resulting from injuries, chronic mechanical stress or aging. Hospital and rehabilitation facilities may not be able to meet the high demand. Chinese Medicine offers various alternative treatments to these patients. One of which is topical herbal application, which provides an economical and safe remedy with minimal adverse effects.

There are many topical products available in today's market for the treatment of acute and chronic injuries. However, most of these products are repetitions of traditional recipes and there is a lack of scientific evidence supporting the efficacy. Since 2003, a research team at CUHK has been exploring the scientific and clinical value of a simplified herbal formula derived from ancient texts for the treatment of injuries. It has been proven, on scientific platforms of cells and animals in the laboratory, that the herbal bath and paste are effective in treating local pain and swelling, as well as promoting blood vessel growth. A clinical trial has been completed for the herbal bath with positive results, while other trials are being analysed.

肢體腫痛是種十分常見的疾病，原因包括運動損傷、工作勞損或老年衰退等，醫院及康復設施未能應付龐大的需求。中藥可給這類患者提供另一種治療選擇；其中價廉、安全有效且副作用少的體外草藥敷治最為普遍。

市面上已有眾多用作治理腫痛的外敷產品，惟多數只是根據傳統古方製造，成效欠缺科學驗證。自2003年，中大研究團隊廣泛參考中國古籍和創傷病例記載，決心研發一條有效中草藥方。我們在實驗室以科學的方式進行細胞和動物測試，證實選定創製的泡浸液和外敷貼確有消炎、止痛及促進血管增生的功效。消腫止痛泡浸液的臨床測試也獲得良好效應，另外還有更多臨床測試結果有待分析。

Environmental & Green Technologies

環境和綠色科技



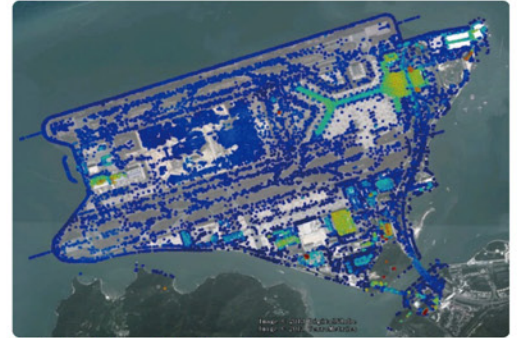


基於壓縮感知演算法的SAR層析成像技術研發 Research and Development of SAR Tomography based on Compressed Sensing

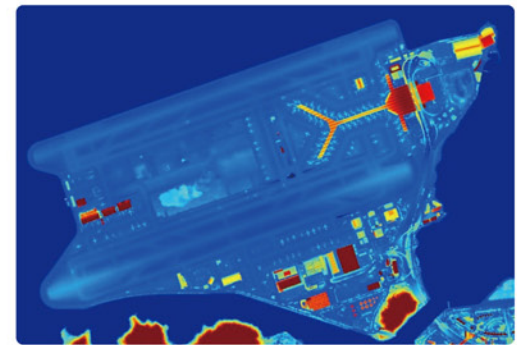
Prof. LIN Hui
Mr. MA Peifeng
Institute of Space and Earth Information Science
太空與地球信息科學研究所
林瓊教授
馬培峰先生

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

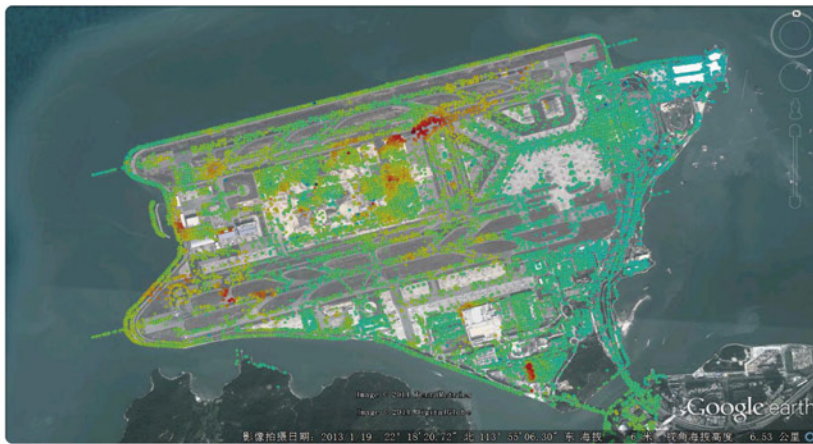
Collaboration with Beijing Geobeans Information Technology Co.
合作夥伴為北京中遙地網信息技術有限公司



Height deduced by TomoSAR
TomoSAR 提取所得的高度



Height deduced by Lidar
Lidar提取所得的高度



Deformation velocity deduced by TomoSAR
TomoSAR 提取所得的變形速度

The purpose of this project is to reconstruct Synthetic Aperture Radar (SAR) tomography of targets and fill the gap of this technology in current commercial software. The product will establish a foundation for the applications of more accurate deformation monitoring, biomass estimation, detection of hidden targets, change of global glacier, etc.

This project will be completed by the integrated development of VC++ and Matlab. Layover problems can be resolved through compressed sensing based superresolution tomography using multi-source and multi-temporal SAR observations. The reflectivity at different heights can be deduced. Finally, 3-D SAR models can be constructed.

The tomographic resolution achieved, i.e. separation capability, can be close to the highest theoretical bound. The outcome can be directly applied to ameliorate the precision of deformation monitoring of 3-D Hong Kong infrastructures by introducing Differential SAR Interferometry (DInSAR) technique.

本項目旨在實現SAR層析成像技術，填補該技術在國際商用軟件中的空白，為高精度三維建築設施形變監測預警、生物量估計、隱蔽目標識別和冰川變化研究等應用奠定基礎。

本次研發基於VC++和Matlab混合編程，利用可獲得超解析度的壓縮感知演算法對香港城區多源、多時相SAR影像進行三維資訊重構，從而分離相互疊掩的建築設施，同時獲取建築設施不同高度的散射強度，最終實現三維成像。

反演的層析向解析度可以接近理論極限值，本項目成果再結合傳統DInSAR技術可直接用於香港地區複雜建築群的形變監測研究。



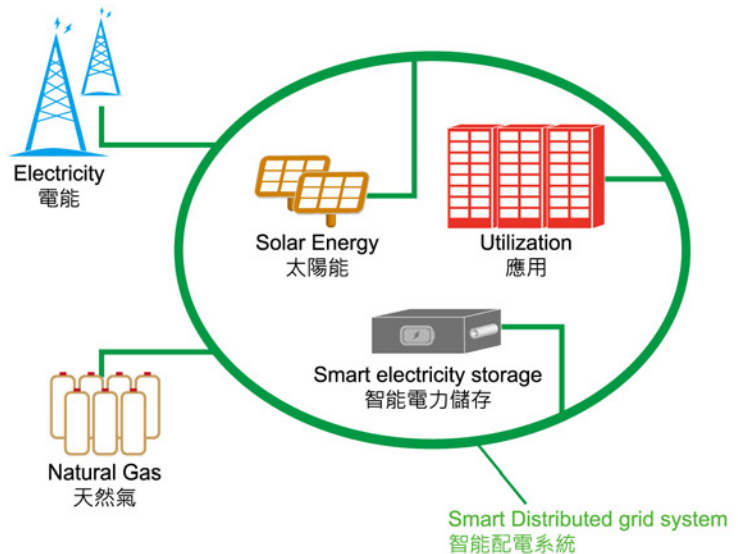
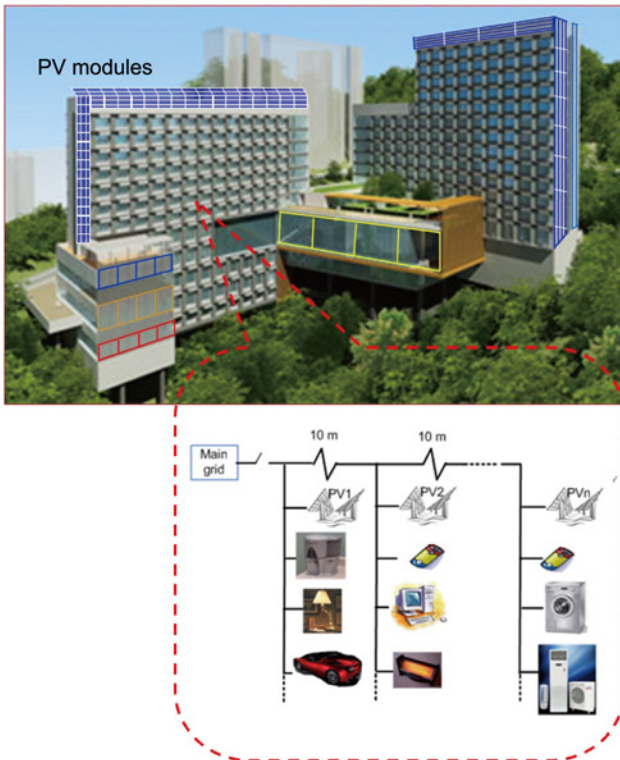
智能化太陽能技術 – 採集、儲存和應用

Smart Solar Energy Harvesting, Storage and Utilization

Prof. WONG Ching Ping
Faculty of Engineering
工程學院
汪正平教授

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

Collaboration with The Hong Kong Polytechnic University,
The Hong Kong University of Science and Technology and
The University of Hong Kong
合作夥伴包括香港理工大學、香港科技大學及香港大學



Microgrid demo will be carried out at a student hostel at CUHK
將於中大學生宿舍進行微電網實際應用示範

With fossil fuels being hazardous to global climate change and nuclear power inevitably posing threats to human life, there is an urgent need to develop clean and renewable energy. Harvesting energy directly from sunlight provides a promising solution to this problem.

Professor WONG Ching-ping, Dean of Faculty of Engineering, The Chinese University of Hong Kong (CUHK) is leading an inter-disciplinary, multi-institutional research team consisting of more than 30 academic experts to carry out a holistic research project, which covers the development of thin film photovoltaic (PV) devices and modules to enhance the performance of solar energy **harvesting**; the design of smart electricity **storage**; and the establishment of distributed grid systems to increase the penetration of solar energy **utilization**. The research project aims to strengthen the competitive edge of Hong Kong in solar energy technologies and their market penetration by combining the newly developed PV modules with the intelligent system integration.

In the final stage, field demonstration of microgrids will be carried out at a student hostel at CUHK by incorporating the PV modules, the smart storage and the advanced management system developed in this scheme. This will be the first R&D project of its kind focusing on rooftop solar panel and building-integrated PV (BIPV) powered urban level microgrid systems at the very end of power grid (lowest voltage level). Uniquely, a full-scale system solution of urban microgrids from specific devices to system operation and management level will be provided, offering a significant reference for PV development in modern metropolitans like Hong Kong.

使用化石燃料發電會導致全球氣候惡化，而核能發電又有機會威脅人類生命安全。因此，開發潔淨的可再生能源實在刻不容緩，直接從太陽光獲取能源是可行有效的解決方案。

香港中文大學（中大）工程學院院長汪正平教授現正領導一支由超過三十位學術專家組成的跨學科、跨院校研究團隊，進行一個整全的研究計劃，涵蓋發展薄膜太陽能電池和組件以提升採集太陽光的效能、設計智能電力儲存、以至研發智能太陽能配電以加深應用。目標透過結合本計劃所開發的光伏組件技術和智能集成系統，增強香港在太陽能技術方面的競爭力，並擴大太陽能在其能源領域的實際使用率。

最後，本計劃將會應用由本項目研發的太陽能電池板、智能電力儲存系統和管理策略方案，在中大學生宿舍進行微電網的實際應用示範。本計劃將主力研發屋頂發電板及與建築物一體化的光伏設施，為城市級的微電網，提供末端用戶使用（即最低電壓）的電力，是同類科研項目中的先鋒。本計劃將從特定設備到系統運作及管理水平，獨有地為城市微電網提供整全的系統解決方案，為香港這類現代大都會在發展光伏太陽能發電方面，起重要的示範作用。



野生大豆的耐鹽基因 Salt Tolerance Gene in Wild Soybean

Prof. LAM Hon Ming
School of Life Sciences / Centre for Soybean Research of the
State Key Laboratory of Agrobiotechnology
生命科學學院 / 農業生物技術國家重點實驗室大豆研究中心
林漢明教授

Funded by Research Grants Council of Hong Kong,
Lo Kwee-Seong Biomedical Research Fund and
Lee Hysan Foundation
由香港研究資助局、羅桂祥生物醫學研究基金及
利希慎基金資助

Collaboration with BGI-Shenzhen,
Institute of Crop Sciences,
The Chinese Academy of Agricultural Sciences,
Kazusa DNA Research Institute, Japan and
Department of Computer Science,
The University of Hong Kong
合作夥伴包括深圳華大基因、
中國農業科學院作物科學研究所、
日本上總DNA研究所及
香港大學計算機科學系

Prof. Lam Hon Ming shows the
difference of salt tolerant soybean (left)
and salt sensitive soybean.
林漢明教授展示耐鹽大豆(左)
及敏鹽大豆。



Domesticated Soybean
培植大豆



Control 對照樣本 Salt-treated 經鹽處理樣本



Wild Soybean
野生大豆



Control 對照樣本 Salt-treated 經鹽處理樣本



Salinization of land worldwide has posed severe threat to agricultural productivity. There are over 900 million hectares of salt-affected land globally where one tenth are located in China. A total of 6.7 million hectares of arable land in China have undergone salinization.

Soybean is the third most important cash crop in international trade. Besides dietary consumption, soybean can also be used to produce biodiesel and cultivation of soybean can replenish soil nutrients. After over 10 years of research and field work, CUHK research team has successfully identified and cloned a major salt tolerance gene from wild soybean. This breakthrough will not only facilitate crop improvement related to saline land cultivation, but will also contribute to relief the global food crisis.

Due to human selection during domestication, many crops have lost genes/alleles that are important for adaption to different environments. Wild soybeans are valuable genetic resources as they grow in a wide range of environments without artificial selection and have no breeding barrier with domesticated soybeans.

The research team in CUHK has started to work with soybean breeders in China to produce soybeans that can be grown on saline lands via non-GM methods. Meanwhile, they have continued their experiments in semi-arid and arid lands in Northwest China, with a goal of identifying drought tolerant genes from wild soybeans. The ultimate objective is to produce 'super-soybean' that is tolerant to both salt and drought.

土地鹽漬化問題嚴重威脅世界各地的農業生產力。全球有超過9億公頃的鹽漬化土地，其中一成位於中國。而中國受鹽漬化影響的耕地則達670萬公頃之多。

大豆是國際貿易市場上第三重要的經濟作物。大豆除食用外亦可作為生物燃料的原材料。種植大豆更可以令土地變得肥沃。經過逾十年的科研和田間考察，中大研究團隊成功鑑定並複製出野生大豆的一個主要耐鹽基因，不但有助作物改良以適應鹽漬化土地種植，也有助紓緩全球糧食危機。

農作物在人工培植的篩選過程中失去適應環境的重要基因或等位基因。野生大豆在野外生長，保留了珍貴的遺傳資源，而且可直接與培植大豆雜交，透過育種進行作物改良。

中文大學的研究團隊現正與中國的大豆育種專家合作，以非基因改造的方法，培育適合在中國鹽漬化耕地種植的新品種。同時，他們在內地西北乾旱地區進行大豆的耐旱實驗，期望複製出野生大豆的耐旱基因，並以培植既耐鹽又耐旱的「超級大豆」為最終目標。

Published in a renowned scientific journal
"Nature Communications", July 2014
刊登於著名科學期刊《自然通訊》(2014年7月)



防止樹木盜竊的護樹監控系統

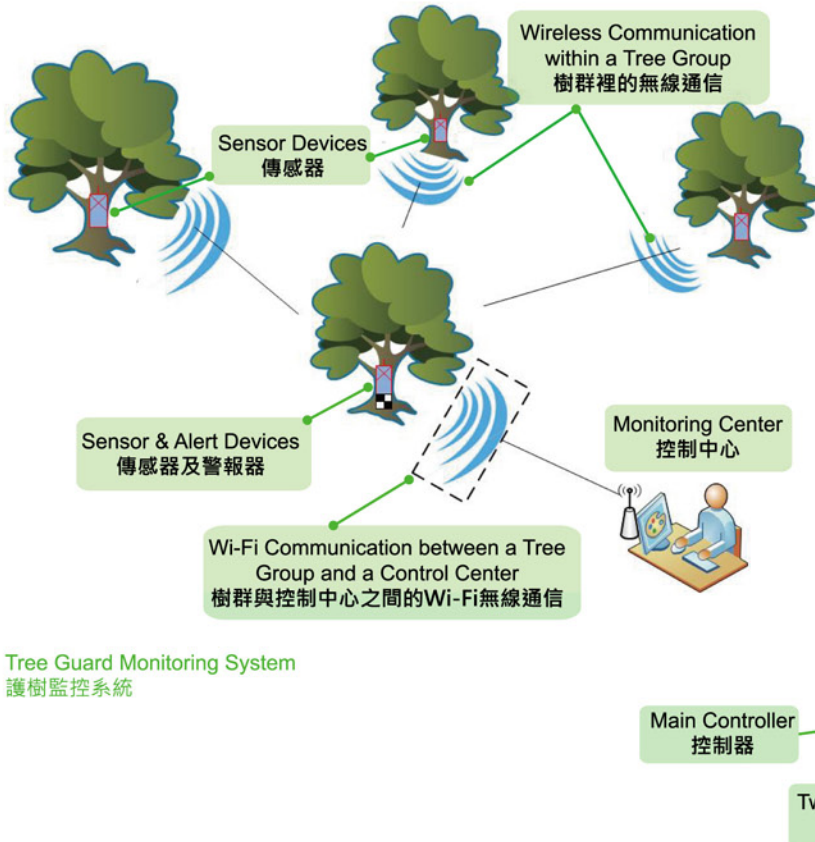
Tree Guard Monitoring System against Tree Thefts

Prof. CHENG Chun Hung
Department of Systems Engineering & Engineering Management
系統工程與工程管理學系
鄭進雄教授

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

Funded by Chung Chi College,
The Chinese University of Hong Kong
由香港中文大學崇基學院資助

Collaboration with Chung Chi College,
Estates Management Office and Security Office,
The Chinese University of Hong Kong
合作夥伴包括香港中文大學崇基學院、
物業管理處及保安處



Tree Guard Monitoring System
護樹監控系統



Two Sensor Units on Front Side
正面的兩個傳感器



Two Sensor Units on Back Side
背面的兩個傳感器

Sensor devices installed on a tree for data collection
安裝傳感器裝置於樹上以收集數據

Tree Guard Monitoring System (TGMS) is an automatic and continuous monitoring system developed to fight against possible tree thefts at places ranging from public country parks, institution managed properties, to private gardens. It is especially vital for the protection of endangered species such as Incense Tree and Buddhist Pine, which are often cut down for black market sales. TGMS will provide functions including tree theft prevention, protection and monitoring, to aid tree management teams to devise proactive and reactive measures for safeguarding invaluable trees.

Multiple sensors, such as sonic, temperature, humidity and tilt sensors, will be integrated into a hardware device with wireless communication capabilities, for monitoring the status of trees continuously. Sensing devices are tested on trees and data analysis algorithms are used to identify the external stimuli exerted on the trees. Alerts will be sent when abnormal activities, such as sawing and hammering, are identified.

TGMS will utilize various wireless technologies to form a scalable wireless mesh network for transmitting sensor data to a monitoring center. The wireless communication network can be scaled up for a wider coverage in two dimensions. The first is the expansion within a tree group, which uses a low-bandwidth, low-energy wireless communication. The second dimension is forming multiple tree groups to extend the coverage using Wi-Fi network communication. The Wi-Fi expansion may leverage on existing Wi-Fi network infrastructure readily available in private premises and Hong Kong government facilities.

護樹監控系統是一個為防止樹木盜竊而研發的全自動連續監控功能，可用於郊野公園、私人管理物業及私人花園等。香樹和羅漢松等瀕危樹種經常被砍伐作黑市買賣，護樹監控系統對它們尤其重要。系統將提供樹木防盜、防護及監察功能，協助管理團隊制定保護樹木安全的主動和反制措施。

多種傳感器（例如聲波、溫度、濕度和傾斜度傳感器等）將被集成到備有無線通信能力的硬件設備上，無間斷地監察樹木的狀況。我們在樹上測試傳感器，並利用模式分析演算法來辨識樹木所受到的刺激。當系統偵測到異常活動，例如樹木被鋸或錘擊等，就會發出警報。

護樹監控系統將利用各種無線技術，開發一個可擴展的無線網狀網絡，把傳感器數據傳輸到監控中心。無線通信網絡可以在兩個層面上擴展，以覆蓋更廣的範圍：（一）利用低帶寬、低能量的無線通信技術，將數據於一個樹群裡的樹與樹之間傳送；（二）利用Wi-Fi無線技術，將數據於樹群與樹群間傳送，或可依賴已備有Wi-Fi設備的私人物業或香港政府設施以作擴展。



**Information &
Communication
Technologies**
信息和通訊科技



手繪動畫立體化 Stereoscopizing Cel Animations

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

Funded by Research Grants Council of Hong Kong and CUHK SHIAE Fund
由香港研究資助局及香港中文大學信興高等工程研究所基金資助

2D Anime
手繪動畫



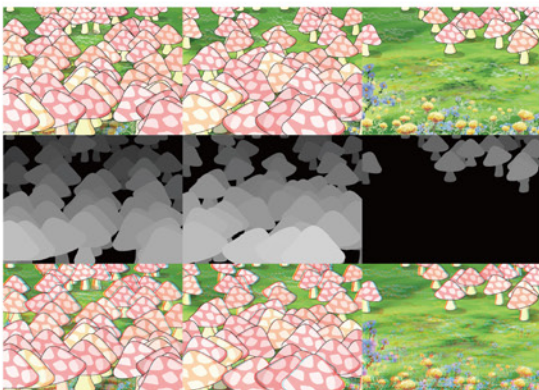
Depth map
深度圖



Stereo
立體幀



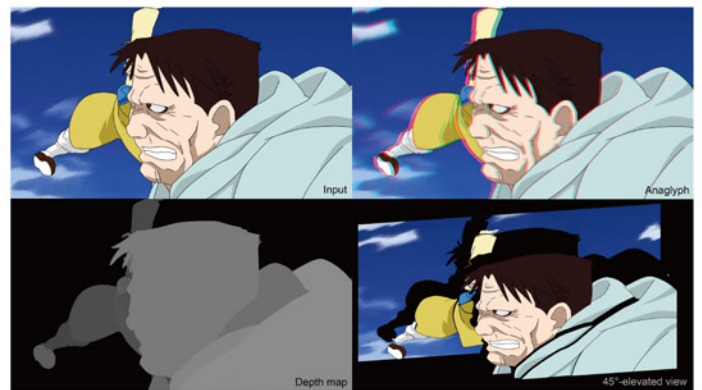
2D Anime
手繪動畫



Depth map
深度圖



Stereo
立體幀



Animation is a worldwide popular entertainment. With the increasing popularity of 3D cinemas and household 3D TVs, there has been a growing demand for 3D animations. The common way to create stereoscopic animation is through 3D modeling and toon-shading. To convert existing 2D animations into stereoscopic ones, a possible way is to first reconstruct the 3D models and then perform toon-shading. However, the manual work is costly and labor-intensive. And often the original 2D cartoon style cannot be preserved.

In this project, we designed the very first fully automatic system to "stereoscopize" (introduce stereoscopic effect to) traditional cel animations. The proposed system eliminates the costly 3D geometry reconstruction process. Instead, it infers the pseudo-depth and thereby computes the disparity of every object in each frame. With the computed depth, the system can then synthesize a stereo pair for each frame by rendering from novel viewpoints.

This technology saves the animation industry from costly labor-intensive manual work. It fits naturally into the existing production flow of the 2D cel animation and is able to fully preserve the original cartoon style.

動畫是一種世界流行的娛樂，隨著3D影院和家庭式3D設備的普及，立體動畫亦愈來愈受到歡迎。製作立體動畫的程序，一般是先建構3D模型，然後做動畫渲染。如果要將現有的2D動畫立體化，則要先重建3D模型，再作動畫渲染工序。這方法成本高且需大量人手製作，更往往未能保留2D動畫的風格。

在本項目中，我們設計出第一個完全自動化地將傳統2D動畫立體化的電腦系統。該系統省卻了重建3D模型的昂貴工序，取而代之，系統憑計算每一幀裡面不同物件的模擬深度，得出左右兩個視圖的視差，從而為每一幀從新視點渲染出一對立體圖。

此技術讓動畫業界大大節省高昂的成本及繁複耗時的手動操作，更可簡單方便地接合現有的2D手繪動畫製程，將2D動畫立體化，同時完美保留2D動畫的風格。

Award: Second Prize in IEEE Hong Kong Section 2013
(Postgraduate Student)
獎項: 2013年IEEE學生論文大賽香港賽區二等獎 (研究生組別)



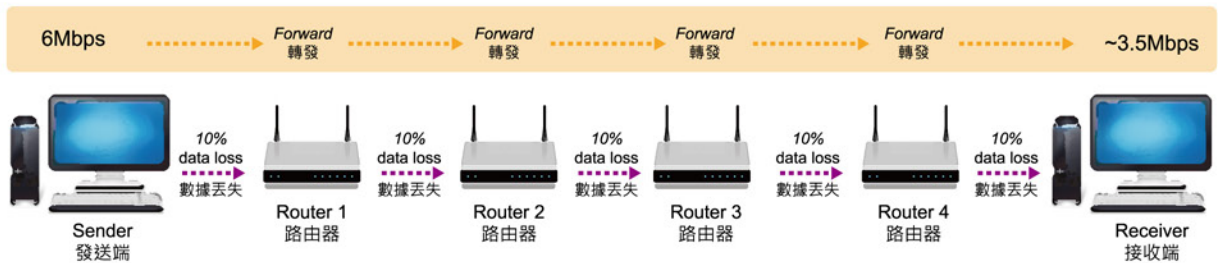
分批稀疏編碼 Batched Sparse Code (BATS Code)

Prof. YEUNG Wai Ho Raymond
Institute of Network Coding
網絡編碼研究所
楊偉豪教授

Funded by Area of Excellence, The University Grants Committee
由大學教育資助委員會卓越學科領域資助

Collaboration with Prof. YANG Shenghao, Tsinghua University,
and P2 Mobile Technologies (P2MT)
合作夥伴包括清華大學楊升浩教授及網進流動科技有限公司

Fountain code 噴泉碼



BATS code 分批稀疏編碼



For a multi-hop chain with the same hop loss rate, BATS Code can transmit at a higher end-to-end rate
在存有同一鏈路丟失率的多跳鏈路上，分批稀疏編碼能達到更高的端對端傳輸率

In recent years, there has been great advancement in wireless communication technologies. However, data loss during wireless transmission is still inevitable. In view of this problem, CUHK research team has developed Batched Sparse Code (BATS Code) to improve the network transmission rate of wireless networks with packet loss.

BATS code is one of the most mature network coding techniques in the world. All existing techniques based on retransmission suffer from significant performance loss due to unavailability of feedback in wireless networks with more than one hop. BATS code overcomes this problem and pushes the wireless multi-hop network transmission rate to close to theoretical limit. Its impact is particularly evident in scenario where feedbacks are not allowed or long delay occurs.

Compared with random linear network coding, BATS code offers a low encoding and decoding complexity, which is of the same order as that of fountain code. BATS code requires a much smaller buffer size at the network intermediate nodes. Yet, while compared with fountain code, BATS code provides higher speed and achieves an end-to-end capacity as good as that of a lossy hop.

A wireless mesh network (WMN) protocol has been built using BATS code. It enables efficient communications through tens of wireless hops. A more sophisticated protocol for large networks with dynamic link loss patterns is being developed. Besides, we completed a proof-of-concept demonstration of using BATS code to maintain high throughput for an end-to-end path consisting of five lossy links. A video streaming demonstration using BATS code has also been carried out successfully.

近年無線通信科技發展迅速，然而，數據丟失的情況在無線傳輸過程中仍然無法避免。有見及此，中大研究團隊研發出分批稀疏編碼，以提高有丟包網絡的傳輸速率。

分批稀疏編碼是當前最成熟的網絡編碼技術之一。現有基於重傳的編碼技術，都會因為不能在無線多跳網絡進行反饋，以致性能明顯下降。分批稀疏編碼克服了這個難題，將無線多跳網絡的傳輸速率提升至接近理論極限，其作用在無法進行反饋或反饋延遲問題嚴重的情况下尤其顯著。

與隨機線性網絡編碼相比，分批稀疏編碼的編碼和解碼較為簡單，和噴泉碼的指令相似。另外，分批稀疏編碼在網絡中間節點的緩存容量需求亦較少。與噴泉碼相比，分批稀疏編碼的端對端速率較高，並可以達至接近丟包網絡的鏈路容量。

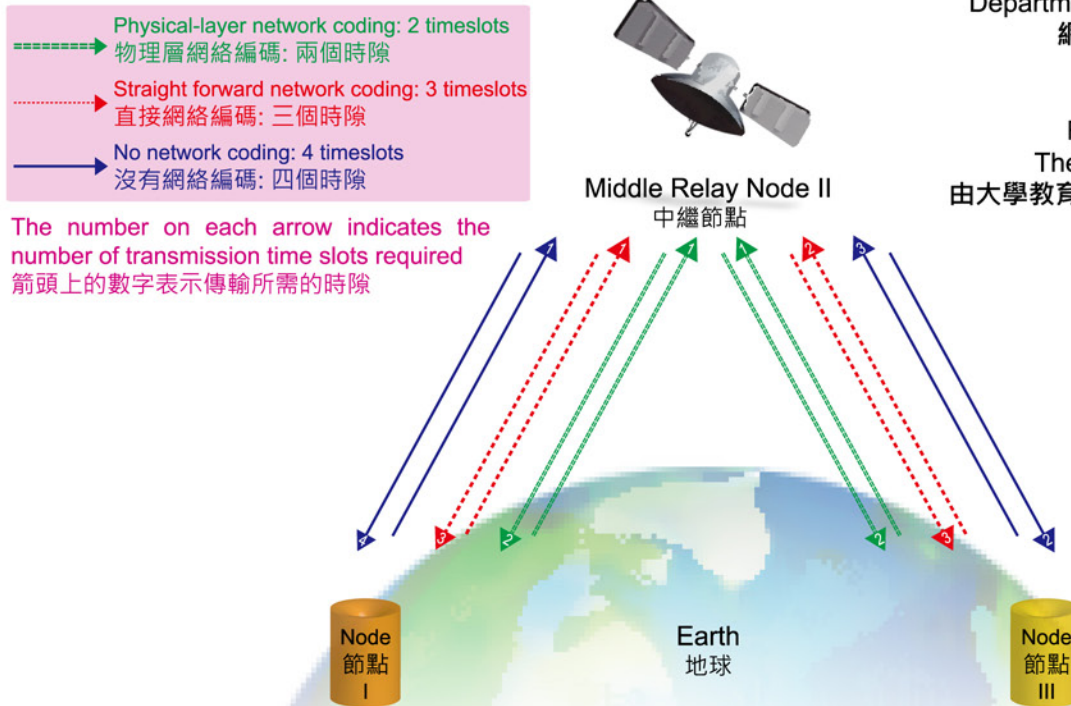
我們構建了一個基於分批稀疏編碼的無線網狀網絡(WMN)協議，可以在具有數十跳的無線網絡中進行高效通信。我們現正開發更成熟的協議，以應用在有動態丟失的大型網絡。另外，最近我們完成了一個概念驗證示範，證明了分批稀疏編碼在連續出現五個丟包的路徑上進行終端對終端傳輸時，仍能保持高通量。我們亦已成功示範使用分批稀疏編碼進行視頻串流傳輸。



物理層網絡編碼 Physical-layer Network Coding

Prof. LIEW Soung Chang
Institute of Network Coding /
Department of Information Engineering
網絡編碼研究所 / 信息工程學系
劉紹強教授

Funded by Area of Excellence,
The University Grants Committee
由大學教育資助委員會卓越學科領域資助



The number of wireless communication users is continuously increasing. Spectrum, however, is a limited resource. Enhancing the efficiency of wireless communication is therefore an important research goal. To realize it, one of the key challenges is to tackle the wave interference problem.

無線通訊用戶數量不斷增加，但無線電頻譜卻是有限的資源。因此，提升無線通訊的效能是重要的研究目標，而其中一項關鍵就是要解決電磁波干擾的問題。

At the physical-layer of wireless networks, all data are transmitted through electro-magnetic (EM) waves. EM wave interference has long been conceived as something we should avoid in wireless communication. Physical-layer Network Coding (PNC), which is developed by CUHK research team, is able to shift the paradigm from this traditional view to embrace interference. PNC allows multiple devices to transmit their messages simultaneously, and its essence is to harness multi-user interference. PNC systems treat the interference as the linear encoding of multiple user signals and compute a linear function of the source messages. The computed functions are then forwarded to the destinations. Upon collecting sufficient linear functions, each destination recovers its desired messages by solving these linear functions.

從物理層剖析無線網絡，所有數據均是以電磁波傳輸。一直以來，我們認為需要避免電磁波互相干擾在無線通訊時發生，但由中大研究團隊研發的物理層網絡編碼反而利用干擾進行傳輸，一反傳統。物理層網絡編碼允許多個通訊設備同時傳送訊息，其精髓之處，是利用多個用戶產生的干擾作為多用戶信號的線性編碼，並計算訊息源的線性函數，然後將其轉發到目的地。當收集到足夠的線性函數時，目的地就可以求解這些線性函數，以恢復所需要的信息。

This mechanism efficiently addresses the interference bottleneck problem, leading to a dramatically improved system performance. To illustrate the performance of PNC comparing with conventional schemes, we take the communication in a linear three-node multi-hop network as an example (refer to graph). It is shown that only two time slots are required in PNC for the two end-nodes to exchange two frames, one in each direction via the middle relay node. In contrast, three time slots are needed in straightforward network coding, while four time slots are needed if network coding is not used at all.

這個機制有效地解決了電磁波干擾這個瓶頸問題，顯著地提升系統的性能。我們以一個線性三節點的多跳網絡為例，比較物理層網絡編碼與傳統方案在傳輸效率上的分別（見附圖）：利用物理層網絡編碼，兩個端節點通過中繼節點去交換信息，只需要兩個時隙。相比之下，使用直接網絡編碼需要三個時隙；而沒有使用網絡編碼的，更需要四個時隙。

PNC has emerged as a promising technique that can significantly improve the capacity and energy efficiency of future wireless networks. PNC is not merely a theoretical concept, but a workable solution in real wireless networks. Recently, our team has built a prototype that can allow two terminals to exchange image files using the PNC mechanism in real-time.

新興的物理層網絡編碼是很有前景的一種技術，可顯著提高未來無線網絡的容量和能源效率。它不只是一個理論概念，更是一個能夠真正應用於無線網絡的可行方案。最近，我們建立了一個原型，利用物理層網絡編碼機制成功在兩個終端實時交換圖像文件。

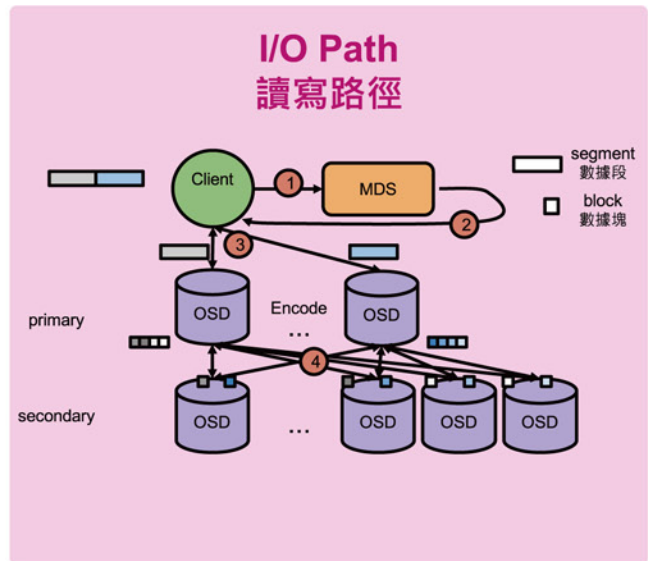
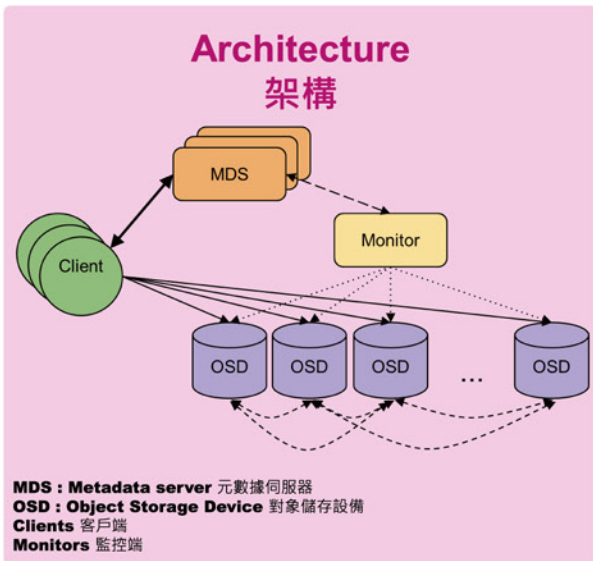


CodFS: 具備高效率更新及快速修復功能的 糾刪碼分佈式儲存系統

CodFS: An Erasure-Coded Clustered File System with Efficient Updates and Fast Recovery

Prof. LEE Pak Ching Patrick
Department of Computer Science and Engineering
計算機科學與工程學系
李柏晴教授

Funded by Innovation and Technology Commission and
Office of Research and Knowledge Transfer Services,
The Chinese University of Hong Kong
由創新科技署及香港中文大學研究及知識轉移服務處資助



Big data analytics provides government and enterprises with useful information which aids their decision making. However, effective storage of such enormous amount of data has been a great challenge. Applying Erasure Coding (EC) is one of the data protection methods in which, instead of replicating a whole file as backup copies, portions of a file are replicated and stored across a set of different locations (nodes) and, upon data corruption, the original file is recovered by retrieving these data fragments. EC guarantees data availability and security while lowers data redundancy.

In this project, research team of CUHK proposes an advanced erasure-coded clustered storage system named CodFS, which makes use of our newly developed scheme called "parity logging with reserved space". CodFS enables efficient updates and fast recovery of big data at low cost.

To achieve high efficiency in updating files, log-based storage is often adopted to append new data rather than overwrite existing data (in-place update). However, reassembling these updates from data and parity chunks stored at different nodes during recovery introduces significant I/O overhead. Our proposed scheme "parity logging with reserved space" takes a hybrid of in-place data updates and log-based parity updates by keeping parity updates in a reserved space next to the parity chunk. Disk seeks can therefore be mitigated to achieve efficient recovery. It is proved that CodFS achieves 60% speedup over conventional in-place data update while preserves the recovery performance. Additionally, to ensure efficient use of storage space, a workload-aware scheme is proposed to dynamically predict and adjust the reserved space size.

分析大數據所獲取的資訊能有助政府或企業作出策略性的決定。然而，要有效地儲存如此龐大的數據，實在是一項挑戰。應用糾刪碼是一種儲存數據的方法，這方法在備份檔案時，不是將整個檔案複製，而是將檔案分割成數據塊，然後複製並儲存在不同的位置。當某個檔案損毀，系統就會讀取存有該檔案備份的數據塊去修復檔案。這方法可確保數據的可用性和安全性，同時減低數據的重複儲存量。

在此項目裡，中大研究團隊基於糾刪碼首創「預留空間式奇偶校驗日誌方案」，提出命名為CodFS的糾刪碼分佈式儲存系統。CodFS可提供低成本的大數據高效率更新及快速修復方案。

為提高更新檔案的效率，不少系統採用日誌儲存方法，把更新的部分順序地寫入硬碟，而非用新數據覆蓋替換現存檔案（原地更新）。然而，當需要進行修復時，這種設計必須讀取分佈在不同位置的數據塊和校驗塊，增加讀寫負載。我們提出的「預留空間式奇偶校驗日誌方案」結合原地更新及日誌校驗更新兩種方式，在校驗塊旁預留一個備用空間，再把校驗更新儲存其中，以減少硬碟搜尋的次數，達至提升數據修復的效率與速度。測試證明，CodFS比故有的原地更新方法快超過六成，同時保留其修復效率。另外，我們亦提出一個按照系統負載去預測和調整備用空間的方案，保證高效率地使用儲存空間。

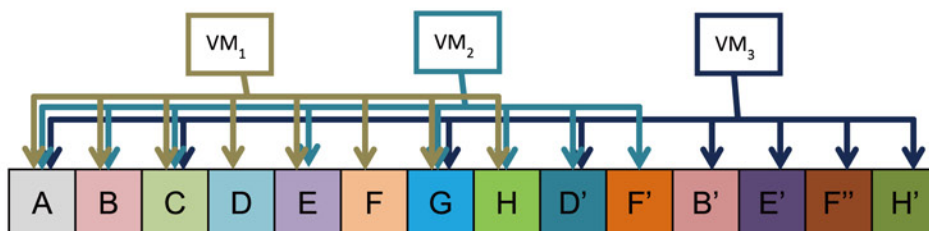


RevDedup: 高效混合在線及逆向重覆數據刪除儲存系統

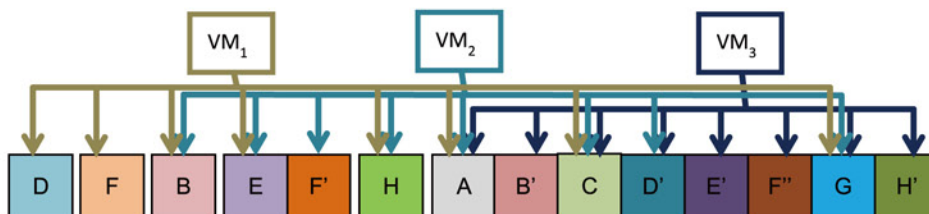
RevDedup: Efficient Hybrid Inline and Out-of-line Deduplication for Backup Storage

Prof. LEE Pak Ching Patrick
Department of Computer Science and Engineering
計算機科學與工程學系
李柏晴教授

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



(Fig. 1) In-line deduplication: Latest backup VM₃ is most fragmented
(圖一)在線重刪：最新備份VM₃的碎片化問題最嚴重



(Fig. 2) Out-of-line deduplication: Latest backup VM₃ is sequential
(圖二)後逆向重刪：最新備份VM₃的數據順序排列

Deduplication has been commonly deployed in storage system to reduce disk space by eliminating redundancy. Inline deduplication and out-of-line reverse deduplication are two conventional deduplication methods. Each, however, has its own shortcomings. CUHK proposes RevDedup which is a hybrid between the two. It provides high backup and restore throughput of recent backup versions, and at the same time facilitates fast deletion of expired versions.

Inline deduplication (Fig. 1) removes duplicates from new data on the write path, inducing fragmentation in the latest backup and thus reducing the restore performance. Sharing of chunks also complicates the deletion process of expired backups. While for out-of-line reverse deduplication (Fig. 2), redundancy is removed from old backups after new data has been stored. It introduces additional I/Os in writing and removing duplicate chunks.

RevDedup efficiently combines the two methods by adopting a two-phase approach: (1) Inline deduplication is first applied at coarse-grained level (large segments of several MBs). It reduces fragmentation of the latest backup versions and thus maintains the restore throughput; (2) Out-of-line reverse deduplication is then employed at fine-grained level (small blocks of several KBs). It shifts fragmentation to old versions and prepares data for fast deletion, while limits the I/O overhead at the same time.

We implemented RevDedup on a real-life virtual machine. Results show that RevDedup achieves high deduplication efficiency with around 97% of space saving; high write throughput at 4-7GB/s; and high read throughput for the latest backup at 1.2-1.7GB/s.

重覆數據刪除（重刪）技術透過刪掉重覆的數據節省硬碟空間，被廣泛使用於儲存系統。在線重刪和後逆向重刪是兩種現有的重刪技術，但各有弊處。中大提出命名為RevDedup的新方案，結合以上兩種技術，以提高讀寫最新備份的速度，同時有助快速刪除過期的備份資料。

在線重刪（圖一）在寫入數據時將新備份的重覆數據刪除，令新備份的數據分佈各處（碎片化），讀取新備份的性能因而減低，刪除過期備份的過程亦會因為共享數據塊而變得更複雜。後逆向重刪（圖二）在數據寫入儲存系統後再把舊備份的重覆數據刪除，額外增加了系統的讀寫負載。

RevDedup採用一個分為兩階段的方案，有效地結合了上述兩種技術：(1)先以若干MB的數據段為單位，粗略地進行在線重刪，減輕了新備份碎片化的問題，保持還原新備份的速度；(2)接著以若干KB的數據塊為單位，精細地進行逆向重刪，將碎片化問題轉移到舊備份並整理數據以備快速刪除，同時有效控制額外讀寫負載的產生。

我們在虛擬機進行實際測試，結果顯示RevDedup的重刪效率很高，達至約97%的空間節省效果。其寫入吞吐量高達每秒4-7GB，而讀取最新備份的吞吐量則高達每秒1.2-1.7GB。



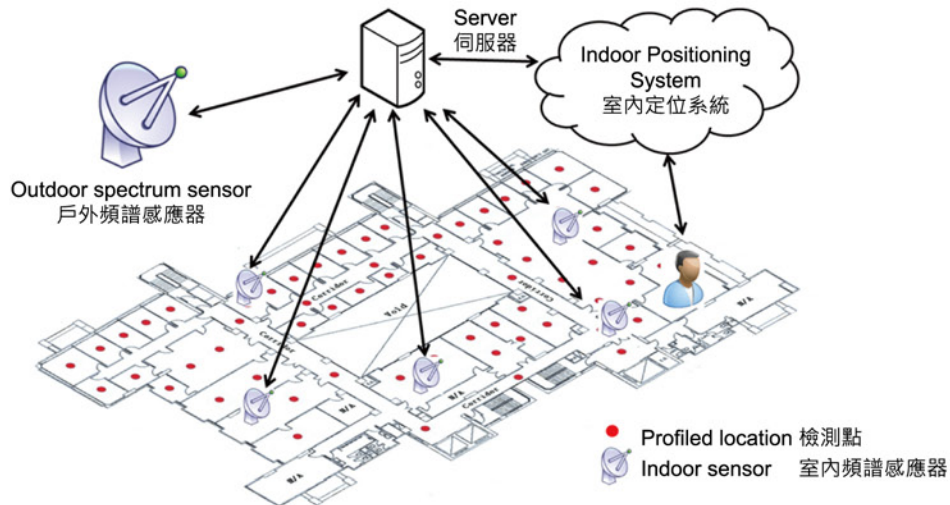
室內空白頻譜無線通信網絡 Indoor White Space Communication System

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

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

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

Indoor TV white space identification and network design 室內空白電視頻譜檢測和網絡設計



Different parts of radio spectrum are allocated for different uses in telecommunications, such as radio broadcast, TV broadcast and mobile data communication. There is a rapid growth in mobile data usage worldwide over recent years. In Hong Kong alone, the local mobile data usage in Dec 2013 reached up to 12.1 million Gigabytes, which is 19 times of that in the same period in 2009. With the limited number of frequencies available, it interests researchers around the world to investigate the efficient use of spectrum. There is a noticeable amount of licensed but underutilized TV spectrum in the TV bands. These unoccupied portions, namely TV White Space, offer the first and promising opportunity to provide additional spectrum for mobile data communication.

It is found that 70% of the traffic demand comes from indoor environment. However, most prior works have focused on exploring outdoor white spaces. We are the first group in the world focusing on indoor TV white space identification and network design. Our system WISER (**White-space Indoor Spectrum EnhanceR**) can effectively identify and track indoor white spaces, without requiring user devices to sense the spectrum. Based on our previous large-scale measurement across 30+ diverse locations in Hong Kong, more than 50% and 70% of the TV spectrum are white spaces in outdoor and indoor scenarios, respectively. WISER can fully utilize up to 70% of the underutilized indoor TV spectrum without interfering currently used spectrum to help improve the indoor wireless network congestion.

These techniques are not limited to TV white spaces and can be broadly used for dynamic spectrum access in other parts of the spectrum. WISER thus has huge potential in wireless communications worldwide.

無線電頻譜被分配作不同通訊用途，例如電台廣播、電視廣播及流動數據通訊等。近年，全球的流動數據使用量急速上升，單單在香港，2013年12月份的移動數據用量已達到1210萬GB，是09年同期的19倍。無線電頻譜是有限的資源，世界各地的科研人員爭先研究高效率的頻譜使用方案。電視頻譜當中，有相當多已得到授權使用的頻譜未被充分利用，這些「空白電視頻譜」，為提供額外流動數據通訊頻譜帶來有前景的研究方向。

早期對於空白電視頻譜的研究主要集中於室外範圍，但統計數據顯示，70%無線數據需求來自室內環境。我們是全球第一個專注在室內空白電視頻譜檢測和網絡設計的研究組。我們的系統WISER能有效而低成本地感測室內的空白頻譜，並將資訊提供給終端用戶進行無線通訊。我們在香港超過30個地點進行的大規模電視頻譜測量顯示，室外和室內環境未被利用的電視頻譜分別達50%和70%之多，WISER系統能在不干擾現有頻譜的情況下，利用達70%的空白頻譜，以支持移動設備的高速無線網接入。

此技術並不限於空白電視頻譜的使用，亦可應用於其他頻段。這對於發展新一代無線網路通訊技術具有極大的潛力。



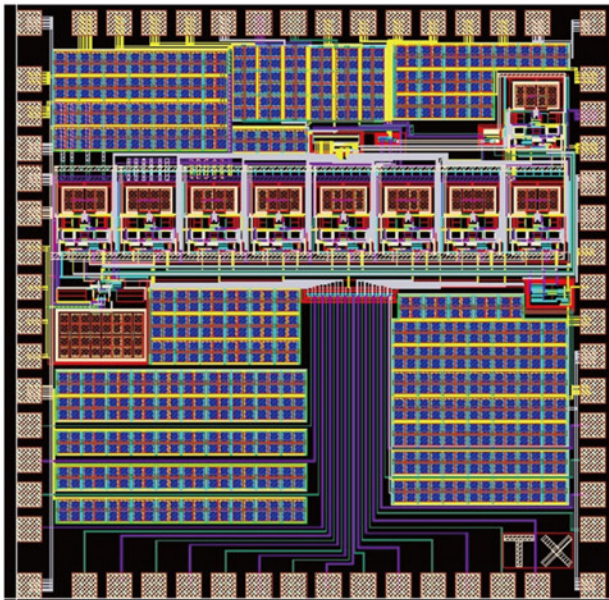
用於4G無線TD-LTE的超高速模擬前端芯片的 關鍵技術研發和產業化

Research and Development on High-speed Analog Front-end for 4G TD-LTE

Prof. PUN Kong Pang
Department of Electronic Engineering
電子工程學系
潘江鵬教授

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

Collaboration with Evoc Intelligent Technology Co, Ltd
& Shenzhen Amplify Electronics Co, Ltd
合作夥伴包括研祥智能科技股份有限公司及
深圳市安派電子有限公司



Layout of an amplifier-less pipelined ADC in 0.18um CMOS
0.18微米CMOS無放大器管線式類比數位轉換器

Long-Term Evolution (LTE) is an emergent technology in wireless communication around the world. Most existing pipelined analog-to-digital converters (ADC), which are integral to wireless communication, rely on high-gain amplifiers to perform. However, as CMOS technologies enters the nanometer region, there is a bottleneck in the design of amplifiers that either high power consumption is resulted or only a low gain is possible.

In this project, an amplifier-less pipelined ADC technique developed by CUHK will be adopted to design two analog front-end internet protocols for 4G TD-LTE: a low-power ADC for the Hong Kong side's mobile terminal and an ultra high-speed sample-and-hold circuit and its related technologies for the Shenzhen side's base station. The amplifier-less pipelined ADC technique can effectively solve the abovementioned bottleneck problem. It can achieve high performance in terms of dynamic range and speed, while reducing the power consumption.

Performance of the baseband ADC in the mobile terminals:

- Less than 6mW power consumption at 20MHz bandwidth
- Tunable bandwidth from 1.4MHz to 20MHz
- 60dB dynamic range

Performance of the ultra-fast sample-and-hold circuit:

- 20 GSps sampling rate
- 8 bit accuracy

LTE無線通信技術在世界各地新興起來，類比數位轉換器是無線通信不可或缺的設備，大部分現有的管線式類比數位轉換器，都依靠高增益放大器來運作，但隨著納米CMOS技術的發展，放大器在設計上遇到瓶頸，若要達到高增益，能源消耗定必很高。

此項目採用中大開發的無放大器管線式類比數位轉換器，以制定4G TD-LTE移動系統的兩組模擬前端芯片網絡協議，包括在香港移動端使用的低功率類比數位轉換器，以及於深圳基站使用的超高速採樣保持器及其關聯技術。無放大器管線式類比數位轉換器將有效解決上述的瓶頸問題，能夠實現高速寬動態範圍同時降低能源消耗。

移動端類比數位轉換器的性能:

- 帶寬在20MHz時，功率為6mW或以下;
- 帶寬可由1.4MHz調到20MHz;
- 動態範圍可達60dB或以上;

超高速採樣保持器的性能:

- 20 GSps採樣率
- 8-bit 準確度



謠言檢測研究及發展 Rumor Detection Research & Development

Prof. WONG Kam Fai
Department of Systems Engineering &
Engineering Management
系統工程與工程管理學系
黃錦輝教授

Funded by Office of Research and
Knowledge Transfer Services,
The Chinese University of Hong Kong
由香港中文大學研究及知識轉移服務處資助

Collaboration with Huawei Ltd.
合作夥伴為華為有限公司

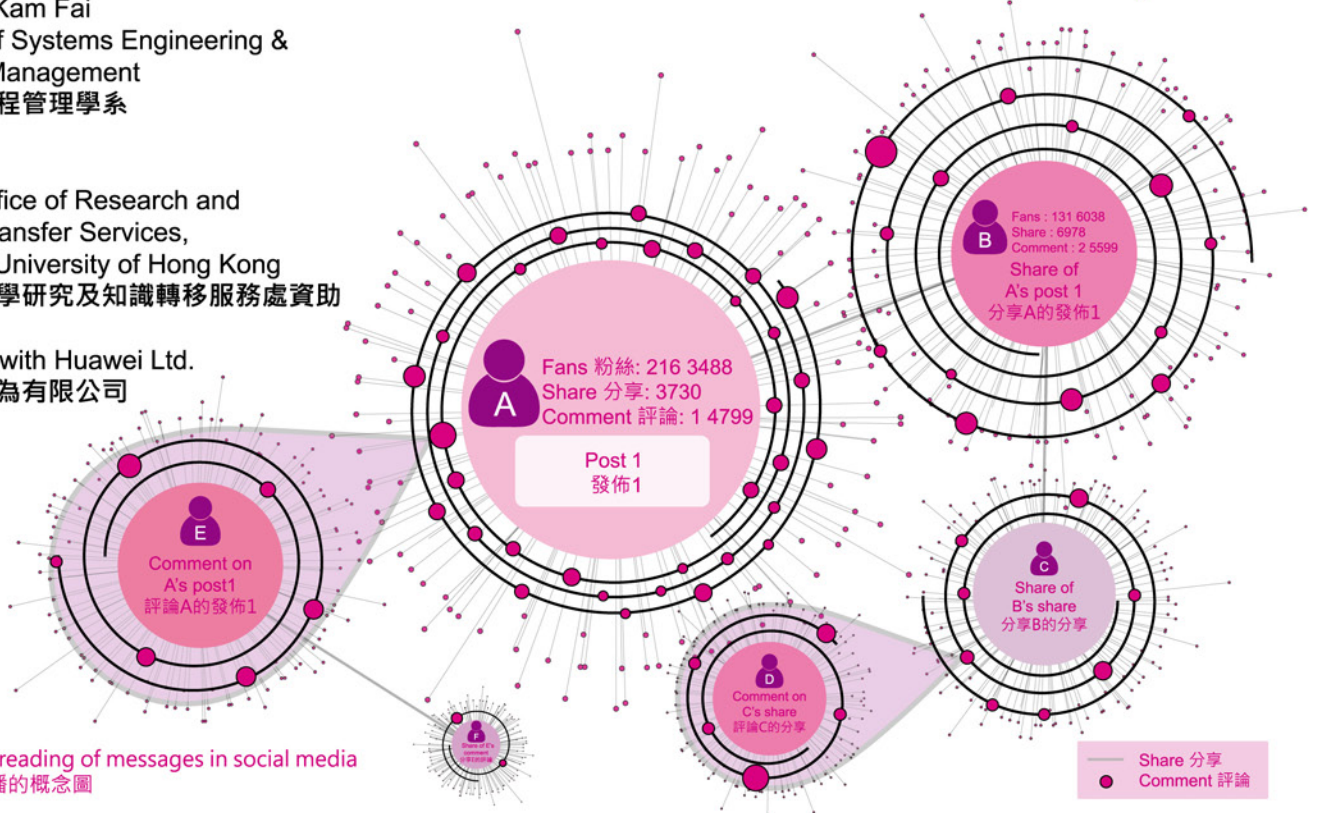


Illustration of spreading of messages in social media
社交網絡信息散播的概念圖

With the advancement of social media, creation and spreading of messages, including rumors, are becoming increasingly easy and rapid, posing enormous impact on society. There are growing interests in the research on rumor detection and credibility ranking. However, existing methods simply based on popularities of topics are ineffective in discovering and identifying suspected emergent rumors. In this project, we propose an opinion-based framework for suspected rumor detection and credibility ranking by calculating the following features:

User Credibility :

Generally, if a user often posts opinionated posts while his/her opinions are supported by other users, it reflects that he/she has a relatively high credibility. Using "Learning to Rank" algorithm, the user credibility will be calculated based on the volume of opinionated posts, the acceptance of opinions and the changes of acceptance of opinions over time.

Uncertainty :

A topic is more likely to be a rumor if more users present uncertain opinions towards it. We will collect a database of uncertain expressions and study the features of the use of vocabularies, grammars and sentence structures. We will then design a binary classifier to identify opinions with uncertainty and thereby calculate the overall degree of uncertainty.

Controversy :

Whether opinions on a certain topic are supporting or opposing each other is another significant feature for determining the credibility of the message. We will design an opinion mining system to analyze the polarity of opinions and thereby calculate the overall degree of controversy.

隨着社交網絡的發展，各種信息以至謠言的製造和散播變得更輕易快捷，對社會帶來深遠影響。自動檢測謠言和計算資訊可信性的研究，因而愈來愈受到重視。但現有的技術僅針對話題的流程度，未能有效地發現及識別剛開始流傳且可能是謠言的信息。本項目提出嶄新的方案，以社交網絡用戶發表的觀點為基礎，循以下幾點檢測和計算信息的可信性：

用戶的可信度：

一般來說，如某用戶發表的訊息經常包含其個人觀點並且能獲得他人的認同，這反映此用戶有較高的可信度。我們根據用戶發表含觀點訊息的數量、觀點的被接納度以及隨着時間改變而變化的接納度進行排序學習演算，從而計算用戶的可信度。

觀點的不確定度：

愈多用戶對一個話題表達不確定的觀點，該話題是謠言的可能性就愈大。我們將收集表達不確定觀點的資料庫，研究其用詞、語法及句法特點，並設計能識別不確定觀點的二元分類器，從而計算話題的整體不確定度。

話題的爭議性：

各人對某一話題的觀點有時會呈現一面倒的趨勢，有時則明顯分成幾個勢均力敵的方向。這是判斷話題內容可信度的另一重要特徵。我們將設計一個意見挖掘系統，分析使用者觀點的傾向，從而計算話題整體觀點的爭議性。



實時環境監測及風險管理傳感網絡系統 Real-time Environmental Monitoring and Risk Management Sensing Network System



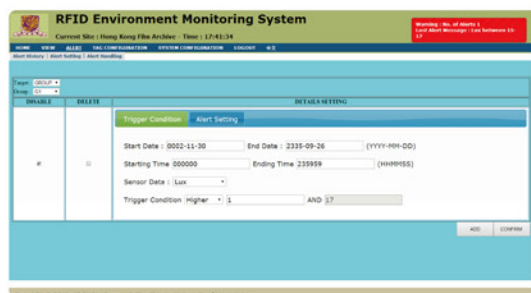
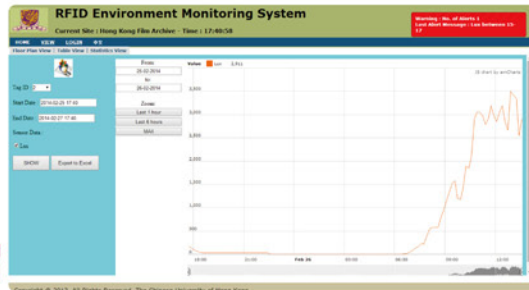
Prof. WU Ke Li
Department of Electronic Engineering
電子工程學系
吳克利教授

Prof. CHENG Chun Hung
Department of Systems Engineering &
Engineering Management
系統工程與工程管理學系
鄭進雄教授

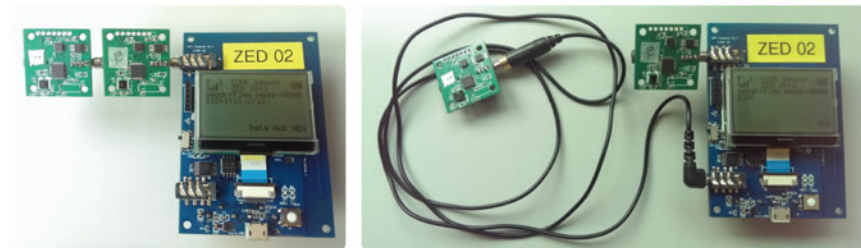
Funded by Innovation and Technology
Commission and Hong Kong R&D Centre
for Logistics and Supply Chain Management
Enabling Technologies
由創新科技署及香港物流及供應鏈管理應用
技術研發中心資助

Collaboration with Air Mail Centre,
Hongkong Post and Central Conservation
Section, Hong Kong Museum of History &
Hong Kong Film Archive, Leisure and
Cultural Services Department
合作夥伴包括香港郵政空郵中心及
康樂及文化事務署轄下文物修復組、
香港歷史博物館及香港電影資料館

Temperature monitoring
溫度監測



Setting monitoring rules for
different environments
設定不同的環境監測指令



Dynamically pluggable hardware platform
可自由插拔的硬件平台

At facilities like exhibition halls, warehouses and distribution centers, storage of invaluable items such as historic artifacts, wine and tea is often involved. To preserve the quality of the goods, environmental conditions such as temperature, humidity, illumination and vibrations must be effectively controlled at optimal level. In view of this, CUHK proposes a "Real-time Environmental Monitoring and Risk Management Sensing Network System", which helps to improve the efficiency and accuracy in managing a vast quantity of flowing goods at large facilities.

We developed a hybrid indoor communication system to leverage on power line and wireless communication for facilitating low energy data communications which support sensor data collection and the control of environment conditions at closed environments. A pluggable hardware platform is designed to house external sensors and utility modules based on monitoring needs. The universal sensor interface allows plug-in of up to eight external sensors and utility modules to an active tag. The data communication protocols developed by CUHK will be further enhanced to connect thousands of wireless tags. We will also optimize the communication propagation algorithm and mechanism to reduce network traffic in a vast hybrid network. The software components designed for the system can provide monitoring and alerting functions as well as analytics of collected sensor data for reporting and predictive purposes.

展覽館、儲存庫和分發中心等這些儲存大量貨物的地方，經常需要處理貴重物品，例如歷史文物、葡萄酒、茶葉等。要妥善保存物品，必須有效控制溫度、濕度、照明、震動等環境條件。有見及此，我們設計了「實時環境監測及風險管理傳感網絡系統」，以提升大型設施處理大量高流量物品的效率及準確性。

中大開發了一個混合有線和無線通訊的室內通訊系統，能以低電量收集封閉地方裡的環境數據及調控其環境條件。我們設計出一個可插拔的硬件平台，能根據監測需要而加插各種傳感器和功能模塊。通用的傳感器接口令有源標籤可連接最多八個傳感器和功能模塊。由中大開發的數據通信協議將進一步被改良，以連接數千個無線標籤。我們亦會優化通訊傳播演算法及機制，減少巨大混合網絡中的流量。配合系統而設計的軟件組件可監測和發出警報，並分析整合環境數據以作報告和預報用途。

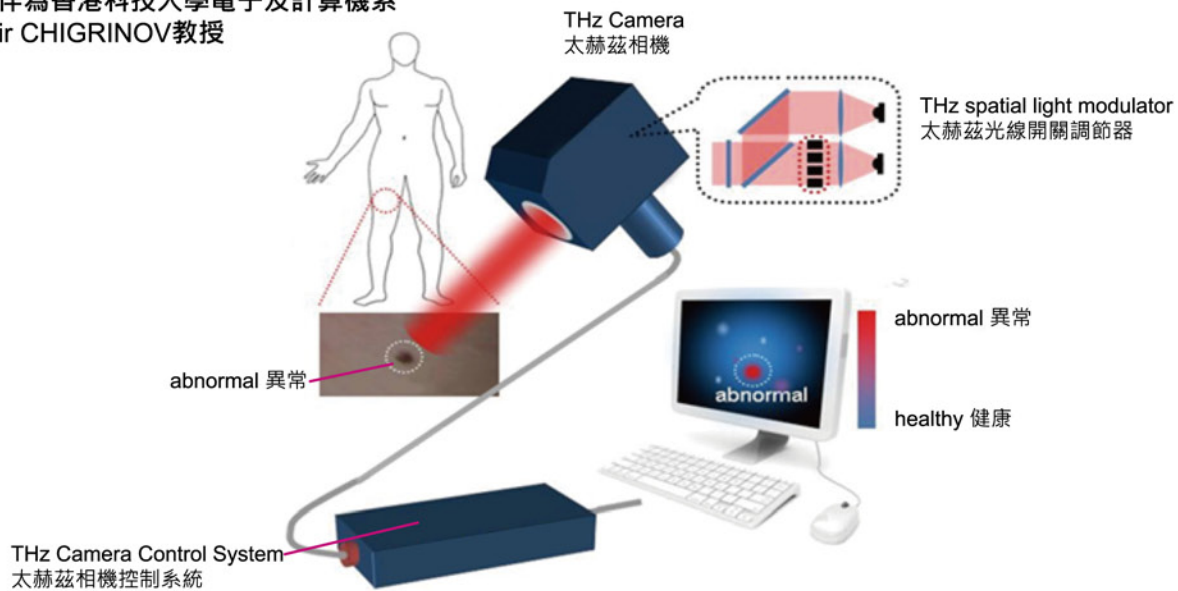


研發用於太赫茲高速成像系統的液晶儀器 Liquid Crystal Device Development for High Speed Terahertz Imaging System

Prof. Emma MACPHERSON
Department of Electronic Engineering
電子工程學系
Emma MACPHERSON教授

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

Collaboration with Prof. Vladimir CHIGRINOV,
Electronics and Computer Engineering Department,
Hong Kong University of Science and Technology
合作夥伴為香港科技大學電子及計算機系
Vladimir CHIGRINOV教授



High speed terahertz imaging system can be applied in medical imaging,
e.g. detection of skin cancers.
太赫茲高速成像系統可應用於醫學成像，例如檢測皮膚癌。

Terahertz light is part of the electromagnetic spectrum between microwave and infrared. It can penetrate clothes, wood and plastics, but it is strongly absorbed by water. With its non-destructive characteristic, terahertz technology is an emerging field for applications ranging from medical imaging, industrial quality control, to hidden weapon detection.

太赫茲波是介乎於微波和紅外線之間的電磁波，能穿透衣服、木以及塑膠等，但會被水強烈吸收。基於其無損檢測的特性，太赫茲技術於醫學成像、工業品質檢定、以及武器搜查範疇發展迅速。

In this project, we aim to design and demonstrate a liquid crystal based spatial light modulator which can operate at terahertz frequencies. Combined with compressed sensing theories, the modulator could ultimately be used to form a single pixel high speed terahertz camera.

在此項目中，我們的目標是設計出能夠於太赫茲波段工作的液晶空間光調製器，輔以壓縮感知技術，最終實現單像素太赫茲高速相機。

Liquid crystal based spatial light modulators are widely used at visible light frequencies but it is a challenge at terahertz frequencies because of the longer switching times (due to the thicker layer of liquid crystal needed for terahertz). To overcome this problem, we have built a groundbreaking electrode design which improves the switching time and transmission efficiency in liquid crystal devices.

基於液晶技術的空間光調製器已經被廣泛應用於可見光波段，但由於液晶器件在太赫茲波段的開關速度慢（因為太赫茲波段需要更厚的液晶層），液晶技術難以應用於太赫茲波段。為解決此問題，我們提出了突破性的電極設計方案，以提高液晶器件在太赫茲波段的開關速度和透射率。

In addition, we will design and evaluate liquid crystal cells suitable for terahertz wave modulation and incorporate the abovementioned electrode design into these cells. As liquid crystal devices offer superior electronic control, the optimized cell design can be used to build a switchable array to form the terahertz spatial light modulator.

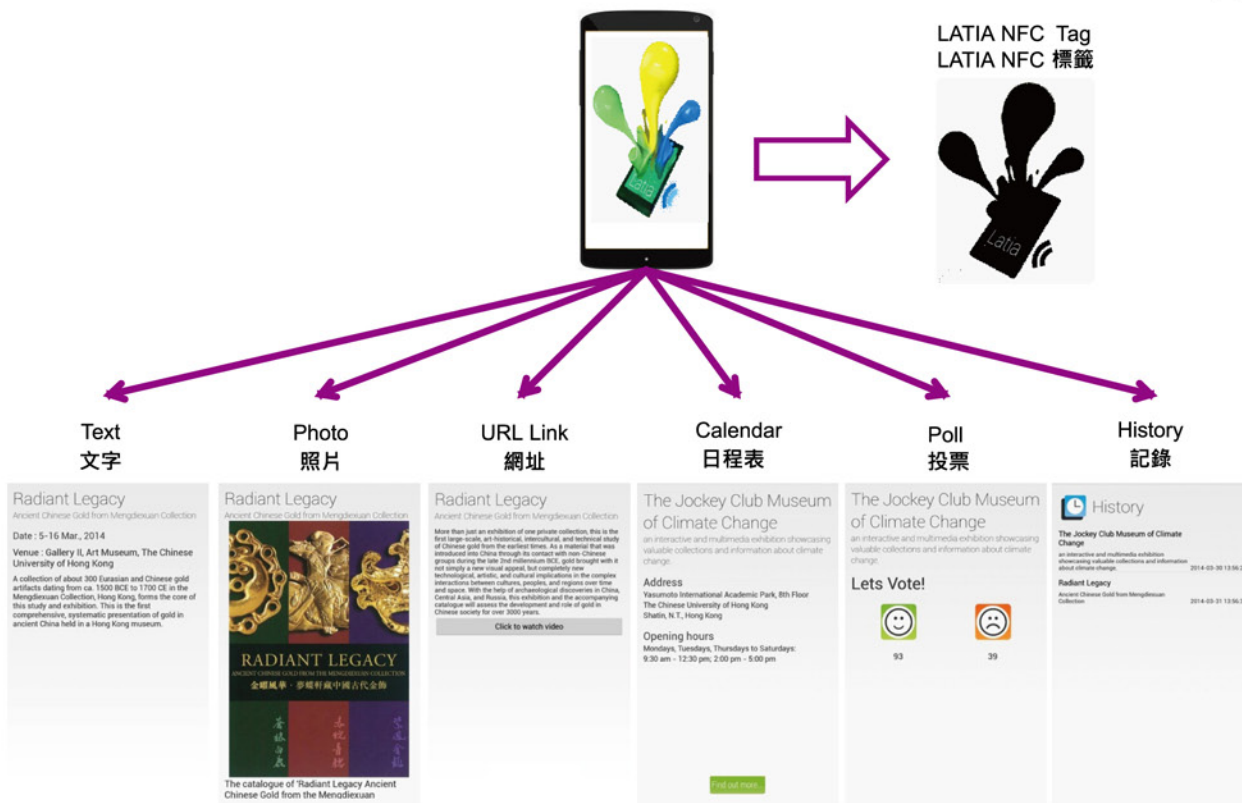
另外，我們將設計及驗證適用於調節太赫茲光的液晶器件，並融入上述的嶄新電極設計。液晶器件在電控方面的優勢，讓我們可利用優化了了的液晶元件製造一個開關陣列，從而得到太赫茲波段空間光調製器。



LATIA: 移動資訊錢包開發庫

LATIA: Mobile Information Wallet Development Library

Prof. LYU Rung Tsong Michael
Department of Computer Science and Engineering
計算機科學與工程學系
呂榮聰教授



Users can design their own Mobile Information Wallet by adding different elements
用戶可加入不同元素設計其「移動資訊錢包」

A large number of exhibitions are held at international cities like Hong Kong every year. Mobile communication devices have become an important tool in exhibitions to effectively deliver information to audience so as to maximize promotion outcomes. We developed an Android application design middleware namely LATIA, which enables exhibition organizers and exhibitors to easily design a "mobile information wallet" to fit their promotion strategy.

The "mobile information wallet" app designed with LATIA allows visitors to load different exhibition information to their mobile device through Near Field Communication (NFC) technology. After downloading the app, they can record the exhibitors/exhibits they have visited, download related information, and even automatically add an event to their e-calendars by simply putting their smart phones or tablets close to the NFC tags on promotion posters, brochures or other promotion materials. The app will be activated once the mobile device detects the NFC tag. It saves visitors from manually launching the app, making it even more convenient.

The interface of LATIA is user-friendly, enabling users to easily design their tailor-made "mobile information wallet" by adding texts, photos, URLs, calendars or even polls/votes the way as they prefer.

國際都市如香港，每年都舉辦形形色色的大型展覽。現今不少展覽都開始利用移動通訊設備，讓訊息能夠更有效地傳達，進一步加強宣傳成效。我們開發命名為LATIA的Android應用程式設計工具，讓展覽籌辦機構及參展商能夠輕易地設計出配合其宣傳策略的「移動資訊錢包」。

由LATIA設計出的「移動資訊錢包」應用程式，讓參觀展覽人士可透過近場通訊技術(NFC)將展覽中的各類資訊載入其流動通訊設備。下載應用程式後，他們只需要將智能電話或平板電腦貼近海報、小冊子等宣傳品上的NFC標籤，便可以隨喜好記錄參觀過的展商/展品，下載有關的延伸資訊，甚至將活動資料自動加入其電子月曆當中。當流動設備感應到NFC標籤，應用程式會自動開啓，參觀人士無須手動操作，令過程更快捷方便。

LATIA的介面簡單易用，讓用戶隨意地加入文字、照片、網址、日程表等資訊，更可加入問卷/投票功能，設計出度身訂造的「移動資訊錢包」。



uReply: 互動移動學習

uReply: Interactive Mobile Learning

Prof. LAM Lai Chuen Paul
Centre for Learning Enhancement and Research
學能提升研究中心
藍濃銓教授

Funded by Teaching Development Grants
由教學發展基金資助

The aim of the Mobile Learning project at CUHK is to pursue the possibilities in enhancing the teaching and learning environment through the use of various mobile technologies.

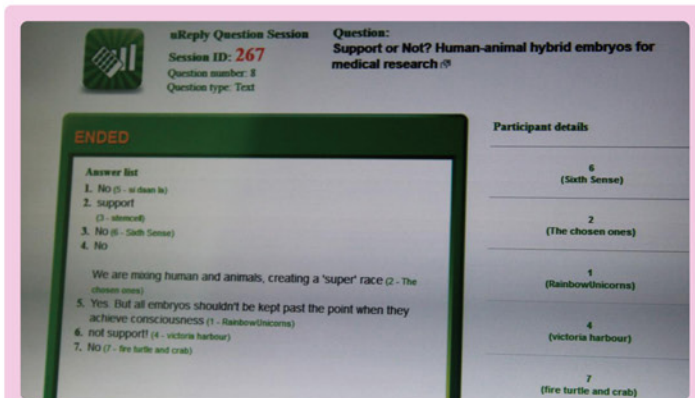
To enrich interactions in classrooms, we designed a web-based student response system namely uReply. The system allows all students in a class to answer a question simultaneously through using mobile devices. Instead of installing costly equipment in a classroom, we adopt the "Bring Your Own Device" (BYOD) strategy. That is, students can access to the platform simply using their own smart phones, tablets or laptop computers.

uReply provides an easy-to-use interface that no prior trainings will have to be given to teachers or students. Teachers can set up a question during class or select a pre-set question which they have prepared in advance. Answers will be sent to the teacher's interface in real time and can be instantly analyzed. In addition, records of the class activities are retrievable by teachers at any later time for further analysis.

香港中文大學移動學習項目的目標，是透過利用各種移動科技，提供更優質的教學環境。

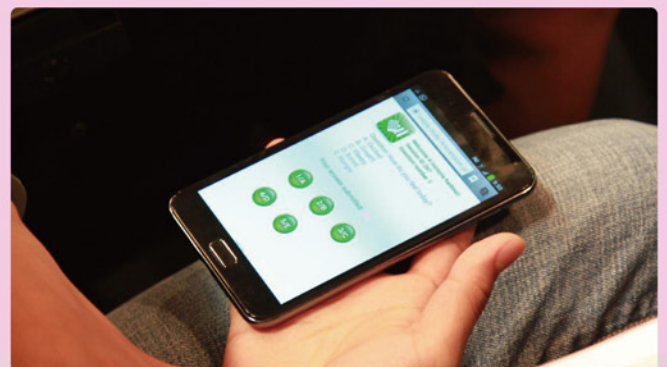
為加強課堂裡的互動，我們設計了一個名為uReply的學生應答網絡系統。系統讓課堂裡的學生能夠一起利用流動設備同時回答教師的提問。本項目的其中一個優勢是無須在課室裡添置昂貴的儀器，相反，我們善用「自帶設備」的方針，讓學生透過使用自己的智能電話、平板電腦或手提電腦去使用應答平台。

uReply提供簡單易用的用戶介面，教師和學生均無須事先學習如何使用。教師可於課堂即時設定或點選已預先設定的問題。學生的答案會實時傳送到教師介面，更可作即時分析。此外，教師更可隨時存取課堂活動的數據，日後作更詳細的分析。



Students' feedbacks can be analyzed instantly and displayed in the format of graphs or tables.

系統可即時統計學生的答案，並以圖表方式顯示。



The system supports multiple-choice questions and short questions. Students can input answers via their own mobile devices such as smart phones, tablets or laptop computers.

系統支援選擇題及文字題，學生可透過他們的流動設備，例如智能手機、平板電腦和手提電腦等，去輸入答案。



透過大型開放式線上課程進行教師專業發展 Teacher Professional Development through MOOC

Prof. JONG Siu Yung, Morris
Mr. LUK Tsun Hin
Ms. LI Silu
Department of Curriculum and Instruction &
Centre for the Advancement of IT in Education
課程與教學學系及資訊科技教育促進中心
莊紹勇教授
陸晉軒先生
李思露小姐

Funded by Education Bureau HKSAR
由香港教育局資助

Collaboration with Education Bureau HKSAR,
Hong Kong Education City and Pukunui (HK)
合作夥伴為香港教育局、香港教育城及布谷鳥(香港)



User Interface of the MOOC
MOOC用戶介面



Formative Assessment Quiz
形成性評估測驗



Virtual Forum for Teacher Community Building
教師社群網上討論區

In this project, the very first in-service teacher professional development massive open online course (MOOC), funded by Education Bureau (EDB), has been developed to aid primary and secondary school teachers to implement WebQuest.

此項目中，我們在教育局的資助下建立了首個在職教師專業培訓大型開放式線上課程(MOOC)，幫助中、小學教師實施WebQuest教學。

WebQuest is a learner-centric project-based learning approach for facilitating K-12 students to pursue collaborative inquiry learning on the Internet, and is becoming an integral part of education. For effective integration of WebQuest into school education, trainings should be provided to teachers to equip them with the pedagogical knowledge and skills required. Yet, most in-service teachers cannot afford time to participate in conventional face-to-face professional development training. MOOC provides a promising solution to the problem.

WebQuest是指以學生為中心、以任務為本的學習模式，能啟發學生運用互聯網進行協作式探究學習，並漸漸成為教學的重要環節。要有效將WebQuest加入教程當中，需加強教師在這方面的知識和技能，但在職教師往往難以抽空參加傳統面對面式的專業培訓課程。MOOC正正為這問題提供了有效的解決方案。

This MOOC is composed of video-based lecture modules, formative assessment quizzes (each articulated to the end of a module), virtual forums for teacher community building (each facilitated by an online tutor), and summative assessment tasks. In the course, participants can select their own learning track by taking different lecture modules in accordance with their own grade of teaching (primary or secondary) and their own subject of teaching (four key learning areas: English Language, Chinese Language, Mathematics, or Humanities). After passing all formative assessment quizzes and completing all community-building and summative assessment tasks, participants will be each awarded an eCertificate, and six hours of continuing professional development (CPD) by EDB.

MOOC提供錄像教學課程，並在每個單元終結時提供形成性評估測驗，另設有由導師管理的教師社群網上討論區，以及綜合評估習作。課程當中，參加者可因應自己的教學級別和科目(包括英文、中文、數學及人文學)去選擇課程單元，制訂個別的學習流程。通過所有形成性評估測驗並完成所有社群及綜合評估習作後，參加者將獲發電子證書，以及得到由教育局提供的持續專業發展課程共六小時。

另外，我們建立了分學科的跨校教師社群，讓用戶交流教學心得。

In addition, inter-school subject-specific teacher communities are built for users to share good teaching practices.



Robotics & Automation

機械人及自動化技術





移動式微漩渦鉗：用於細胞操作和 納米醫療的低成本非侵入式工具

Mobile Microvortex Tweezers: Noninvasive, Low-cost Tools for Cell Manipulation and Nanomedicine

Prof. ZHANG Li

Department of Mechanical and Automation Engineering
機械與自動化工程學系
張立教授

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

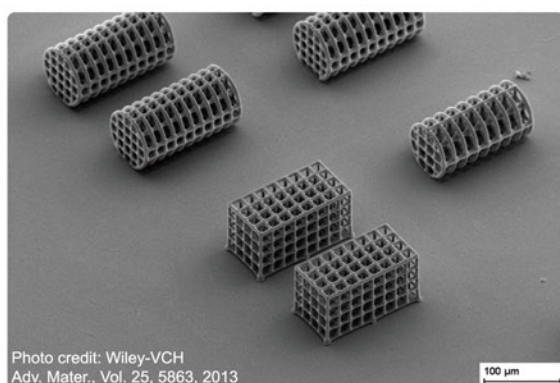
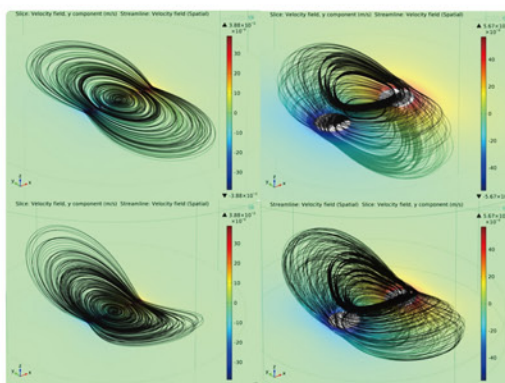
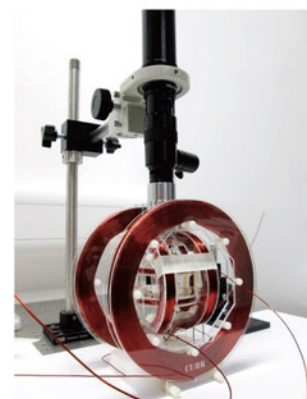


Photo credit: Wiley-VCH
Adv. Mater., Vol. 25, 5863, 2013

Scaffold-like microrobots which are remotely
controlled by magnetic fields
由磁場控制的支架型微型機械人



Microvortices generated by rotation of a microrobot
由微型機械裝置轉動而產生的微型漩渦模擬



Electromagnetic coils with a light
microscope setup
電磁線圈與光學顯微鏡裝置

To assist high precision manipulation of cellular-scale objects such as cells and microorganisms, we are developing a micro-robotic system namely Mobile Microvortex Tweezers (MMT). The technology enables us to control magnetic microrobots containing drug or cells to travel in body fluids, such as blood, urine, or cerebrospinal fluid, to a target position. MMT thereby has high potential for nanomedicine such as in vivo targeted drug/cell delivery for the minimally invasive medical treatment.

MMT is composed of mainly a PC controller, a vision system, electromagnetic coils and a magnetic microrobot. The PC controller manipulates the generation of electromagnetic field by electromagnetic coils, which in turn remotely actuate and control the motion of the magnetic microrobot. Microvortices are generated by the rotation of the microrobot and are used to trap and transport microscale objects, including living cells and microorganisms. MMT could maneuver extremely small fluid volumes down to femto-liters (10^{-15} L). It provides a noncontact and controlled manipulation means for cells and other biological samples with minimal change to their physiological condition.

MMT enables manipulation of individual microscale objects in 2D or 3D with a high spatial and temporal resolution. Compared to other advanced cell-manipulation tools, e.g. optical tweezers and magnetic tweezers, MMT provides a low-cost and noninvasive manipulation solution, and have no restrictions on the material properties of the sample.

為了可準確操作如細胞和微生物般細小的樣本，我們正研發名為「移動式微漩渦鉗」(MMT)的微型機械人系統。此項技術讓我們能夠控制磁性微型機械人在體液（例如血液、尿液和腦脊液等）裡移動到目標位置，於活體靶向藥物/細胞運輸等納米醫學範疇有廣泛的應用前景。

MMT主要由電腦、觀察系統、電磁線圈和微型磁性機械裝置四部分組成。電腦操控電磁線圈產生電磁場，從而遙距驅動和控制微型機械人的運動。因微型機械裝置轉動而產生的移動微型漩渦可以捕捉和移動微米級的樣本，包括活體細胞和微生物。MMT可操控微小至飛升（ 10^{-15} 升）的極小體積流體，提供非機械接觸式的、可控的微操作技術，讓我們可以在對生理環境產生最小影響的情況下操作細胞和其它生物體。

MMT能夠在二維或三維空間以高定位和時間精準度操作微米級的樣本。相比光鉗和磁鉗等先進生物微操作工具，MMT提供了一種低成本和非侵入式的微操作技術，而且可操作任何材料屬性的樣本。



用於車輛懸架的可再生能源磁流變阻尼器 Regenerative Magnetorheological Dampers for Vehicle Suspensions

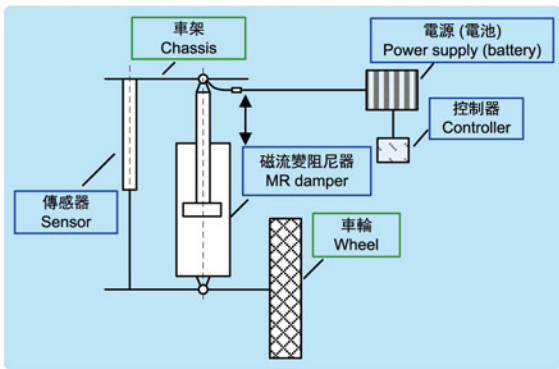
Prof. LIAO Wei Hsin
Dr. CHEN Chao
Mr. ZOU Li
Department of Mechanical and Automation Engineering
機械與自動化工程學系
廖維新教授
陳超博士
鄒力先生

Funded by Innovation and Technology Commission &
Research Grants Council of Hong Kong
由創新科技署及香港研究資助局資助

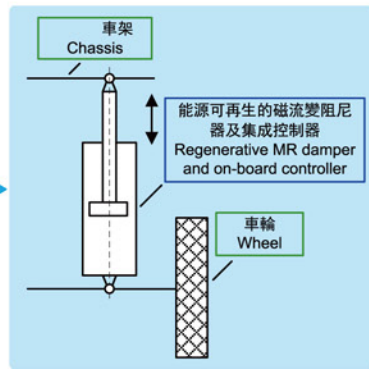
Collaboration with
Automotive Parts and Accessory Systems R&D Centre
合作夥伴為香港汽車零部件研究及發展中心

Controllable force range 可控阻尼力的範圍	Increased by 300% 增大300%
Car body vibration acceleration (RMS value) 車輛振動的加速度 (均方根值)	Reduced by 34% 減小34%
Average harvested power 平均收集到的能量	40 W

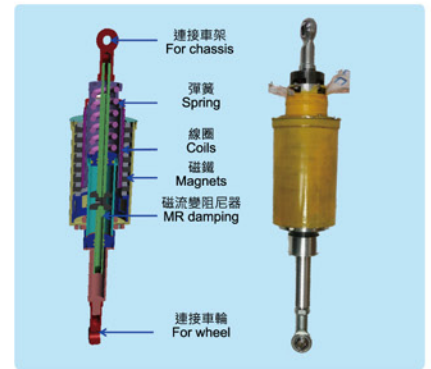
Compared with Original Equipment (OE) damper of electric car MyCar CV2
(under D level ISO standard road and 60 km/h car speed)
跟電動車MyCar CV2的原裝阻尼器相比
(ISO標準D級路面·60公里/時車輛行駛速度)



Conventional MR damper
傳統磁流變阻尼器



Regenerative MR damper
可再生能源磁流變阻尼器



Structure and prototype of regenerative MR damper
可再生能源磁流變阻尼器的結構及原型照片

Dampers are an energy dissipation device installed in vehicle suspension system for reducing vibration of vehicle body and improving ride comfort. Upon accelerating, cornering, braking and passing road irregularities, a large amount of energy is wasted due to the energy dissipation by dampers. CUHK research team proposes regenerative Magnetorheological (MR) dampers with self-contained power regeneration ability. Kinetic energy generated in vibration will be converted into useful electrical energy to sustain the dampers. Moreover, extra batteries and dynamic sensors that are required in current MR damper systems can be eliminated.

The proposed dampers will promote both renewable energy and vehicle performances. Overall energy efficiency of the vehicle will be improved, while fuel consumption and emission will be reduced. With other advantages including reduction in size and weight, higher reliability and less maintenance required, performance of vehicle suspensions is improved.

In addition, our technology will also benefit electric and hybrid electric vehicles, as it can be used to charge the vehicle batteries and thus increase the battery running time. The technology is especially beneficial to densely populated cities, such as Hong Kong and Beijing.

阻尼器是一種安裝於車輛懸架以減緩車身振動以及令車程更舒適的消耗動能裝置。當車輛加速、轉彎、剎停以及駛過凹凸不平的路面時，大量動能於阻尼器中給浪費掉。中大提出能自製再生能源的磁流變阻尼器，將振動所產生的動能轉化為電能供阻尼器使用，並解決傳統磁流變阻尼器需額外安裝電源和動態感應器的問題。

我們的磁流變阻尼器不但促進再生能源的應用，更可提升車輛的性能。技術提高了車輛的整體能源效益，並減少燃油消耗及廢氣排放。此磁流變阻尼器的體積較小、重量較輕、可靠性較高而且保養需求較少，車輛懸架系統的性能因而得到改善。

此外，技術亦將有利於電動汽車和混合電動汽車，因為磁流變阻尼器可以在行駛時將車輛電池充電，增加電池的運用時間。這項技術尤其適用於人口稠密的城市例如香港、北京等。

Awards and Honours:

- China Youth Science and Technology Innovation Award, 2011
- Champion of Professor Charles K. Kao Student Creativity Awards 2011 (Postgraduate Individual Entries)
- Highlighted on the front cover, selected in 2012 Highlights, "Smart Materials and Structures", 2012

獎項及榮譽:

- 中國青少年科技創新獎2011
- 高錕教授學生創意獎2011冠軍(研究生個人組)
- 被選為《智能材料與結構》期刊的封面文章及2012年研究亮點



香港中文大學
The Chinese University of Hong Kong



香港中文大學 創新科技中心
Centre for Innovation and Technology
The Chinese University of Hong Kong

If you are interested in the projects listed, please contact
Centre for Innovation and Technology
The Chinese University of Hong Kong

如果閣下對本書內的科研項目感興趣
請與**香港中文大學創新科技中心**聯絡



項目資料已上載於以下網頁
Project information is also available at
www.cintec.cuhk.edu.hk/exhibition

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

