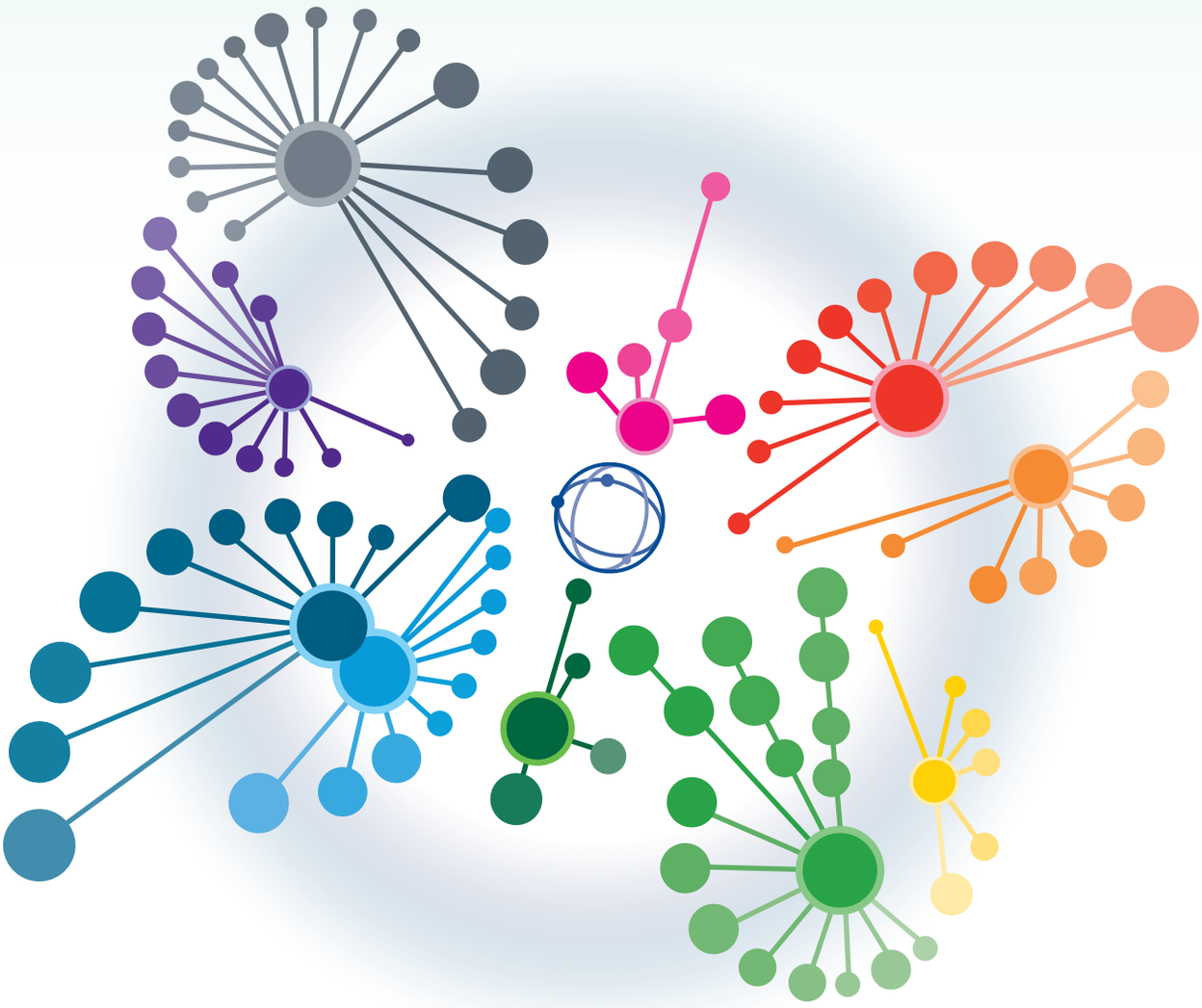

Innovation For Better Life

2012-2013

香港中文大學

The Chinese University of Hong Kong

Preface序言

Thank you for your interest in the innovations of The Chinese University of Hong Kong (CUHK). Founded in 1963, CUHK is a forward looking comprehensive research university. Like all great research universities in the world, CUHK has the mission to create, preserve and disseminate knowledge. Furthermore, we have committed ourselves not only to advancing academic research but also upholding public services.

We would like to share with you some of the latest research results through this booklet. One of our goals is to support university technology transfer to the industry. Direct commercialization of university research results is an effective way to facilitate industrial innovation, thereby contributing to the advancement of Hong Kong towards a knowledge-based economy.

This booklet provides the abstracts of some of our recent projects and detailed information can be found from the website : www.cintec.cuhk.edu.hk/exhibition

If you are interested in any of our projects, please contact us,
by phone: (852) 3943 8221 or email: enquiry@cintec.cuhk.edu.hk

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

感謝您對香港中文大學 (中大) 創意發明的興趣，中大於1963年成立，是一所具前瞻性的研究型綜合大學，與世界上其他卓越的研究型大學一樣，中大承擔起創造、保存和傳播知識的使命。我們不僅致力促進學術研究，更不遺餘力地服務社會大眾。

透過此刊物，我們希望與您分享中大最新的科研成果。中大應用科研的目標之一，是支援業界轉移大學的科技至應用層面，使大學的科研成果商品化，這是帶動業界發展創新科技的有效途徑，有助推進香港轉型為知識型經濟體。

本刊只提供中大部分最新研究項目的摘要，而有關項目的詳細資料，請瀏覽以下網址：
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如您對任何項目感興趣，歡迎您透過電話：(852) 3943 8221或
電郵：enquiry@cintec.cuhk.edu.hk與我們聯絡。

香港中文大學
創新科技中心主任
黃錦輝教授

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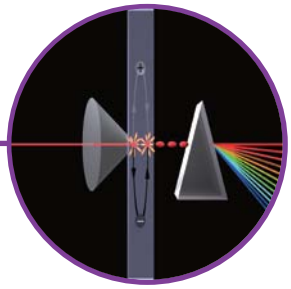

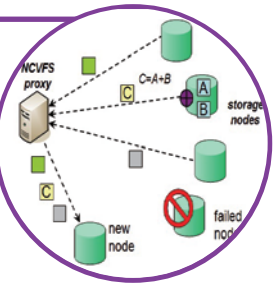

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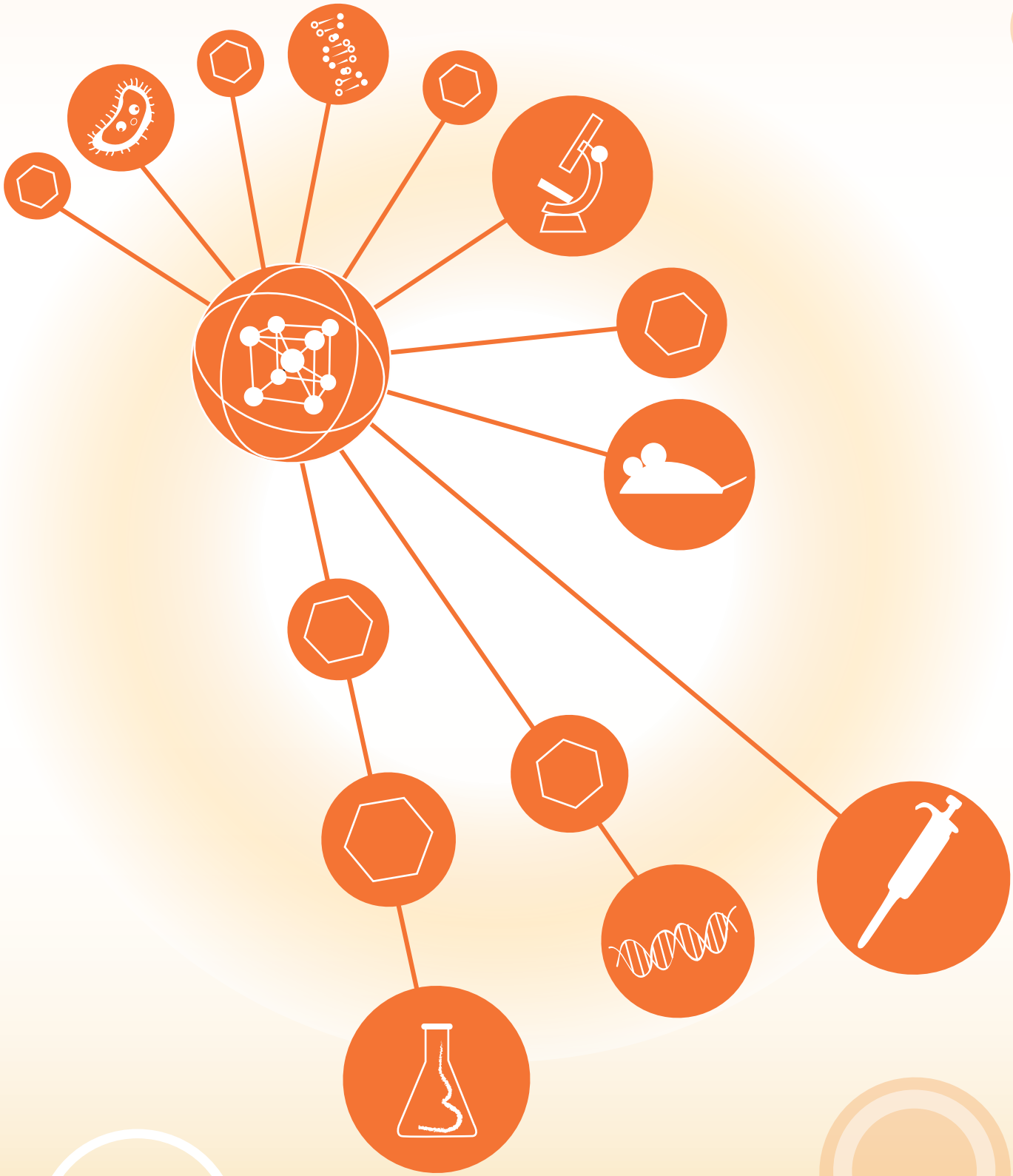

A Novel T1rho Imaging Method with Low Specific Absorption Rate for High Field MRI
一種具有低射頻能量特定吸收率的高場磁力共振T1rho成像技術

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影像及介入放射學系
袁璟教授

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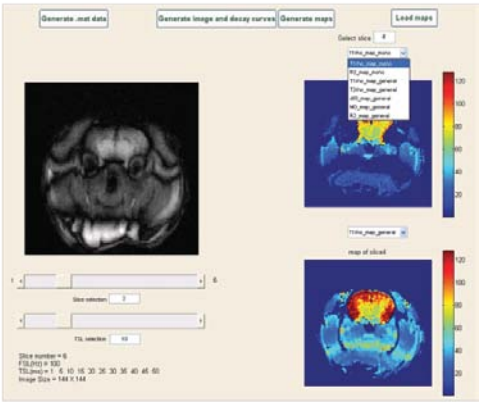
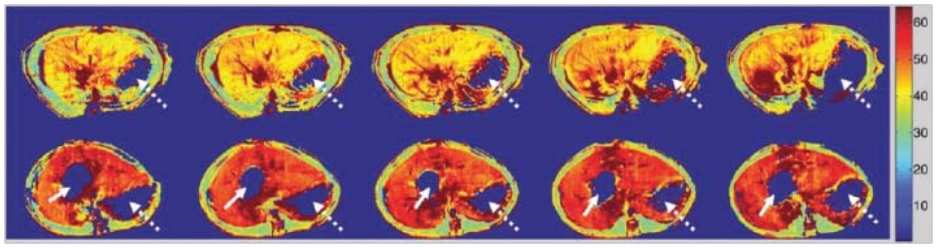


Interface of T1rho estimator software
T1rho 估算軟件的介面



T1rho maps of bile duct ligation (BDL) rat liver (lower row). The upper row is control rat.
曾受膽管結紮手術的大鼠肝臟T1rho圖像(下排)，上面一排是對照組。

T1rho relaxation is a novel contrast mechanism in MRI to investigate low frequency motional processes in tissues. It has been widely applied for various clinical applications as a sensitive biomarker for identification of early stage of many diseases. However, the introduction of a spin-lock radiofrequency (RF) pulse cluster in the T1rho imaging pulse sequence significantly increases the RF energy deposit and hence causes the potential excessive temperature rise in the object, thereby hindering the application of T1rho imaging for clinical use, especially in high resolution imaging at high magnetic field strength.

CUHK research team is developing a novel T1rho imaging method with low specific absorption rate (SAR) to eliminate the safety concern for high field T1rho imaging. This imaging method is implemented by the T1rho imaging pulse sequence design with single-transmitted or parallel transmitted RF pulses at very low spin-lock frequency, and a novel post-processing algorithm based on a modified general theoretical model for T1rho mapping. Additional to the SAR reduction, the novel T1rho imaging method will also enhance the imaging performances in terms of spatial resolution and scan time. This method will be verified and applied for identification of early disk degeneration and quantification of liver fibrosis.

基於T1rho參數的自旋弛豫，可產生一種新型的磁力共振掃描（MRI）影像對比度，反映活體生物組織中的低頻運動狀態及過程。T1rho可作為敏感的生物標記方法，應用於多種疾病的早期診斷。然而，T1rho掃描序列中必須使用一種稱為自旋鎖相（spin-lock）的射頻脈衝，令生物體在掃描過程中額外吸收射頻能量，導致體溫過度上升，因而限制了T1rho掃描技術在MRI臨床掃描中，特別是在高磁場強度，高分辨率MRI中的普及。

研究團隊正開發一種適用於高磁場強度，具有很低射頻能量特定吸收率（SAR）的新型T1rho成像技術。在這種T1rho成像的掃描序列中，研究團隊設計了單線圈激發或者多線圈並行激發的低頻spin-lock脈衝，用於產生T1rho對比度，以顯著降低SAR。與此對應，研究團隊應用了一種普適於極寬頻率範圍的理論模型計算T1rho-map。除降低SAR外，此技術亦有望於提高影像的空間分辨率以及縮短掃描時間。此技術將應用於早期椎間盤蛻變的辨識及肝臟纖維化的定量標定。

An Innovative Approach for Treatment of Bone Defect Using a Rapid-prototyped Composite Scaffold Material Incorporating an Osteopromotive Molecule

一種新穎的骨缺損治療途徑：含有促進骨形成小分子的快速成型工藝製備的複合材料支架

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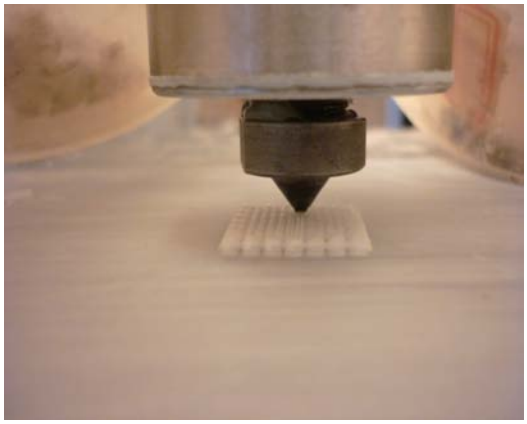
矯形外科及創傷學系
秦嶺教授

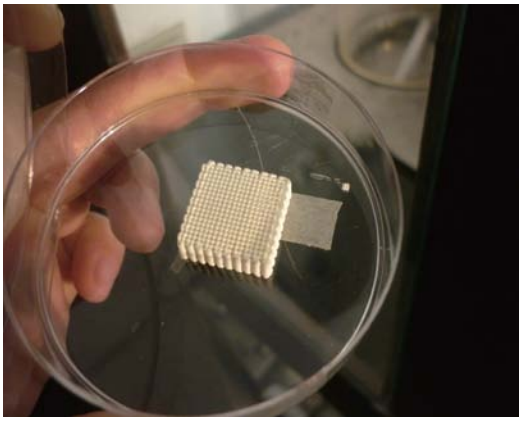
Funded by Innovation and Technology Commission
由創新科技署資助

Collaboration with Guizhou Tongjitang Pharmaceutical Company Limited; Sharpwell Technology Limited; Institute of Traditional Chinese Medicine & Natural Products; Jinan University; and Tsinghua University
合作夥伴包括貴州同濟堂藥有限公司、標準科技有限公司、暨南大學中藥及天然藥物研究所、清華大學

Rapid prototyping machine
快速成型機器



Prototyping process
成型過程



Composite Scaffold Material
複合材料支架

Bone defect repair is usually found in orthopaedic surgery due to trauma, fracture and osteonecrosis. However, failure of bone defect repair in surgical tunnel after core-decompression for removing dead bone in steroid-associated osteonecrotic lesion is still a great challenge, which induces joint collapse with poor surgical prognosis. The patho-physiology is attributed to reduction in bone-forming-capability of marrow-stem-cells after steroid treatment and lack of platform for cellular activities in surgical tunnel. The investigators have identified an osteopromotive molecule Icaritin that promote bone-forming-capability of marrow-stem-cells and rapid-prototyping technology for an innovative composite scaffold material incorporating Icaritin (PLGA/TCP/Icaritin) has also been established. The composite scaffold material is novel, stable, readily available, easily applicable and cost-effective.

修復由創傷、骨折和骨壞死導致的骨缺損是常見的骨科手術。治療激素性骨壞死的手術中，病灶死骨清除後隧道的骨缺損無法修復，仍是骨科的臨床挑戰，將導致關節塌陷和癒後不良。這與骨髓幹細胞成骨潛能降低和缺乏支持細胞活動的平台有關。中大研究團隊鑒定淫羊藿素是一種能促進幹細胞成骨潛能的小分子，並已建立含該分子的快速成型工藝製備的複合材料支架（PLGA/TCP/Icaritin）的技術。這種支架嶄新、穩定、現成，易於使用及符合成本效益。

Award : Gold medal winner at the 2011 International Federation of Inventors' Association (IFIA)
獎項 ：2011國際發明人協會聯合會(IFIA) 金獎

Website 網址 : http://www.cintec.cuhk.edu.hk/exhibition/project.php?pid=290

Tendon-Derived Stem Cell (TDSC) Sheet as an Off-the-shelf Bio-therapeutic Product for Tendon and Ligament Tissue Engineering
肌腱幹細胞(TDSC)膜作為一種即用的肌腱和韌帶組織工程生物治療產品

Prof. LUI Po Yee Pauline
Department of Orthopaedics and Traumatology

矯形外科及創傷學系
呂寶儀教授

Funded by Innovation and Technology Commission
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TDSC sheet
肌腱幹細胞膜

A TDSC cell sheet was applied on a tendon for tendon repair.
肌腱幹細胞膜應用在肌腱上

Tendon/ligament heals poorly and inefficiently after injury. The research team have used an innovative strategy to promote TDSCs to self-synthesize their own extracellular matrix to form a highly elastic and coherent cell sheet in vitro. The elastic TDSC sheet is not easily digested by trypsin. The progenitor cells in the TDSC sheet produce high amounts of collagenous and non-collagenous proteins, which can promote tendon and ligament repair.

The competitive advantages of the TDSC sheet include:
(1) Eliminating the need of using an external scaffold for cell delivery
(2) Natural extracellular matrix and preliminary fibrillar structure to guide survival, proliferation and differentiation of TDSCs and stimulate tissue repair
(3) Providing some tensile mechanical strength for bearing early mechanical load during tissue repair
(4) Promoting early tendon and tendon-bone junction healing

肌腱或韌帶受損後癒合效果不佳，現有的療法存在不足。研究團隊利用一種創新方法，體外促進肌腱幹細胞合成自身所需的胞外基質，形成一種具有高度彈性、緊密結合，且不易被胰酶消化的細胞膜。肌腱幹細胞膜中的原始細胞產生大量的膠原和非膠原蛋白，故能促進肌腱和韌帶修復。

肌腱幹細胞膜的特點包括：
(1) 無需額外支架即可遞送細胞。
(2) 天然的胞外基質和原纖維結構，有利於肌腱幹細胞存活、增殖、分化，並刺激組織修復。
(3) 於組織修復過程中早期的力學負荷，提供一定應力。
(4) 促進肌腱和肌腱 - 骨連接處的早期癒合。

Website 網址 : http://www.cintec.cuhk.edu.hk/exhibition/project.php?pid=286

A Bio-activity Guided In Vitro Pharmacokinetic Method to Improve the Quality Control of Chinese Medicines

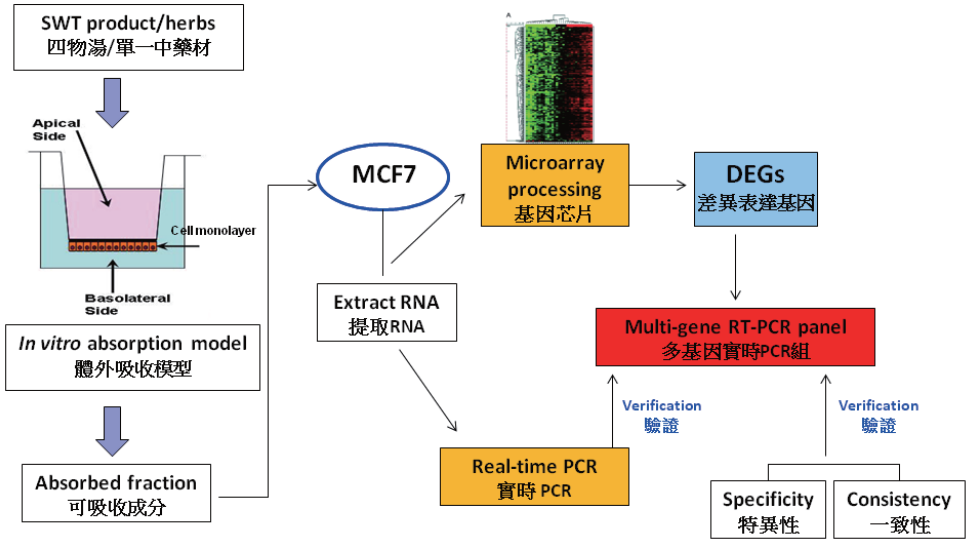
以生物活性為指導的體外藥代動力學方法在中藥產品質量控制中的應用

Prof. ZUO Zhong
School of Pharmacy

藥劑學院
左中教授

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

Collaboration with Zigen Pharmaceutical Limited; Center for Advancement of Drug Research and Evaluation, College of Pharmacy, Western University of Health Sciences, USA; National Center for Toxicological Research, U.S. Food and Drug Administration
合作夥伴包括時珍科技藥業有限公司、美國威斯頓大學藥劑學院藥物發展研究及評估中心及美國食品藥品監督管理局毒理研究中心



The gene expression profile from a designated cell line exposed to the absorbable components of SWT or its single herbs will be scanned using microarray technology. A panel of DEGs will be identified after analysis of the microarray data. Then a cost-effective Real-time PCR panel will be constructed and validated for easy sample analysis.
通過對四物湯以及其四種單一中藥材可吸收成分進行基因芯片掃描和數據分析，篩選出差顯表達的基因，完成多基因實時PCR系統的構建並進行此系統的驗證。

Selected chemical markers are unlikely to represent the overall bioactivity of a **T**raditional **C**hinese **M**edicine (TCM) product since there are many unknown components unique to the product which could be absorbed and produce other pharmacologic effects. Thus, the availability of certain biological activity marker unique to a specific TCM product will be most useful to serve as identity marker/fingerprint for the product. We propose to investigate the applicability of a panel of special **D**ifferentially **E**xpressed **G**enes (DEGs) developed from microarray processing and analysis, to serve as unique fingerprint for **S**i-**W**u-**T**ang (SWT) products as a pilot study. Such fingerprint not only will be meaningful (representing composite in vivo bioacitvity) but also useful for quality control during the manufacturing process as well as serving as a diagnostic feature for the product in distinguishing it from counterfeit products. Apart from testing the specificity of SWT products and its single herb components, the new approach can potentially be applied to other TCM products for quality control and “identity testing”.

中藥產品的質量控制現時通常採用相關化學標記物，但它們未能代表中藥的全部活性，效果並不理想。只有與產品生物活性相關的特異性標記成分，才可爲該產品提供特異性的指紋圖譜。本項目旨在利用生物芯片的技術鑒定出一套四物湯產品的差顯表達基因，以其作爲四物湯特異性指紋圖譜。該指紋圖譜可代表四物湯產品的整體功能，有實用意義，並可用於產品的質量控制和區分僞劣產品。本項目所用的方法，不但可以檢測四物湯和四種單一中藥材的特異性，而且可用於其他中藥的質量控制和特徵性檢測。

Website 網址 : http://www.cintec.cuhk.edu.hk/exhibition/project.php?pid=291

Application of Novel Isothermal Molecular Authentication Technique for On-site Quality Control of Chinese Medicinal Material
利用新型恆溫分子鑒定技術進行實地中藥材質量控制

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中醫中藥研究所
邵鵬柱教授

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

Collaboration with Shenzhen Institute for Drug Control
合作夥伴為深圳市藥品檢驗所

Prof. SHAW Pang Chui (left 4), Prof. LAU Bik San Clara (Left 5) and their research team
邵鵬柱教授(左四)、劉碧珊教授(左五)及研究團隊

The novel isothermal molecular authentication technique developed by CUHK research team involves three major procedures, namely on-site DNA extraction, amplification and detection. Ten selected Chinese medicinal materials from animal, plant and fungal samples will be tested. DNA is extracted from Chinese medicinal materials on-site using our handy extraction tools. Selected DNA region is amplified using specific primers by isothermal amplification techniques. The identification results are observed by naked-eyes. Our developing technique is superior to the conventional molecular authentication methods in several aspects and facilitates quality control of Chinese medicine.

(1) Higher efficiency: amplification time is 50% or less than conventional amplification method, a few copies of DNA is sufficient.
(2) Increased accuracy: the use of internal control primers reduces false negative results.
(3) Easy detection: simple detection of results by naked-eye observation.
(4) Lower cost: no need to purchase costly equipment such as thermal cycler and gel electrophoresis system.
(5) Better accessibility: no need of sophisticated laboratory equipment so that the authentication process can be done in places where laboratory equipment is limited.

研究團隊開發的新型恆溫分子鑒定技術，包括三個主要步驟，並以十種動物、植物和真菌類中藥材作試驗。他們利用簡單方便的DNA提取工具在現場提取中藥材的DNA，再利用特異性引物並且以恆溫DNA擴增技術（LAMP、HDA及RPA)擴增所選的DNA片段，透過肉眼觀察可得知鑒定結果。新技術較傳統的分子鑒定方法更優勝，大大方便了中藥的質量控制。

(1) 更高效率: 擴增所需時間比常規擴增方法少50%或以上，並只需少量DNA拷貝。
(2) 更高準確度 : 利用特別的內參照引物減少假陰性結果。
(3) 更容易檢測 : 透過肉眼觀察得知檢測結果。
(4) 降低成本 : 無需購買昂貴的儀器設備，如熱循環儀和凝膠電泳系統。
(5) 更高的可用性 : 不需先進的實驗室設備，使鑒定過程可在實驗室設備有限的地方進行。

Website 網址 : http://www.cintec.cuhk.edu.hk/exhibition/project.php?pid=289

A Novel Approach for the Non-invasive Diagnosis of Colorectal Cancer
嶄新大腸癌及癌前瘜肉的無創檢測法

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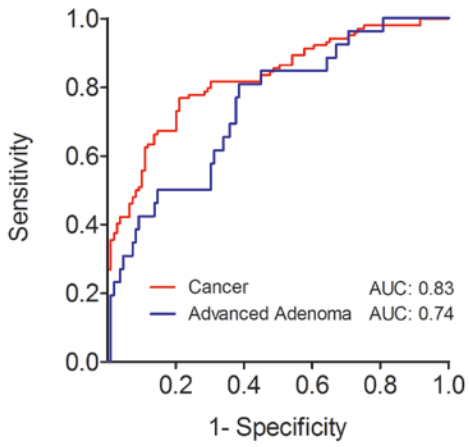
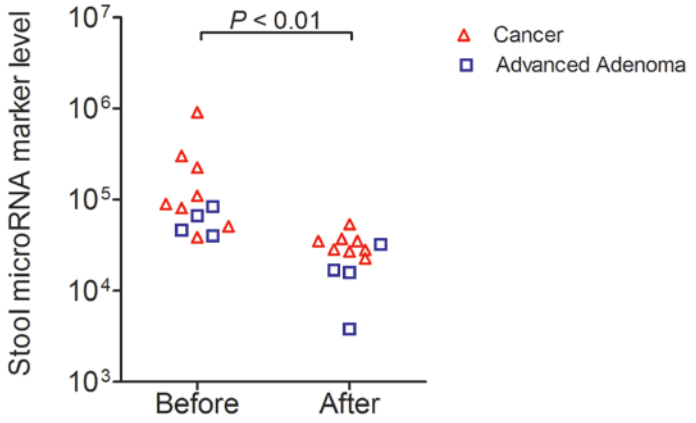


The sensitivity and specificity of the detection of colorectal cancer and advanced adenoma
檢測法對大腸癌及癌前瘜肉的敏感性與特異性



Level of stool-based microRNA marker is lower after the removal of colorectal cancer or advanced adenoma
患者除去大腸癌或晚期腺瘤之後，在大便中檢測到的微小核糖核酸含量較之前少。

Colorectal Cancer (CRC) is the third most common cancer worldwide and the second most common cancer in Asia Pacific region. CRC incidence is increasing rapidly in Hong Kong. Due to a lack of specific symptom of early stage or precancerous stage of CRC, the disease is often diagnosed at advanced stages which are difficult to cure. Screening asymptomatic patients allows the detection and removal of early stage lesion. In this project, we established an effective screening test to identify patient with CRC or precancerous adenoma.

Colonoscopy is the current gold standard for diagnosing CRC. However, its invasive nature, the cost of equipment and the demand for manpower have hampered the wide application of this procedure. Fecal occult blood test that detects the presence of blood in stool is a commonly used screening test, but this method has a low sensitivity and many CRC patients can be missed. Here we established a non-invasive, economical and accurate method of detecting colorectal cancer and its precancerous adenoma. Since colonocytes exfoliate consistently and shed into the lumen, molecular alterations found in tumors thus can be detected in stool. Through detecting the level of specific microRNAs in stool, this technique can discriminate patients with colorectal cancer or adenoma from healthy individuals.

大腸癌是全球第三常見癌症，亞太區內第二大常見癌症，其發病率在本港不斷上升。由於早期大腸癌及癌前瘜肉沒有明顯病徵，一般到晚期才被發現。篩查沒有明顯病徵人士有助有效檢測和切除早期癌症或癌前瘜肉。

目前大腸鏡是最可靠的診斷方法，但由於此方法具入侵性，且對人手和器材需求較大，它未被廣泛應用。大便隱血測試是現時最常用的篩查方法，然而它的敏感性低，部份患者可能被漏診。有見及此，中大研究團隊正開拓一套無創、經濟、準確度高的大腸癌及瘜肉檢測方法。由於腸道細胞不斷脫落，大腸癌細胞內的分子變異能在大便中檢測到。檢測大便中特定微小核糖核酸含量能有效辨認大腸癌及瘜肉患者。

Website 網址 : http://www.cintec.cuhk.edu.hk/exhibition/project.php?pid=288

Structure-based Drug Design Targeting Helicobacter Pylori
以蛋白質三維結構為基礎研發針對幽門螺旋桿菌的標靶藥物

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Collaboration with King's College London and University of Hong Kong
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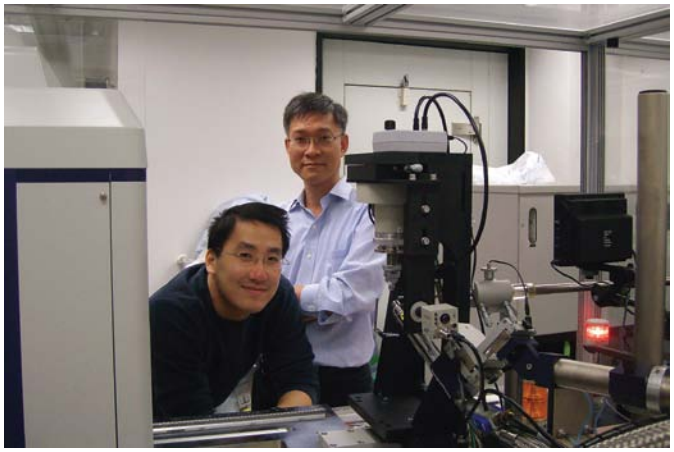
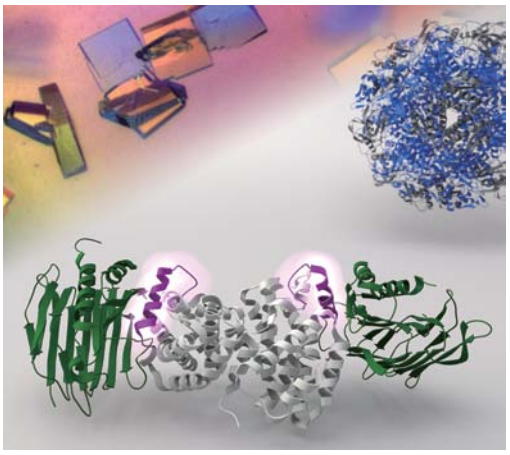


Prof. WONG Kam Bo (right) and his graduate student, Ivan FONG, with the X-ray diffractometer
黃錦波教授(右)及其研究生方宇亨攝於X射線衍射儀前



X-ray crystallography reveals the molecular structure of the helper proteins UreF-UreH that are responsible for delivering nickel ions to the urease
利用X射線晶體學技術呈現負責運送鎳離子到尿素酶的輔助蛋白UreF-UreH的分子結構

H. pylori damages the mucous coating of the gut, allowing stomach acid to eat away the sensitive organ lining, causing ulcers and carcinoma. Half of the population worldwide is infected with this bacterium. Key to the bacterium's survival in the acid bath in the human stomach is its use of an enzyme called urease, which catalyzes the breakdown of urea to neutralize gastric acid. Unlike most other enzymes, urease does not work immediately after being produced by the bacterium. Two nickel ions need to be delivered to activate it.

Using X-ray crystallography, our team has revealed the molecular structures of three helper proteins UreF, UreH and UreG and how they hook up collectively to assemble a molecular machine that delivers nickel ions to urease. More importantly, we showed that disrupting the formation of the UreF-UreH-UreG complex can inhibit the synthesis of active urease. As active urease is the key to the survival of H. pylori, we aim to design new drugs that target the UreF-UreH-UreG complex, which will be a novel and viable strategy to eradicate the pathogen.

幽門螺旋桿菌會損害腸道黏膜，導致消化性潰瘍甚至胃癌。現時全球已有一半人口受感染。幽門螺旋桿菌能在胃酸中生存，是由於它可生產尿素酶以分解在胃內的尿素，使之釋放出氨，從而中和胃酸。然而，與其他大多數酶不同的是，尿素酶由病菌產生後，不可直接發揮其作用；它需要接收到兩個鎳離子以後，才可轉化為有活性的酶。

利用X射線晶體衍射技術，中大研究團隊發現了三個尿素酶輔助蛋白UreF、UreH和UreG如何自行集結成一個分子機器，將鎳離子運送到尿素酶，並證實了破壞UreF-UreH-UreG分子機器的形成能抑制活性尿素酶的合成。由於活性的尿素酶是幽門螺旋桿菌賴以生存的關鍵，我們將以UreF-UreH-UreG分子結構為標靶而開發的藥物，發展出根除致病菌的新策略。

Awards：The result of our research has been published in the *Journal of Biological Chemistry* and selected as "Paper of the Week".
獎項：研究成果已在*Journal of Biological Chemistry*刊登並被評選為「本周最佳論文」。

Website 網址: http://www.cintec.cuhk.edu.hk/exhibition/project.php?pid=287

CUHK Research Solves Long-standing Mystery of Human Reproduction Unveiling New Page for Diagnosis of Infertility

中大破解人類胚胎成孕之謎 開展診斷不孕症的新路向

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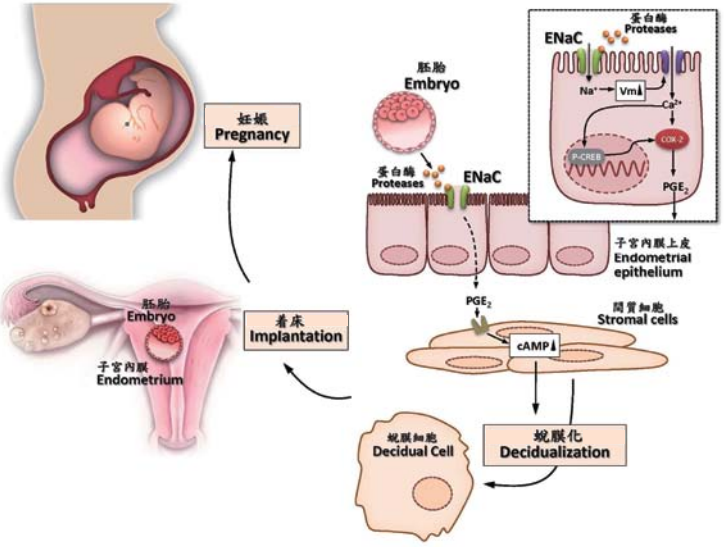

Working model of ENaC in embryo implantation
鈉離子通道在胚胎著床中的作用示意圖

The attachment of the embryo to uterine epithelium followed by the so-called decidualization process in the stroma beneath the epithelium is a prerequisite for successful pregnancy. However, embryo implantation remains a poorly understood process. In particular, it remains unclear how signals, either physical or chemical, from the embryo at the uterine surface are converted into chemical signals leading to decidualization in the stromal cells that do not have direct contact with the embryo.

CUHK research team has discovered the important role of the **E**pithelial **N**a+ **C**hannel (ENaC) in embryo implantation. ENaC expressed in the uterine epithelial cells can be activated by protease released by the implanting embryo, which in turn triggers a sequence of events that lead to enhanced production and release of prostaglandin E2 (PGE2), a key factor involved in implantation. Interestingly, The team also found that uterine ENaC expression levels prior to **I**n **V**itro **F**ertilization (IVF) treatment are significantly lower in women with implantation failure as compared to those with successful pregnancy.

The findings do not only solve one of the long-standing mysteries surrounding human reproduction and shed new light on the cause of miscarriage and low successful rate in IVF, but also provide a novel method for diagnosis of infertility and target for contraception.

胚胎附著子宮內膜後，引起的滋養層細胞分化的「蛻膜化」過程是成功懷孕的先決條件。然而，胚胎最初只接觸到子宮內膜表層的上皮細胞，而來自胚胎的物理或化學的信號如何傳遞到子宮內膜下面的滋養層細胞，從而引發「蛻膜化」，則一直成謎。

中大研究團隊發現，子宮內膜的上皮細胞鈉離子通道在胚胎著床（或胚胎植入子宮）過程中有不可或缺的作用。鈉離子通道可以被胚胎釋放的蛋白酶激活，讓上皮細胞釋放出可以誘導滋養層細胞『蛻膜化』的重要分子——前列腺素E2（PGE2）。研究團隊又發現曾接受輔助生殖技術卻未能成孕的婦女，其子宮內膜的上皮細胞鈉通道的表達水平，明顯低於通過此技術成功受孕的婦女。

這些發現不但揭開了長期以來關於胚胎植入子宮的啟動過程的謎團，還闡述了流產或試管嬰兒成功率低下的一個重要原因，亦為診斷不孕及進行避孕提供了新的方法。

Honor : The research was published in the latest issue of *Nature Medicine*, one of the most influential high-impact journals in the medical field worldwide.
榮譽 ：這項研究在國際醫學界其中一份最具影響力的期刊《自然醫學》上刊登。

Website 網址 : http://www.cintec.cuhk.edu.hk/exhibition/project.php?pid=302

Using New XL Probe to Assess Liver Disease in Obese Patients
引入加大碼探頭為肥胖人士進行無創肝纖維化檢查

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Collaboration with University of Bordeaux, France
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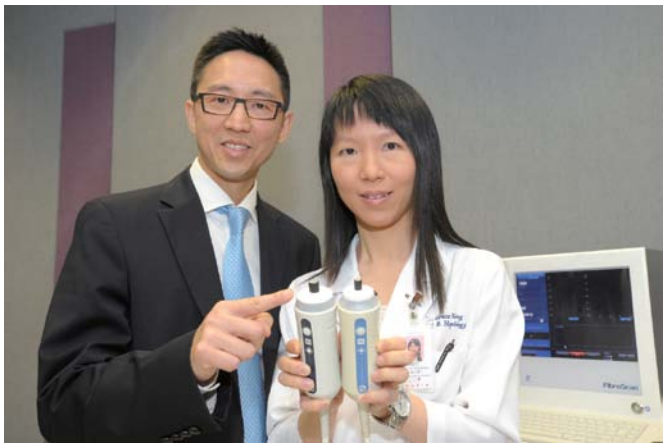
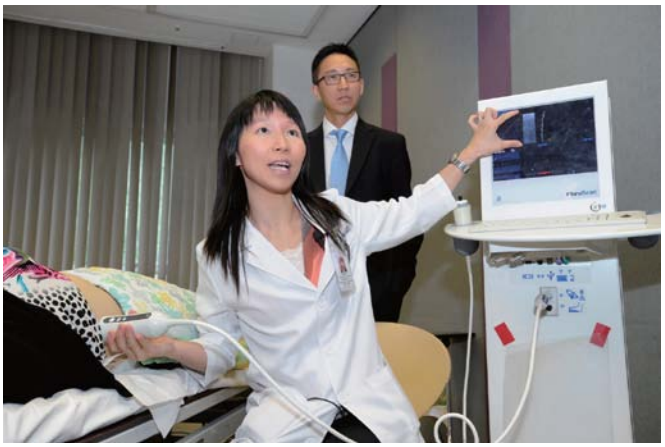


Prof. CHAN Lik Yuen Henry (left) and Prof. WONG Lai Hung Grace (right) show the new XL probe (left) and the regular M probe (right) of Fibroscan.
陳力元教授 (左) 與黃麗虹教授 (右) 展示無創肝纖維化掃瞄器的加大碼探頭 (左方) 和正常探頭 (右方)。



Prof. WONG Lai Hung Grace (front) demonstrates different imaging results made by the new XL probe and the M probe of Fibroscan on an obese patient.
黃麗虹教授(前)示範兩種探頭在肥胖病人身上量度肝纖維化程度的效果。

Obesity is closely associated with liver diseases. It is very important to assess the liver condition of obese people because up to 80% of them may have fatty liver, which may lead to cirrhosis and liver cancer. CUHK and University of Bordeaux in France has recently conducted a collaborative research to pioneer the use of the new XL Probe to assess liver fibrosis among obese subjects with a deeper penetrance of measurement, and which can also enhance the performance of Fibroscan.

Over the last few years, liver stiffness measurement by Fibroscan, an accurate, reproducible and non-invasive test using ultrasound Doppler technique, has been developed to detect liver fibrosis and cirrhosis and is commonly used in Hong Kong. Fibroscan fails to give reliable results in about 30% of obese patients due to their thick subcutaneous fat layer. In view of this, a new XL probe was developed for liver stiffness measurement in obese patients. CUHK recommends the use of the new XL probe for liver stiffness measurements so that patients can enjoy a safer and more accurate assessment of liver condition.

肥胖與肝臟相關的疾病有密切關係。據資料顯示，八成肥胖人士同時患有脂肪肝，嚴重者可能演變成肝纖維化及肝硬化。因此，準確檢測肥胖人士的肝臟纖維化程度相當重要。香港中文大學(中大)與法國波爾多大學合作進行突破性研究，率先引入加大碼探頭（XLprobe）為肥胖病人進行肝纖維化檢查，並證實能有效深入肥胖人士的皮下脂肪層，準確量度其肝纖維化的程度。

近年，肝纖維掃瞄器已發展為量度肝纖維化和肝硬化程度最準確而無創傷的檢查方法。肝纖維掃瞄器就是藉著切變波的原理去量度肝臟的軟硬程度，然而，由於肥胖人士的皮下脂肪層較厚，約三分一患者在檢查時不能顯示實際數據。有見及此，專為肥胖人士檢測肝臟軟硬程度的加大碼探頭便應運而生。中大建議若未能使用正常探頭檢測肝纖維化程度的肥胖人士，應選用最新加大碼探頭作檢查。

Website 網址 : http://www.cintec.cuhk.edu.hk/exhibition/project.php?pid=303

Sonoanatomy & Simulation for Ultrasound-guided Regional Anesthesia
超聲引導局部麻醉解剖及訓練系統

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Department of Computer Science and Engineering
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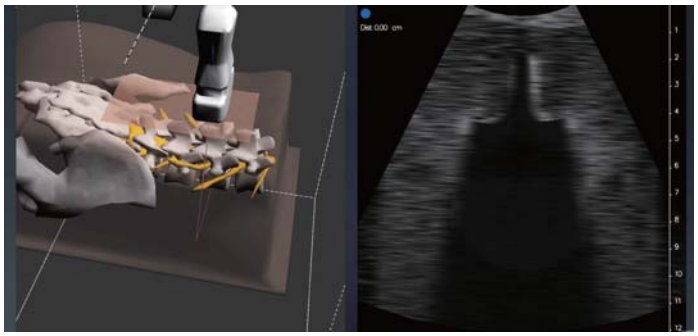
A simulated para-sagittal scan over spine
模擬脊柱超聲段矢狀面掃描



A simulated ultrasound cross-section over spine
模擬脊柱超聲橫切面掃描

Regional anesthesia is the process of injecting local anesthetics into the body for nerve block in order to offer operative pain relief. Conventional regional anesthetic techniques that are dependent on anatomical landmarks (such as bone) of skin surface are associated with a relatively high failure rate (up to 20%). In the recent decade, the use of ultrasound-guided regional anesthesia is growing rapidly. The success of these procedures is dependent on the correct identification of the neural structures and the surrounding soft tissues in the ultrasound scan. Due to the importance and the complexity of nervous system, it is essential for an anesthetist to possess a firm knowledge of ultrasound-imaged anatomy (sonoanatomy) before he or she operates on a patient.

In this project, we propose to build a virtual sonoanatomy and simulation system to facilitate physicians in learning ultrasound guided regional anesthesia. One of the main objectives of this proposed research is to develop state-of-the-art virtual environment that facilitates interactive sonoanatomy learning. The research issues to be addressed include image segmentation, 3D anatomical model reconstruction, data fusion of multiple modalities data, realistic rendering and deformation, interactive navigation and visualization as well as multi-sensory human-computer interaction. This training system will provide an actual view of ultrasound images, in real-time, while performing an examination on a life-like mannequin. This is a cost-effective approach to provide standardized clinical education, training and accelerated learning. The proposed system is anticipated to strengthen and compensate existing anesthetic training.

局部麻醉是把麻醉劑注射入人體神經，以緩解手術後疼痛的過程。傳統的局部麻醉技術是依賴於皮膚表面的解剖標誌（如骨骼），失敗率相對較高（高達20%）。近十年來，使用超聲引導下的局部麻醉增長迅速。成功關鍵在於用超聲波掃描以正確識別神經結構和周圍的軟組織。由於神經系統十分重要和複雜，因此麻醉師在對病人進行局部麻醉前，必須具備超聲影像解剖的一定知識。

在這個項目中，我們提出建立一個虛擬超聲影像解剖和仿真系統，以促進超聲引導局部麻醉師的學習。這項研究的主要目標之一是發展最先進的虛擬環境，有利於學習互動超聲影像解剖。研究需要解決的問題包括圖像分割、重建多種方式數據的三維解剖模型、數據融合、逼真的渲染和變形、互動式導航和可視化，以及多感官的人機互動。這個培訓體系提供了一個實時且逼真的超聲圖像作局部麻醉訓練。這是一個具有成本效益的方式，提供標準化的臨床教育、培訓和加速學習。預期本系統能加強和彌補現有的麻醉培訓。

Website 網址 : http://www.cintec.cuhk.edu.hk/exhibition/project.php?pid=285

環境和綠色科技
Environmental & Green Technologies

Development of a High-efficiency Integrated PS-InSAR Platform and Early-warning System
高效PS-InSAR形變監測與預警集成平台研發

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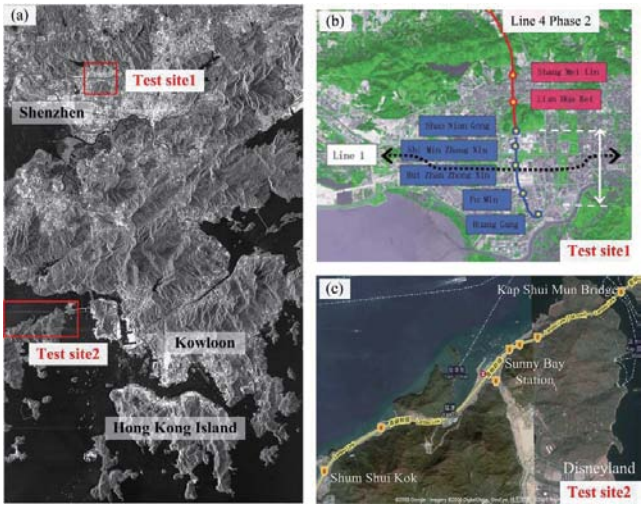
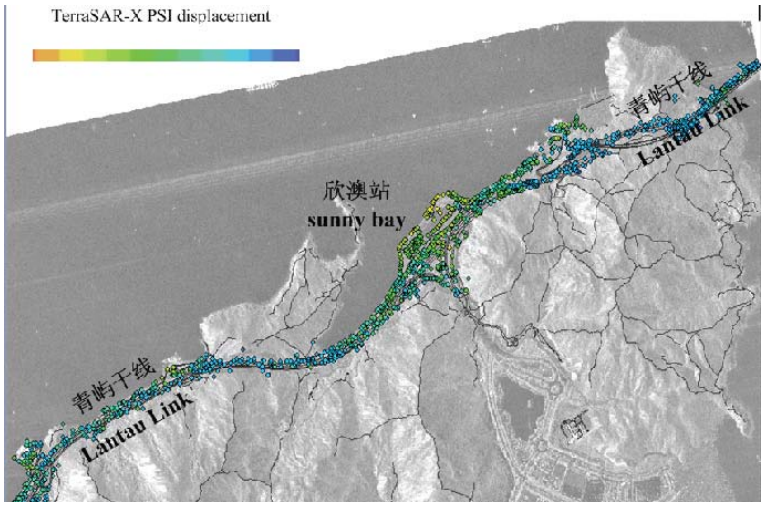


Locations of the test sites using TerraSAR-X data
應用TerraSAR-X衛星數據作分析的試點區域



Linear deformation rate of line-of-sight derived from 15 scenes of TerraSAR-X data over the Section from Kap Shui Mun Bridge to Shum Shui Kok of Hong Kong Lantau Link
利用TerraSAR-X衛星數據，在汲水門大橋至深水角的香港青嶼幹線上15個地點，勾勒出該路段的線性變形率

Land subsidence in the reclaimed land; landslide during or after rainstorm have become problems in Hong Kong. Monitoring the land deformation efficiently and sending out a warning in time, can alert people to flee and prevent damage to lives and properties. The objective of this project is to provide early-warning service before the occurrence of the above geo-hazards based on high accurate, large-scale land subsidence derived by **PS-InSAR** (Persistent Scatterers – Interferometric Synthetic Aperture Radar) technologies. We plan to develop an efficient PS-InSAR processing platform and early-warning system. The platform will offer ground subsidence surveillance of Hong Kong and **P**earl **R**iver **D**elta (PRD), which is significant for geo-hazards early-warning & intelligent decision, providing technical solutions for satellite earth observation, software development and value-added product dissemination in Hong Kong. With the aid of deformation models development and integration, the platform is capable of providing deformation and early-warning information for city groups, high-speed transportation lines as well as instable slopes which cannot be found in any of the software tools in the market.

填海土地出現沉降、暴雨期間或之後發生山泥傾瀉，都是香港面對的問題。有效地監測地表形變，及早發出警報，提醒人及時走避，能減低人命傷亡及財產的損失。本項目目的是要利用PS-InSAR(持續散射體干涉合成孔徑雷達)準確度高、能監測大範圍地表形變的技術來提供以上一類地質災害預警服務。我們計劃開發一個高效的PS-InSAR處理平台和預警系統，將為香港及珠江三角洲提供基於雷達遙感的地表形變信息，有助於地質災害預警和輔助決策，為香港在衛星對地觀測、軟體研發及其增值服務提供相關技術與解決方案。通過開發和集成形變模型，平台具有大範圍區域監測能力，可為監測城市群地表沉降、高速交通網絡形變和危險斜坡提供高效分析工具，而現時市場上並無具有上述監測功能的軟體平台。

Website 網址：http://www.cintec.cuhk.edu.hk/exhibition/project.php?pid=281

Development of Key Technologies and Demonstration Systems for Guangdong, Hong Kong and Macau Water Quality and Quantity Remote Sensing Monitoring
粵港澳水質水量遙感監測系統關鍵技術及示範

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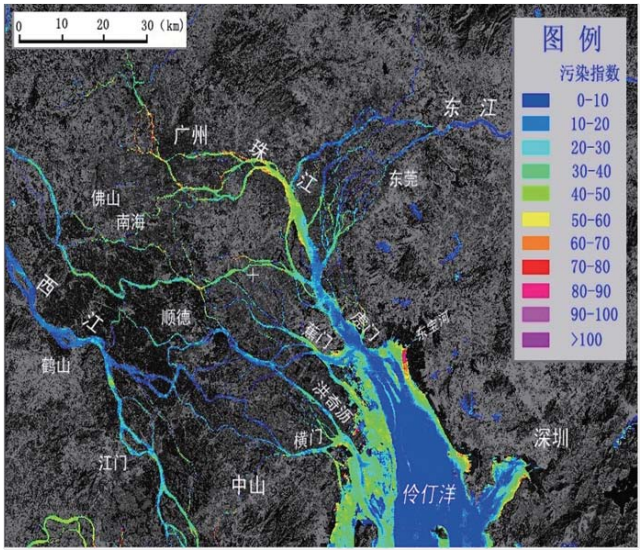
Collaboration with Water Supplies Department, HKSAR; Environmental Protection Department, HKSAR ;
ESRI China (Hong Kong) Ltd.; Cartography and Cadastre Bureau, Macau SAR ;
Environmental Protection Bureau, Macau SAR; National Remote Sensing Centre; GeoBeans;
Sun Yat-Sen University ; University of Macau; The Second Institute of Oceanography
合作夥伴包括香港水務署、香港環境保護署、ESRI 中國 (香港)有限公司、澳門地圖繪製暨地藉局、澳門環境保護局、
國家遙感中心、北京中遙地網信息技術有限公司、中山大學、澳門大學、國家海洋局第二海洋研究所



Monitoring of the water pollution in PRD area
珠江三角洲水環境污染監測圖

This project will study the implementation of operational remote sensing monitoring of Guangdong, Hong Kong and Macau surface water quality and quantity and coastal sea water quality by remote sensing technology, which will acquire important information like the spatial distribution of major water quality parameter and the location of pollutant source regularly. Together with routine monitoring, it can significantly enhance water monitoring efficiency of the region; thereby help preserving water resources in the region, ensuring sustainable and stable economic and social development by providing important supporting information.

This project will develop key technologies for inland surface (including Dong Jiang River) and coastal water quality and quantity remote sensing monitoring, establish a demonstration system for the Pearl River Delta water resources monitoring. The products will be the foundation of future operational system.

Implementation of the project not only reduce resources used in water samplings and quality analyses, but also enhance the capability of the governments of Guangdong, Hong Kong and Macau in the water quality monitoring for the entire region and rapid responses to various pollution issues. The monitoring method and program of water remote sensing developed in this project can be promoted to other provinces.

本項目將研究利用衛星遙感技術對粵港澳地表水質水量和近岸海洋水質實施業務化遙感監測，定期獲取主要水質參數空間分佈和污染源空間位置等重要資訊。與常規監測相配合，將可使該地區水環境監測的效能產生跨越式的提升，為該地區水環境保護，以及經濟和社會持續、穩定發展，提供重要的資訊支援。

項目將研發粵港澳內陸水源(包括東江支流)和近岸海洋水質、水量遙感監測及其實際應用的關鍵技術，建立粵港澳水質水量遙感監測示範系統，作為粵港澳水質水量遙感監測的業務化基礎。

項目的實施將可減少區域水環境監測的水面採樣分析數量，從而節約大量的資金，並加強粵港澳即時水質監測，加快應對各種水質污染問題。本項目建立的水環境遙感監測方法和程式亦可推廣至其他省份。

Website 網址：http://www.cintec.cuhk.edu.hk/exhibition/project.php?pid=297

Development of a Fine Forecasting System for Coastal Ocean Dynamic Environment
近岸海域海洋動力環境精細化預報系統的開發

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

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

Collaboration with Hong Kong Observatory; Civil Engineering and Development Department,HKSAR; Laurel Technologies Company Limited; Tianjing Haihua Technology Development Center; and The First Institute of Oceanography, State Oceanic Administration
合作夥伴包括香港天文台、土木工程拓展署、香港勞雷工業有限公司、天津市海華技術開發中心及國家海洋局第一海洋研究所

Prof. PAN (right) was leading project team members in collecting field data of marine parameters during a sea area investigation near Hong Kong.
潘家禕教授（右一）領導研究小組成員現場採集海洋環境參數，調查香港的近岸海域環境。

It is of great significance in coastal engineering, marine tourism and sports, marine aquaculture, offshore oil and gas exploitation, marine environmental protection, and coastal disaster prevention to precisely predict coastal ocean dynamic parameters of wave and tidal current. However, there is no effective and practical software system to implement precise forecasts of such marine dynamic parameters for the Hong Kong coastal waters.

The project aims at developing a marine environmental service system based on numerical prediction technology in the nesting domain frame for precise prediction of the coastal dynamic environmental parameters. The project will (1) develop a marine multi-parameter forecasting system for storm surge, tidal current, waves. The data include: tidal currents, significant wave height, dominant wave direction, wave period, wave spectrum, and storm surge sea level; (2) finish an integrated forecasting software under **G**eographic **I**nformation **S**ystem (GIS) platform.

The system developed in this project will support the government operational services. For instance, Hong Kong observatory will use the system for its marine environment forecasting services to the publics. The Civil Engineering and Development Department will also use the system for the coastal water modeling supporting the port and near-shore engineering structure constructions.

近岸海洋動力環境參數如潮流和海浪的精準預測對海岸工程、海洋旅游、海上體育活動、海洋養殖業、海上油氣資源開發、海洋環境保護、沿岸災害防護具有重大意義。香港尚無有效的海浪與潮流的預報系統，因而需求甚大。

本項目擬建立以潮流和海浪數值預報為基礎的海洋環境保障服務系統，通過多重嵌套技術，實現近岸地區海洋動力環境要素的精細化預報。本項目將 (1) 完成風暴潮、海浪、潮汐與潮流多參數一體化數值預報系統，預報數據包括：海洋潮流場、有效波高、主波向、主波周期、波譜、風暴潮水位 (2) 完成基於地理資訊系統平台的海洋環境多參數一體化集成軟件系統。

本項目的成果可應用於政府部門，如天文台將透過該系統為香港近岸的海況特別是災害性海況預報；香港土木工程署則可將該系統輸出的海浪參數，用於海洋工程模型中，以支援港口及近岸工

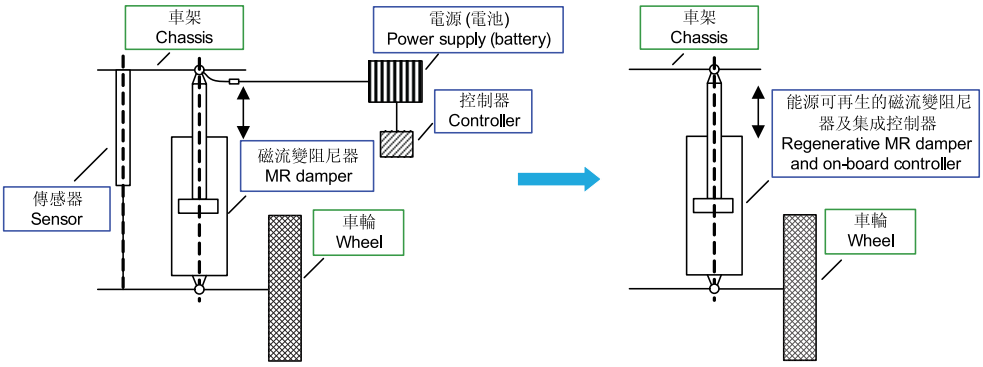
Website 網址：http://www.cintec.cuhk.edu.hk/exhibition/project.php?pid=298

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

Prof. LIAO Wei Hsin
Dr. CHEN Chao
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

Preliminary application to motorcycle suspensions
初步應用於摩托車的懸架系統



(a) based on current MR damper
基於當前的磁流變阻尼器

(b) based on our regenerative MR damper
基於我們提出的能源可再生磁流變阻尼器

Configurations of vehicle suspensions
車輛的懸架系統

Dampers are an energy dissipation device to reduce the vehicle body vibration and improve the ride comfort. During the everyday use of vehicles, a large amount of energy is wasted due to the energy dissipation by dampers under the road irregularities, accelerating, cornering and braking processes. To reduce the energy waste and get rid of extra batteries for current MR damper systems, CUHK research team propose regenerative MR dampers for vehicle suspensions, which have self-contained power regeneration ability. The wasted vibration energy can be converted into useful electrical energy.

The proposed damper will promote both renewable energy and vehicle performances. It will increase the overall energy efficiency of the vehicle, and reduce the fuel consumption and emissions. In addition, the performances of the vehicle suspensions will be improved, with other advantages of size and weight reduction, higher reliability and less maintenance. Our technology will benefit electric and hybrid electric vehicles as well, as it could charge the batteries during vehicle running and increase the run time of vehicle battery. This technology is especially beneficial to densely populated cities, such as Hong Kong, as well as rough roads in Mainland China.

阻尼器是一種安裝於車輛以減少車體振動、提高乘坐舒適度的耗能設備。車輛在日常使用時，在凹凸不平的路面，以及在車輛加速、轉彎和制動過程中，阻尼器消耗很多能量。市面上現有的磁流變阻尼器需要額外的電池驅動，為了減少能源浪費及使用，我們提出「用於車輛懸架的可再生能源磁流變阻尼器」，它具有自行再生能源的能力，可以將浪費的振動能量，轉化為有用的電能。

我們提出的磁流變阻尼器將促進再生能源和提升車輛的性能，加強車輛的整體能源效益，減少耗用燃油及排放廢氣。此外，我們的磁流變阻尼器擁有體積較小、重量較輕、可靠性較高及保養需求較少的優點，車輛懸架的表現因而得到改善。我們的技術將有利於電動和混合動力電動汽車，因為它可在車輛運作時充電，增加車輛電池的運用時間。這項技術尤其適用於人口稠密的城市如香港，以及中國內地崎嶇不平的路面。

Website 網址：http://www.cintec.cuhk.edu.hk/exhibition/project.php?pid=304

信息和通訊科技
Information & Communication Technologies

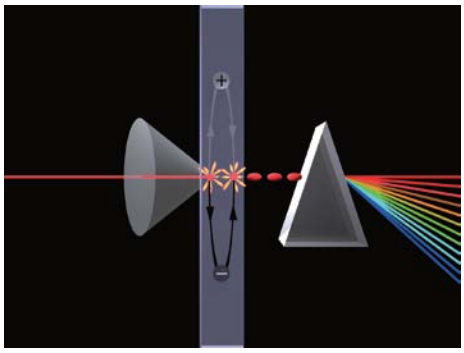
Ultrafast Optical Modulation for Optical Communications
用於光通訊的超快光調制技術

Prof. LIU Renbao
Department of Physics

物理系
劉仁保教授

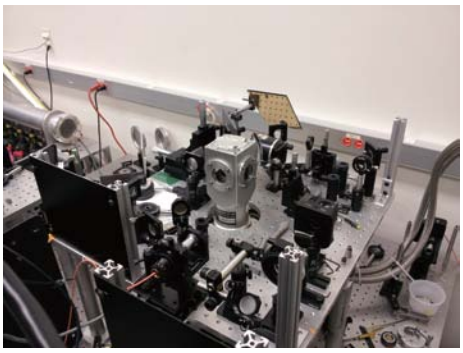
Collaboration with PhD student Mr. Ben Zaks and Prof. Mark Sherwin from University of California, Santa Barbara (UCSB)
合作夥伴為加州大學聖芭芭拉分校的博士研究生Ben Zaks及教授Mark Sherwin

Funded by Research Grants Council, Hong Kong University Grants Committee
由香港大學教育資助委員會研究資助局資助



Light modulation and optical comb (illustration by Shaowen Chen)
光調制和光梳（陳少文繪）

The Free Electron Laser at UCSB, the source of the THz light used in the experiments (photo by Ben Zaks)
加州大學聖芭芭拉分校的自由電子激光器提供實驗所需的太赫茲光



Experimental setup (photo by Ben Zaks)
實驗裝置

Thanks to the Nobel Prize winning invention of optical fibers by Prof. Charles Kao, former Vice-Chancellor of CUHK, optical communication has been the backbone of information technology. Prof. Liu Renbao's research team and his experimental collaborators have also made a key breakthrough toward ultrahigh-speed optical communication. The maximum rate of data transfer in an optical communications network is directly linked to the maximum rate at which light can be modulated. The research has demonstrated optical modulation of light at THz speed (TeraHertz, 1,000,000,000,000 times per second), a rate which is 100 times faster than current modulation techniques. This process could allow the realization of data transfer at TB/s.

With such high-speed communication one would be able to transfer a whole quadruple-layer blue-ray disc or an entire electronic library of one million books in a second, potentially revolutionizing the world's approach to information and information availability. However, the current experiments used free electron lasers produced by large-scale accelerators. That is impractical for household applications. Hopefully, high-speed transistors may be used in the future to amplify THz signals so as to modulate light in optical fibers. Compact desktop devices are not inconceivable.

Honor : This work was published in the prestigious journal *Nature*.
榮譽：研究已於國際權威學術期刊《自然》發表。

中大前校長高錕教授發明光纖，令光學通信成為現代資訊技術的基礎。物理系劉仁保教授的研究團隊及合作夥伴也在超高速光學通信研究取得重大突破。光調制最大速率直接決定光通信網絡的最大數據傳輸率。這研究實現了高達太赫茲（每秒萬億次）的極高頻率光調制，這比當前最快鈮酸鋰調制器的調制技術快100倍以上，超快光調制令Tb/s（每秒萬億位）的數據傳輸成為可能。

若實現如此高速光通信，傳輸一張4層的藍光碟或一個包含百萬冊圖書的電子圖書庫只需時一秒，這有可能徹底改變世界上的信息處理方法與信息可用性。不過，目前的實驗必須利用巨型加速器來產生自由電子激光，尚未適合日常應用。研究團隊希望將來利用高速晶體管放大信號來直接調制光纜中的光束，便可製成適用於家居或商用的小型裝置。

Website 網址：http://www.phy.cuhk.edu.hk/rbliu/

Secure Overlay Cloud Storage for Mobile Applications
雲端儲存安全附加系統在流動程式上的應用

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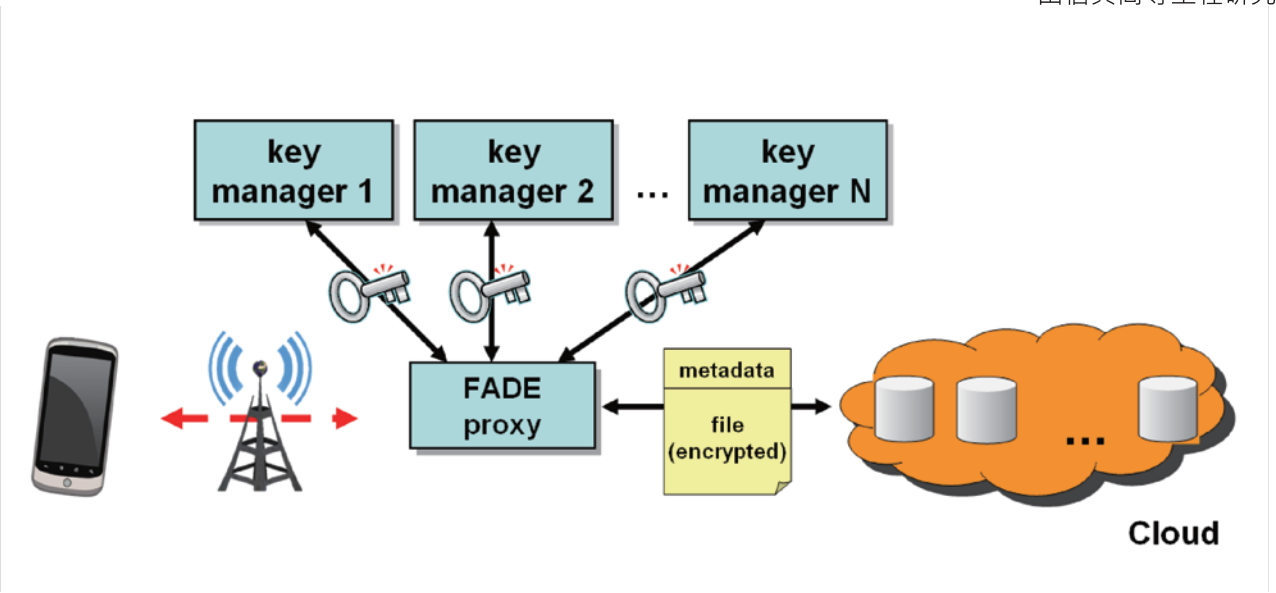
李柏晴教授

Funded by Shun Hing Institute of Advanced Engineering
由信興高等工程研究所資助



To reduce the financial overhead of data storage, enterprises and government agencies can now outsource data storage management to third-party cloud storage services (e.g., Amazon S3), which provide abundant storage resources for hosting terabytes of data on an on-demand basis. With the advent of mobile devices, individuals can also be benefited from cloud storage by moving personal data, such as photos or videos to the cloud.

We design and implement a secure overlay cloud storage system called FADE, a practical proxy system that protects outsourced data with the security guarantees. FADE ensures confidentiality, integrity, access control, and assured deletion. FADE seeks to be compatible with today's cloud storage infrastructures, in order to create a new value-added security service to the emerging cloud storage technology.

We develop an Android-based mobile storage application that integrates seamlessly with FADE. Our application has two properties: (1) it saves the amount of data transfer over the wireless communication between mobile devices and the FADE proxy using redundancy elimination techniques, and (2) it leverages FADE to provide security guarantees for the mobile data being stored in the cloud.

為了減少數據儲存方面的開支，企業和政府機構可以把數據儲存管理外判到第三方的雲端儲存服務（例如 Amazon S3），外判提供的充裕空間可按實際需要來儲存數以萬億字節的數據。隨著流動電腦及通訊器材的普及，個人用戶亦可利用雲端儲存服務，把個人數據(如相片或影音)搬到雲端上。

我們設計和實踐一個實用的雲端儲存數據安全附加系統FADE以保護外判數據。FADE提供加密、完整、訪問控制及確保刪除的安全特性，它亦同時可適用於今天的雲端儲存架構，為新興的雲端儲存技術製造一種新的增值安全服務。

我們設計了一套可與FADE結合的Android流動儲存系統。該系統有兩個特性：(1) 它利用重復刪除技術以節省流動設備和FADE代理系統之間的無線傳輸數據，和 (2) 它利用FADE以保證流動數據儲存在雲端上的安全特性。

Website 網址：http://www.cintec.cuhk.edu.hk/exhibition/project.php?pid=242

Network Coding Distributed Storage of Video Files
視頻文件之網絡編碼分佈式存儲

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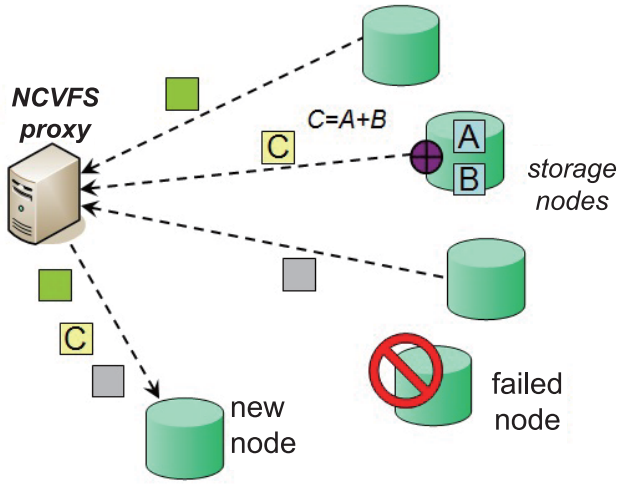
Funded by Innovation and Technology Commission
由創新科技署資助

Collaboration with Television Broadcasts Limited
合作夥伴為電視廣播有限公司



During recovery, storage nodes send encoded data. NCVFS proxy regenerates the data for the new node. Repair traffic is minimized.
在修復過程中，存儲節點發送編碼數據。NCVFS代理服務器重新生成數據發送到新的存儲節點，使修復流量減到最小。

With the proliferation of video data and hence demand for data storage in general, it is critical to provide a fault-tolerant and secure cloud storage solution for storing a massive amount of video files. We propose the **N**etwork-**C**oding-based **V**ideo **F**ile **S**ystem (NCVFS), a distributed storage system which leverages on the concept of network coding, to provide scalable fault-tolerant data storage.

NCVFS is designed as a distributed file system that interconnects multiple storage nodes. It uses network coding-based storage schemes to allocate data blocks in different storage nodes. We enhance the file system to support the data repair operation using network coding. That is, if a node is failed, then the repair operation will (1) read data blocks from survival nodes, (2) regenerate lost data blocks, and (3) write the regenerated blocks to a new node.

NCVFS not only achieves the same level of reliability as traditional RAID (Redundant Array of Inexpensive Disks)-like systems, but also minimizes the repair bandwidth during data recovery. The latter implies a significant improvement on the overall system reliability. The underlying technologies of NCVFS are applicable to other (non-video) file types and are expected to be applied in other areas/industries, and hence fuel the data storage industry as a whole.

隨著視頻數據的廣泛應用及數據存儲需求，我們需建立一套容錯和安全的雲端存儲解決方案以存儲大量的視頻文件。我們提出基於網絡編碼的視頻文件系統（NCVFS），利用網絡編碼的分佈式存儲模式以提供可擴充及容錯的數據儲存。

NCVFS是一個分佈式文件系統，它能互連多個存儲節點，並使用以網絡編碼為基礎的方法分配數據塊在不同的存儲節點上。我們在文件系統設計上加上了使用網絡編碼的數據修復操作。簡單來說，如果一個節點失敗，修復操作將為: (1) 從現有操作的節點上讀取數據塊 (2) 重建丟失的數據塊 (3) 把再建的數據塊寫入到一個新的節點。

NCVFS不但實現了跟傳統RAID（獨立磁碟備援陣列）代碼同級別的可靠性，還大幅減少了數據修復流量，代表整體系統可靠性有顯著改善。此外，NCVFS亦旨在支援網絡視頻內容串流。NCVFS的基礎技術亦適用於一般類型的文件，預計可應用於不同領域/行業，從而支援整個數據儲存工業發展。

Website 網址：http://www.cintec.cuhk.edu.hk/exhibition/project.php?pid=295

Network Coding Enabled Peer to Peer (P2P) Networking
基於網絡編碼的對等互聯網絡技術

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楊偉豪教授

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

Research team of Prof. YEUNG Wai Ho Raymond
楊偉豪教授的研究團隊

With the proliferation of social networking and multimedia contents, the need for transfer and sharing of large data files has been increasing extremely rapidly. Large hosting centers such as content providers inevitably use content delivery networks to cope with the demands of the large number of concurrent users. However, these fluctuating demands from time to time still manage to take down major content providers. P2P is considered a cost-effective technology to provide scalable content delivery because of the legend that the more people who download a file, the faster the downloading. But when a file is not very popular, the benefit of P2P is outweighed by the protocol overhead. Caching data in distrusted peers in a P2P system also generates concerns about digital rights protection.

Technically, how to optimize the computation and bandwidth costs of individual peers is a major challenge. We propose to develop a new P2P system, called NeP2P, by applying cutting-edge network coding technologies. The benefits offered by network coding include a very small protocol overhead, automatic encryption of data for copyright protection, and optimal usage of network bandwidth. Moreover, network coding enables efficient use and distributed management of peer storage.

隨著社交網絡及多媒體內容風行世界，傳送及分享大型檔案的需求急速增長。大型寄存中心如各內容提供商無可避免地需要使用內容傳遞網絡，以應付大量並發用戶的需求。然而，即使如大型的內容提供商仍不時因波動的用戶需求量而癱瘓。 對等互聯網絡技術 （P2P）因著其愈多用戶同時下載速度愈快的特性，被認為是符合成本效益地傳送可延展內容的技術。但當所傳送的並非熱門檔案，使用P2P技術所帶來的好處就會被協議開銷抵銷。另外，將數據緩存於對等互聯網絡中不可信的節點（Peer）會帶來數碼版權保護問題。

我們建議以尖端的網絡編碼技術開發一個新的對等互聯網絡系統—基於網絡編碼的對等互聯網絡技術(NeP2P)。使用網絡編碼所帶來的好處包括：很少量的協議開銷、為保護版權將數據自動加密以及最優網絡帶寬使用量。此外，使用網絡編碼可以有效地使用和分配管理節點存儲。

Website 網址：http://www.cintec.cuhk.edu.hk/exhibition/project.php?pid=305

A Software Toolkit for Rapid Development of Interactive 3D Web Applications
一個支援三維互動式Web應用程式快速開發的軟體工具包

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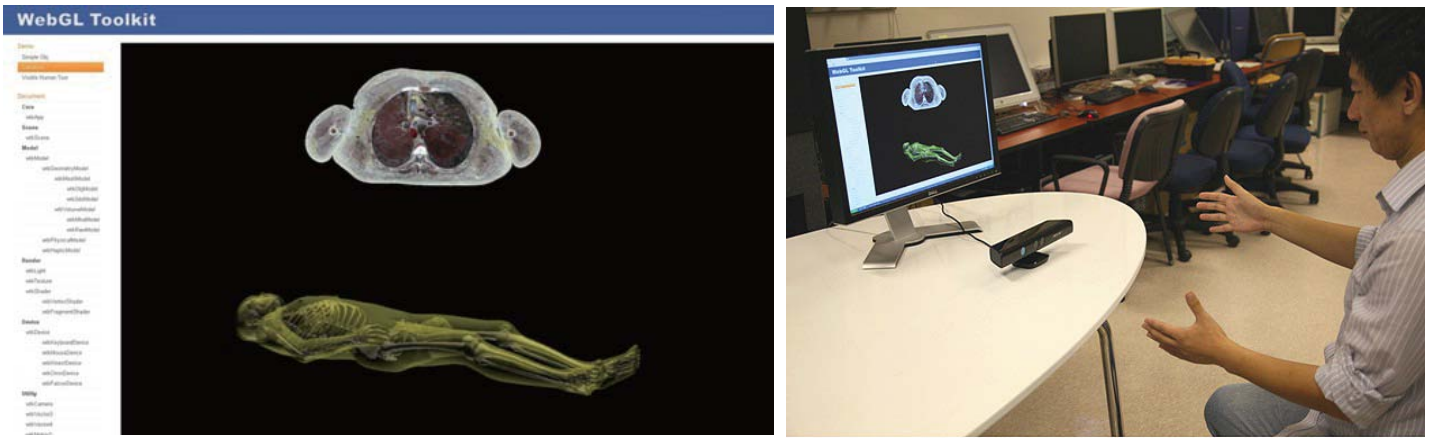
計算機科學與工程學系
王平安教授

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



The Web-based anatomy learning system developed based on our WebGL software toolkit
利用我們的WebGL軟件開發包開發出的基於Web的人體解剖學習系統

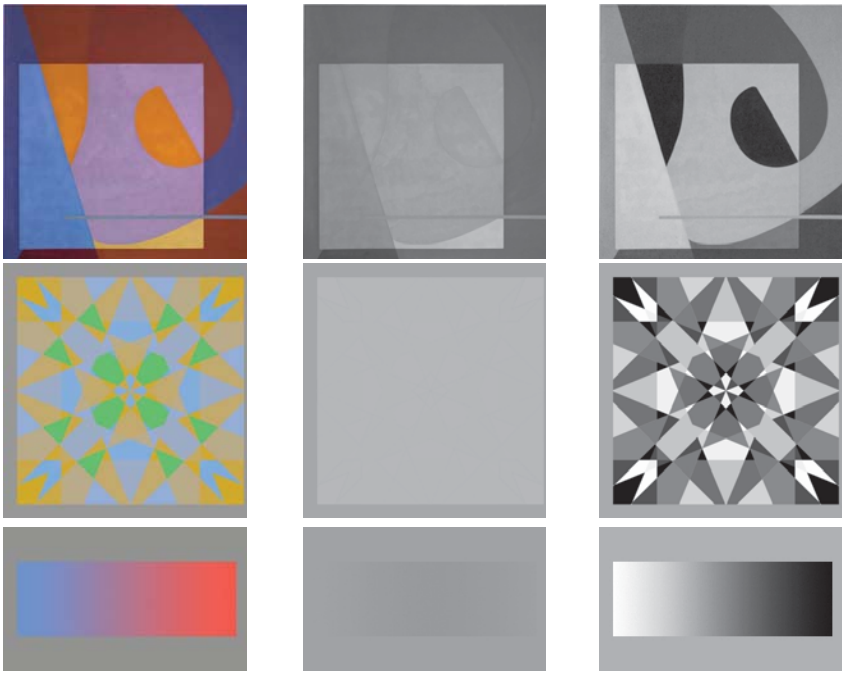
While the advent of broadband has increased the viability of using interactive 3D models to learn, entertain and advertise on the Web. However, today's Web is still lacking of high performance interactive 3D applications. Currently, it is challenging and time-consuming to develop a high-performance interactive 3D application on Web without the support of plug-ins installed in browsers. The research team is developing a new software toolkit to promote current technologies in three aspects. First, they will integrate their hardware accelerated rendering techniques with recent released WebGL in order to interactively visualize more complex 3D models within any compatible Web browser without use of any plug-ins. Second, they will adapt newly developed physically-based modeling and simulation techniques to realistic 3D animations on the Web. Third, they will extend a developed haptic simulation framework to support haptic-enabled interaction through browsers. This project will support Hong Kong game industry, web-based electronic commerce industry, advertising industry and other digital entertainment enterprises by providing a toolkit allowing developers to construct more attractive and robust interactive 3D web applications.

寬頻網絡的出現和發展，促使人們透過互動式3D模型在網上學習、玩樂和進行廣告宣傳。不過，現時網上缺乏高性能的3D互動應用程式，而在沒有插件的支援下，直接在網上開發這些程式既費時耗力又富挑戰性。研究團隊正開發新的軟體工具包，從三方面提升現有的技術。首先，研究團隊將結合硬體加速視覺化技術和最近發佈的WebGL技術，為在網上即時顯示複雜的3D模型提供支援。其次， 他們將優化新近開發的物理建模及模擬技術，支援網上的逼真3D動畫效果。第三，他們將擴展一個開發出來的觸覺模擬框架，使其支援網上的觸覺交互。這個軟體工具包，有助開發者快速構建更強效和有吸引力的互動式3D網上應用程式，推動香港遊戲工業，以網絡為基礎的電子商務、廣告業以及其他數碼娛樂公司的發展。

Website 網址：http://www.cintec.cuhk.edu.hk/exhibition/project.php?pid=292

Contrast Preserving Decolorization
保留原有顏色對比的脫色技術

Prof. JIA Jiaya Leo
Department of Computer Science and Engineering
計算機科學與工程學系
賈佳亞教授



Color Image
彩色圖像

Y Channel (luminance channel) of CIE color space
CIE顏色空間的亮度通道

Our Decolorized Image
(Chrominance contrast is preserved)
我們的脫色圖像 (色度的對比得以保留)

Decolorization, the process to transform a color image to a grayscale one, is a basic tool in digital printing, stylized black-and-white photography, and in many single channel image processing applications.

We propose an optimization approach aiming at maximally preserving the original color contrast. Our main contribution is to alleviate a strict order constraint for color mapping based on human vision system, which enables the employment of a bimodal distribution to constrain spatial pixel difference and allows for automatic selection of suitable gray scale in order to preserve the original contrast.

脫色是一種彩色圖像轉換到灰階的過程，也是數碼印刷、黑白藝術風格攝影，以及許多單色圖像處理應用上的基本工具。

中大研究團隊提出了一種優化方法，目的是在脫色過程中，最大限度地保留彩色圖像原有的顏色對比。研究團隊的主要成果是基於人類視覺系統，減輕顏色映射嚴格的順序約束，從而令雙峰分佈方法，能夠限制空間的像素差異，並允許自動選擇合適的灰度，以保持原有的對比。

Website 網址：http://www.cintec.cuhk.edu.hk/exhibition/project.php?pid=301

Combining Sketch and Tone for Pencil Drawing Production
結合鉛筆線條和色調的圖像素描化技術

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Input Photo
輸入圖像

Pencil Drawing
鉛筆素描

Color Pencil Drawing
彩色素描

CUHK research team develops a new system to produce pencil drawings from natural images. The results contain various natural strokes mimicking human styles and are structurally representative.

During the production process, the pencil drawing system consists of two main steps, i.e., pencil stroke generation and pencil tone drawing. Their effects complement each other. Specifically, stroke drawing aims at expressing general structures of the scene, while the tone drawing focuses more on shapes, shadow, and shading than on the use of lines. The latter procedure is effective to perceptually depict global illumination and accentuate shading and dark regions.

In light of structure and lighting information conveyance, the pencil drawing system establishes a style that artists use to understand visual data and draw them. Meanwhile, it lets the results contain rich and well-ordered sketches to vividly express the original scene.

中大研究團隊研發出一個新系統，將自然圖像製作成鉛筆素描。製成的作品含有各種模仿人類風格及結構上有代表性的自然筆觸。

製作過程中，鉛筆素描系統有兩個主要步驟，即產生鉛筆線條及描繪鉛筆色調，二者相得益彰。具體而言，描繪線條旨在表達畫面的整體的結構，而色調描繪更著重形狀、陰影。後者在表達整體光線方面，以及突出陰影和黑暗的區域，均十分有效。

按照結構和光暗的表達，鉛筆素描系統可讓藝術家們掌握可視化資料，並繪製出來。同時，它可讓製成品包含豐富有序的素描，生動地表達了原來的畫面。

Award：The project won the " Best Paper Award " at the International Symposium on Non-Photorealistic Animation and Rendering 2012.
獎項：該項目在2012年非真實感動畫和渲染國際研討會上，獲得「最佳論文獎」。

Website 網址：http://www.cintec.cuhk.edu.hk/exhibition/project.php?pid=299

Effective Video De-noising Technology
有效去除影像雜訊的技術

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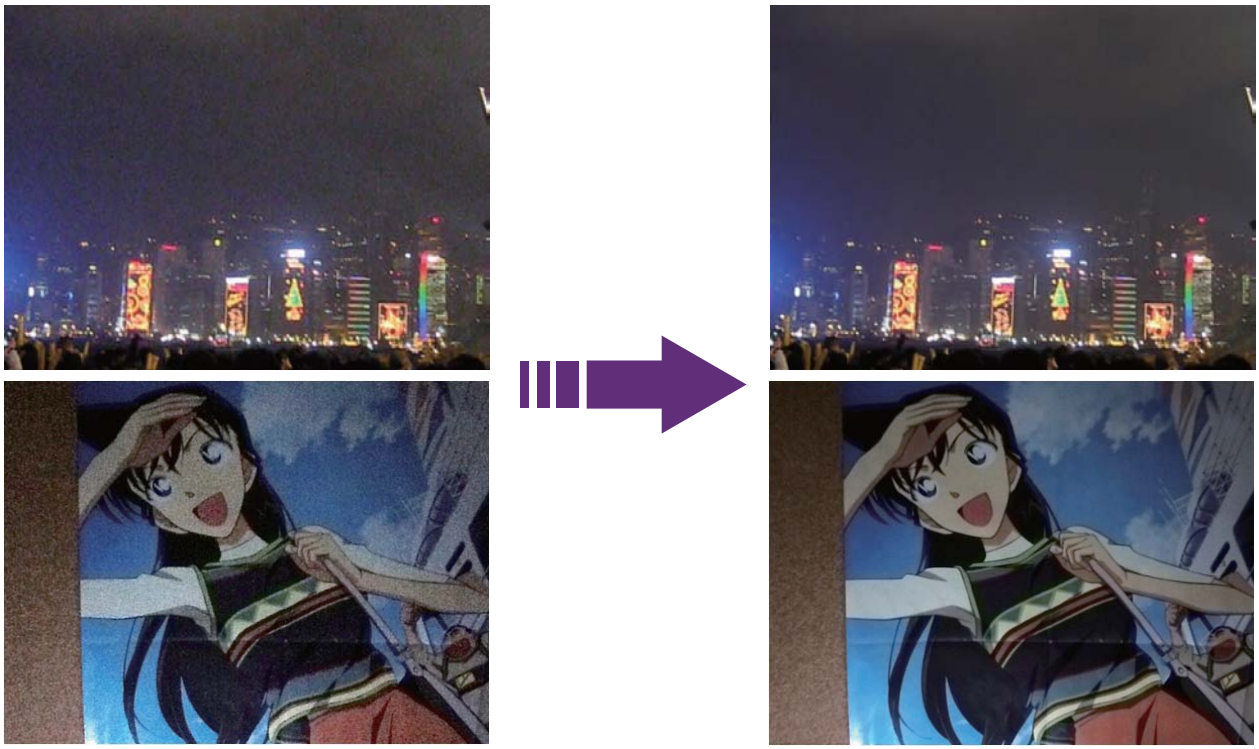

Original video (left) and the de-noising outputs (right)
原有影像(左)及雜訊去除修復後結果(右)

Video noise is a serious problem that may either harm user experience or obstacle video processing. Video footages taken at low-light environments by using digital video camera, mobile phone camera, webcam, surveillance system, often contain noticeable noise and grains. We developed a system that can robustly remove noise from videos. The quality of noise reduction provided by our method is very high because our method uniquely incorporates high quality motion estimation techniques. It preserves details and keeps video temporal coherence, which other denoising methods cannot achieve. Besides, our method is accelerated by using **G**raphics **P**rocessing **U**nits(GPUs), and achieves near real-time performance. It is also hardware-friendly and can be easily adapted to other hardware configuration. This technique can possibly be used to improve videos produced from mobile cameras and benefit surveillance systems to improve video quality. It can also remove small scratches in legacy movies. It is an essential tool in video damage suppression for both industries and end users.

影像雜訊是嚴重問題，會影響影像質素和妨礙影片處理。在光線不足的環境下，以數碼攝錄機、手機鏡頭、視像鏡頭或監控系統等拍攝得來的影片，通常都會出現明顯雜訊和粗微粒。我們開發了一個系統，可以強效去除影片中的雜訊。我們提出的去除雜訊技術質素是相當高的，因為結合了高質素的運動估算技術，可以保留影像細節，同時確保影片的同步協調性，而其他相類方法並未能做到。此外，我們的方法使用圖像處理器加速運行，可達致實時處理的效果，而且易適用於任何硬件。這種技術可以應用來改善由移動攝錄機拍攝的影片，亦有利於監控系統，以提高視頻質量，另外，它也可以消除老電影上的瑕疵，是適用於業界及用家的影片修復必備工具。

Website 網址：http://www.cintec.cuhk.edu.hk/exhibition/project.php?pid=284

Learning Villages
學習村莊

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Entrance Interface of LV
「學習村莊」的進入介面

First-tier Discussion (Village-level)
第一層「村莊層討論」

Second-tier Discussion (House-level)
第二層「房屋層討論」

Learning Villages (LV, http://www.learningvillages.net) operates in a form of MMORPG (Massively Multi-player Online Role-Play Game) in which each village represents an issue of enquiry. In this virtual world, every student has his/her own avatar to participate collaboratively in inter-school "two-tier" enquiry learning. He/she can create a village, taking the role of chieftain, for initiating an issue-enquiry discussion. In this village, with respect to the issue, any students (villagers) in the LV community can build different types of houses to contribute discussion resources, raise questions, propose hypotheses, delineate arguments, and provide evidence pieces. Further, they can construct different types of roads to interconnect the houses to visualize their in-between relationships in a form of mind-map. This is the first-tier "village-level" discussion. In addition, every house in the village is enterable, functioning as an individual forum to facilitate deeper enquiry into the content discussed inside that particular house. This is the second-tier "house-level" discussion. When the number of quality houses reaches a certain amount, the village will be upgraded by their learning facilitators (usually their teachers). Benefits brought to the students by the upgrade include higher social status conferment for enjoying extra privileges in the virtual world, such as pet keeping, mini-game playing, etc. The use of LV has been successfully implemented in primary schools in the past few years, and has been extended to secondary schools this year.

學習村莊（LV, http://www.learningvillages.net）是一個虛擬互動電子學習平台，以「大型多人線上角色扮演遊戲」（MMORPG）的模式，讓同學有趣地進行「兩層」的議題探究。在這個平台裡，每位同學都有自己的「替身」（Avatar），以代表自己在LV虛擬世界中進行跨校協作探究學習。他們可透過創建「村莊」成為「村長」，並為自己的「村莊」建立一個探究議題，號召感興趣的同學加入其中，成為「村民」。在這個「村莊」裡，「村民」可以透過建設不同類型的「房屋」，貢獻與議題相關的資源，提出自己的問題、假設，建立不同的觀點並提供支持理據。除了建設「房屋」，同學還可在「房屋」之間搭建不同類型的「道路」，使整個「村莊」得以像「腦圖」（Mind-map）般，展示不同「房屋」之間的關係。這就是第一層「村莊層討論」。此外，「村莊」裡的「房屋」是可以進入的。每間「房屋」都是一個獨立的論壇，「村民」可對個別「房屋」的討論內容進行更深入的探究。這就是第二層「房屋層討論」。當這些「房屋」的建設達到一定質量和數目後，「村莊」會被升級，升級「村莊」的任務通常由「學習促進者」（老師）擔任。「村莊」的升級會為「村長」和每位「村民」在LV虛擬世界中帶來更高的社會地位，以享受更多的特權，例如飼養寵物，玩小遊戲等。在過去數年，LV已成功在小學推行使用，今年更推廣至中學。

Website 網址：http://www.cintec.cuhk.edu.hk/exhibition/project.php?pid=296

Interocular Distance Measurement and Axis Tracking Engine (IDMATE) for 3D Superimposition Perception
提供三維疊加知感的眼間距離測量和眼間軸跟踪引擎

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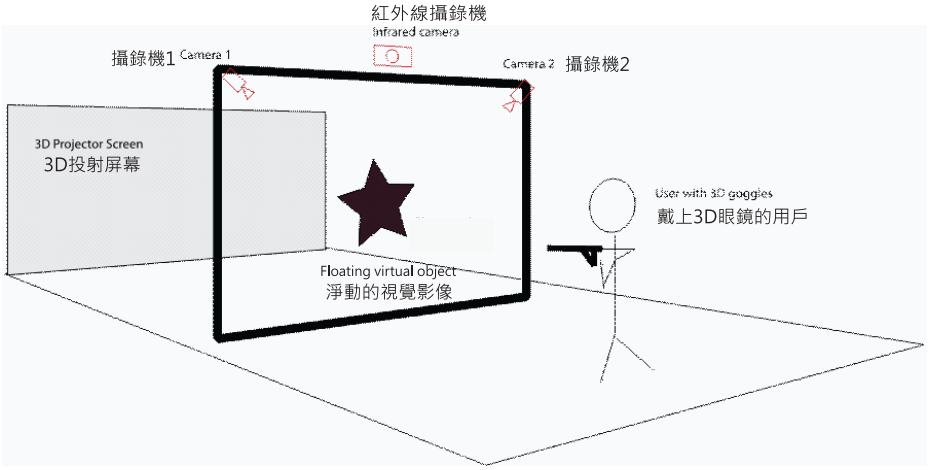
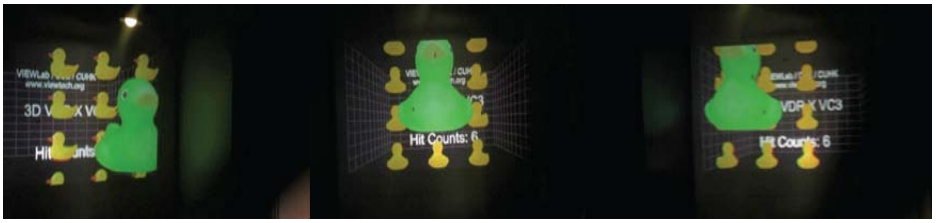
Funded by Innovation and Technology Commission
由創新科技署資助

3D Superimposition Perception 三維疊加知感





Right, centre and left view of View Dependent Rendering (VDR)
視線依據顯像中的左、中、右影像

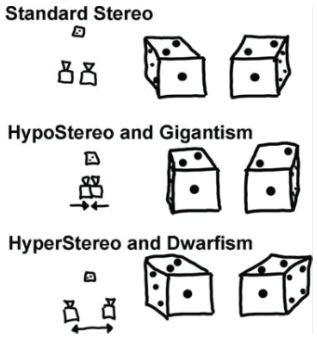
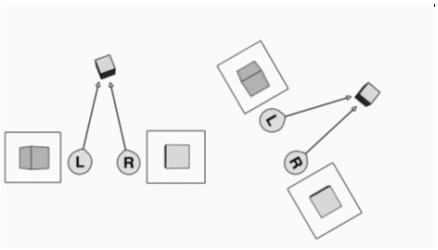


Illustration of incorrect interocular distance images
圖中顯示錯誤的眼間距離影像。



Images are incorrect if interocular axis is rotated
若兩眼間的軸能旋轉，看到的影像將有偏差。

3D Superimposition Perception is a new digital entertainment experience which allows the virtual 3D object viewed with 3D goggle to be aligned with the physical world seamlessly. This is made possible only when the interocular distance is measured and the interocular axis is tracked. This project aims at developing Interocular Distance Measurement and Axis Tracking Engine (IDMATE) and corresponding Software Development Kit (SDK). The IDMATE SDK will support the 3D Superimposition Perception in digital entertainment, tactical training, tele-presence, tele-education and tele-collaboration applications.

三維疊加知感是一個新的數字娛樂體驗，從三維護目鏡看到的虛擬三維物體，可與現實世界無縫對齊 。這是只有當兩眼間的距離能被測量，兩眼間的軸能被跟踪，才能成功。本項目旨在研發兩眼間的距離測量和軸跟踪引擎（IDMATE），以及相應的軟體開發套件（SDK）。IDMATE SDK 將支持在數碼娛樂、戰術培訓、遠程存在、遠程教育和遠程協作應用的三維疊加知感。

Website 網址：http://www.cintec.cuhk.edu.hk/exhibition/project.php?pid=309

Core Technologies for Surveillance Video Searching
快速搜尋保安錄影的核心技術

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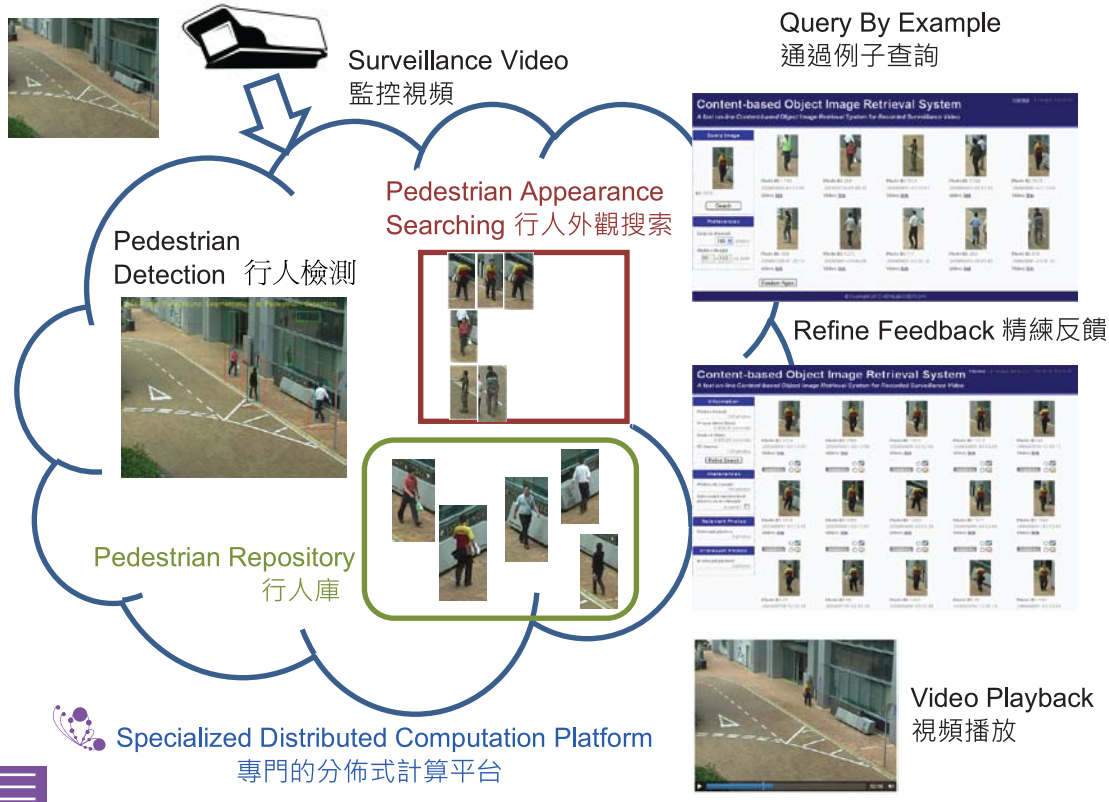
Funded by Innovation and Technology Commission
由創新科技署資助

Applied Science and Technology Research Institute and
Shenzhen ZTE Netview Limited
合作夥伴為香港應用科技研究院和深圳中興力維技術有限公司



At present, there is no practical surveillance video of searching system products available. This is due to the lack of the high-efficiency, high-dimensional visual feature indexing algorithm to solve the problem of a large number of surveillance video image retrieval.

This project aims at developing a content-based object image indexing and retrieval technology for surveillance application.

(1) **Pedestrian Appearance Searching**
Close to human visual perspective

(2) **Highly Scalable**
Specialized Distributed Computation Platform

(3) **Fast Query Response**

現時世界還未出現實用的監控視頻的內容對象的圖像索引和檢索系統的產品，問題在於高效率的高維視覺特徵索引算法，去解決大量監控視頻圖像檢索的問題。

本項目旨在開發高效率的視覺特徵索引算法，應用於一套實用的監控視頻系統來建構快速的影像索引和檢索功能。

特點：
(1) **行人外觀搜索**
接近人類視覺角度

(2) **高度的可擴展性**
專門的分佈式計算平台

(3) **快速的查詢響應**

Website 網址：http://www.cintec.cuhk.edu.hk/exhibition/project.php?pid=271

Compact Antenna Arrays for Beamforming and MIMO Applications
可用於波束形成和多輸入多輸出系統(MIMO)的小型化天線陣列

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

Collaborated (with) The Hong Kong Applied Science and Technology Research Institute Company Limited
與香港應用科技研究院合作

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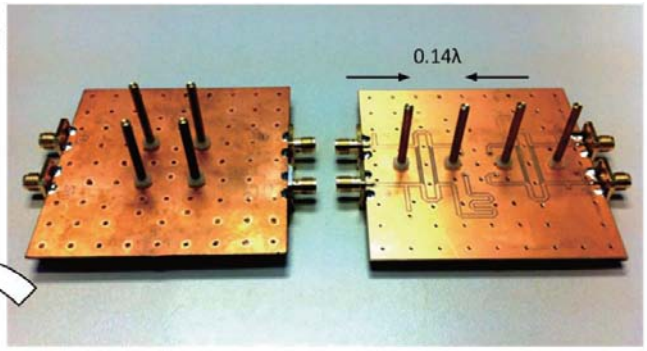
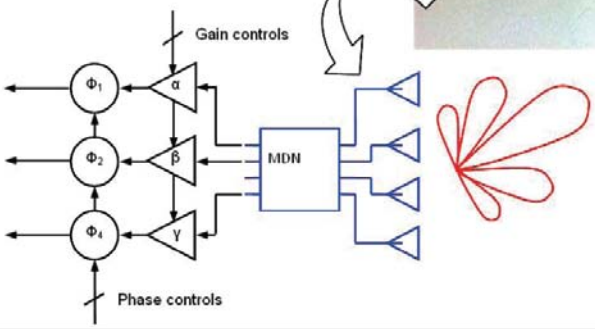
Prototype Mode-based Linear and Circular Arrays
基於輻射模式佈置而成的直線和圓型天線陣列原型

A beamforming array module can be built using the proposed mode-based array. It has a 360-degree scanning capability.
利用輻射模式設計矩陣而製成的波束導向天線陣列，其可控掃描範圍涵蓋 360 度。





Both compact linear and circular arrays can be built using the proposed mode-based technique. For both prototypes, the inter-element spacing is 0.14λ, corresponding to approximately 18 mm (62.5mm for conventional arrays) at 2.4 GHz.
無論是直線或圓型天線陣列，都可以輻射模式來設計，在實物原型中，天線元件間距可低至 0.14 波長，即工作頻率在 2.4GHz 時，間距約 18mm。相比於傳統做法的 62.5mm, 縮減至少於本來的三分一。

Multi-function mobile communication devices are so popular that they are becoming the necessities for modern daily life. 4G/LTE network is becoming popular as well because of the demands for more efficient mobile data transmission. Therefore, the development of compact **M**ultiple-**I**nput-**M**ultiple-**O**utput (MIMO) capable wireless communication terminals is necessary. The major limitation of conventional arrays for multi-antenna systems is the half-wavelength inter-element spacing requirement for minimizing mutual coupling and spatial correlation. Indeed, this requirement is the primary reason that prevents those multi-antenna systems from being implemented in modern small-size handheld devices with wireless communications capabilities.

This project is aimed to develop a technique to realize compact antenna arrays for use in size-limited smart-antenna and MIMO applications. Specifically, a very compact and cost effective antenna array module will be developed for wireless positioning systems. The proposed technique allows very compact and cost effective arrays to be built for the next generation wireless (e.g. WiMAX and 4G/LTE) devices, which will utilize the MIMO architecture for enhanced capacity and reliability. Particularly, in this project, a compact beamforming array module (a smart-antenna application) can be realized to allow more efficient and accurate positioning systems being implemented.

具備多功能的流動通訊設備越來越普及，幾近成為現代人的生活必需品，為了更有效收發流通數據，4G/LTE網絡亦將會變得普及，有需要研發精巧的多輸入多輸出（MIMO）無線通訊終端設備來配合。要縮小這些多天線系統的主要限制，在於天線元件的間距要求不少於半波長，以確保天線不會出現過量相互耦合和互相影響。事實上，這是阻礙了在現代輕便設備配置MIMO無線通訊功能的首要原因。

本項目旨在開發一種技術，實現可用於智能天線和MIMO系統的精巧型天線陣列。具體來說，研究團隊將開發一個為無線定位系統而設、非常小巧全面和具成本效益的天線陣列模塊。此技術將充分發揮MIMO架構，增強通訊負載能力和系統可靠性，為下一代無線設備（如WiMAX和4G/LTE）建構非常精巧和具成本效益的天線陣列。本項目特別製作了一個精巧的可控波束導向陣列示範原型（智能天線的應用），它可以用作建立更有效和準確的定位系統。

Website 網址：http://www.cintec.cuhk.edu.hk/exhibition/project.php?pid=283

Real-time Application-layer Performance Analyzer for Mobile Data Networks
移動數據網絡實時應用層性能分析儀

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Funded by Innovation and Technology Commission
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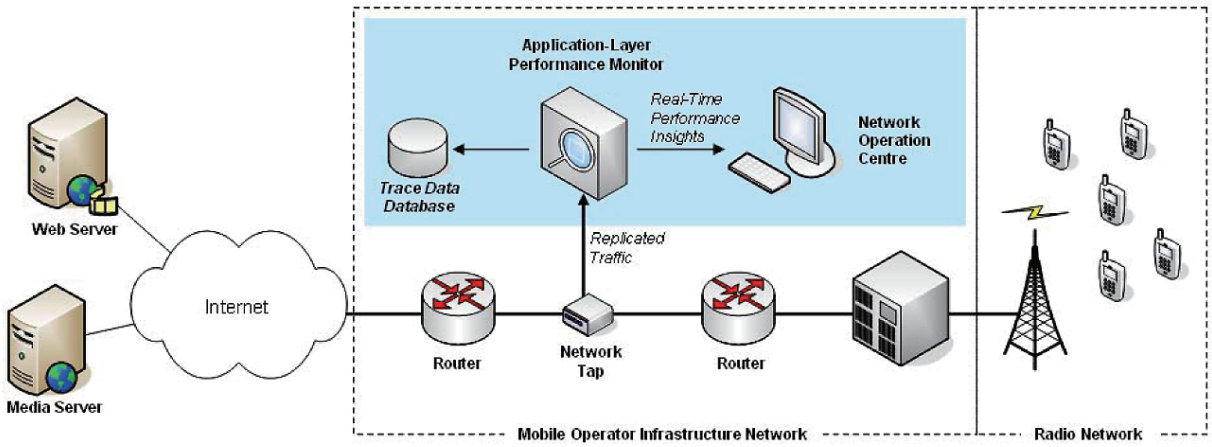
Passive, real-time monitoring platform



CUHK is developing a novel performance monitoring system to carry out real-time performance measurement at the application-layer, to improve the current network monitoring tools which are limited to measure performance at the network-layer.

The proposed system has three novel features. Firstly, it supports the definition of application-layer monitoring modules which incorporate the performance requirements of specific applications such as video streaming in measuring their performances. Secondly, it implements a novel bottleneck-analysis module which can analyze **T**ransmssion **C**ontrol **P**rotocol(TCP) flow data to determine the actual bottleneck (e.g., the Internet source or the radio network) for mobile operator to follow-up. Thirdly, we extend the application performance monitor so that multiple monitoring nodes can be installed in various segments of the network to correlate and compare traffic characteristics as they traverse throughout the network, thus enabling the analysis of potential choke points within the network infrastructure.

The Application-layer Performance Analyzer proposed in this project will equip mobile operators with the necessary insights and tools to bring Hong Kong's mobile data services to the next level, strengthening Hong Kong's position as a leading information hub.

中大正進行一創新的實時應用層實時性能監測系統，以解決現有的網絡監測工具只局限於網絡層性能監測的問題。

建議的系統有三個特點：首先，我們可以定義各種應用層之監測模塊，如視頻串流，納入具體的應用性能要求，以衡量他們的實際表現。第二，我們將發展一個新的瓶頸分析模塊，以分析傳輸控制通訊協定的數據流，用作確定實際的瓶頸（例如：互聯網源或無線電網絡），以便流動通訊運營商改進網絡的質素。第三，我們將研發多點式網絡監控技術。透過安裝於網絡不同環節的監控點，從而比較及分析應用層數據流於網絡各點之性能，以分析網絡中之潛在瓶頸。

這項目所發展的先進網絡監測工具將有助流動營運商把服務質素提升至更高層面，鞏固香港作為通訊樞紐的領先地位。

Website 網址：http://www.cintec.cuhk.edu.hk/exhibition/project.php?pid=282

機械人及自動化技術
Robotics & Automation

Clothbot
爬衣服機械人

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合作夥伴為中國科學院香港中文大學深圳先進集成技術研究所的吳新宇博士及劉園園先生

Clothbot
爬衣服機械人

Conventional climbing robots are designed to work on hard substrate, but few are designed to climb soft surface such as clothes which is soft and deformable. Clothbot is a novel climbing robot which has high maneuverability on flexible clothes. It weighs only 140 grams with a novel gripper consisting of two parallel wheels which can grip continuously and stably on various kinds of clothes. Clothbot also has an omni-directional tail of two DOFs, so that it can change its center of gravity to control the moving direction on complex and undeterminate clothes. Clothbot is able to access most positions of the clothes by moving straight and turning around with only four motors. It is compact, small and light-weighted but has a load capacity six times its own weight.

Clothbot can be a pet robot for interaction with human beings when it climbs on their clothes. With sensors, Clothbot can respond to touches and shakes like a pet.

常見的爬行機械人多只適用於硬物上，很少能用於柔軟和可變形的表面，如衣服和布匹等。這個嶄新的爬衣服機械人，採用獨特的運動方式，能夠在柔軟的布上爬行，並發揮高度的機動性。它有一個由兩個平行的輪子組成的爪子，可以夾著衣服連續和穩定地爬行。它亦有一條二自由度的全向尾巴，能夠靈活的擺動，用於控制機械人爬行時的重心，維持機械人平衡。爬衣服機械人僅需使用四個細小的驅動裝置，就可直線移動及轉彎，到達衣服的不同位置。它的體積小，僅重140克，負載能力可達本身重量的六倍。

爬衣服機械人可以作為寵物機械人，當它靈活地在衣服上爬行時，可與穿著者互動。它攜有姿態傳感器，當它被觸碰或者搖晃時，能像寵物一樣做出動作回應。

Website 網址：http://www.cintec.cuhk.edu.hk/exhibition/project.php?pid=308

Technology Development and Application for Solid Modeling by Layered Depth-Normal Images in High Resolution
基於高分辨率分層深度法矢圖像的實體建模技術開發和應用

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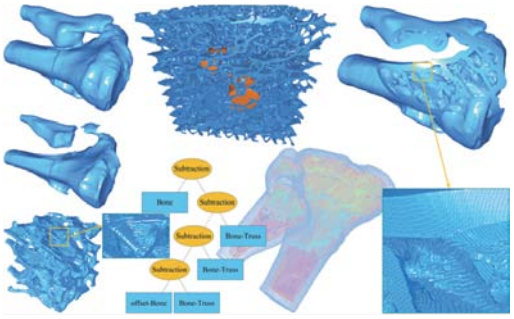
Fused Deposition Modeling
熔融沉積成型

StereoLithography Apparatus
光固化成型



Highly parallel Boolean operation for osseous scaffold model
骨支架模型的高度並行布爾運算

The project aims at developing geometric modeling techniques for 3D object with complex topology and geometry that are widely used in many industrial applications (e.g., microstructure design and manufacturing, biomedical products and applications, jewelry products, reverse engineering).

The market available CAD/CAM systems lack of the ability to modeling and processing models with very complex topology and geometry (e.g., scaffolds of Bone and mesostructures in solids). By exploiting high-resolution **L**ayered **D**epth-**N**ormal **I**mages (LDNI) for processing complex 3D objects in various applications, both the efficiency and accuracy of shape modeling and rapid prototyping can be greatly improved.

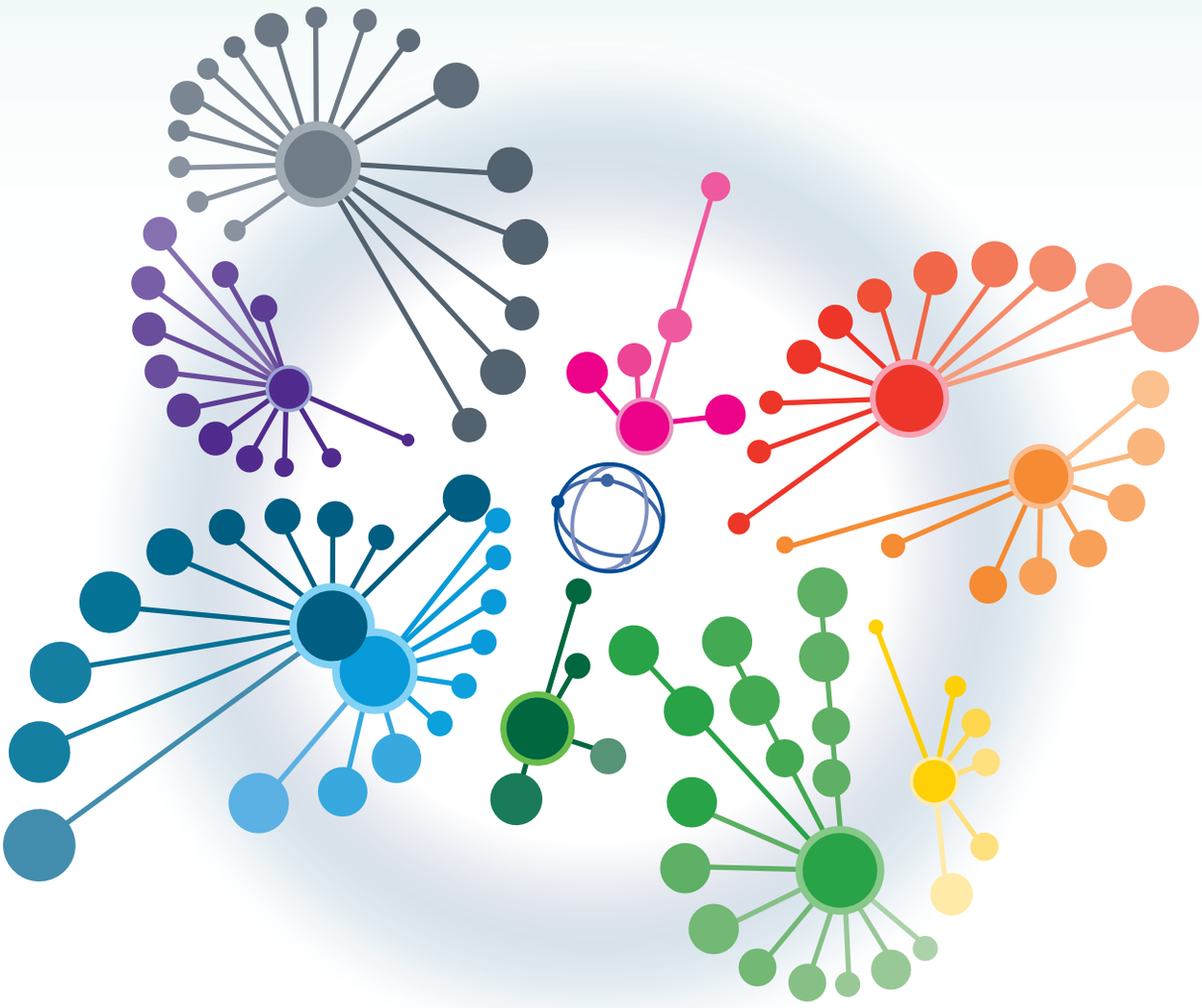
The project will develop the following technologies:
(1)A novel geometric modeling technique for designing 3D complex objects represented by LDNI in high resolutions
(2)A new slicing algorithm to directly generate slices of contours that are topological faithful to the designed models
(3)A new support-structure generation algorithm that can automatically generate optimized support-structures for the rapid prototyping of designed models.
(4)A prototyping CAD/CAM system for modeling 3D models with complex topology and geometry

本項目旨在開發具有複雜拓撲結構和形狀物體的三維幾何造型技術。此技術在許多工業應用中被廣泛使用，包括微觀結構設計和製造、生物醫藥產品和應用、珠寶產品及逆向工程。

市場上現有的CAD / CAM系統缺乏建模和處理模型非常複雜的拓撲結構及幾何形狀模型（例如骨支架和固體中的meso結構）的能力。而利用高分辨率分層深度法矢圖（LDNI）去處理在各種應用中面對的複雜三維物體，可大大提高建模和快速成型技術的效率和準確度。本項目將開發以下技術：

(1) 一種新的支持高分辨率分層深度法矢圖，能夠處理複雜的三維幾何模型
(2) 一種新的切片算法，能夠直接生成切片輪廓，同時保持本身設計模型的正確拓撲
(3) 一個新的生成支撐結構的算法，可以自動生成優化支撐結構，用於將設計模型快速轉換成實物模型的技術上
(4) 一個支持三維複雜物體建模的CAD / CAM原型系統

Website 網址：http://www.cintec.cuhk.edu.hk/exhibition/project.php?pid=294



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