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2016 - 2017

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The Chinese University of Hong Kong
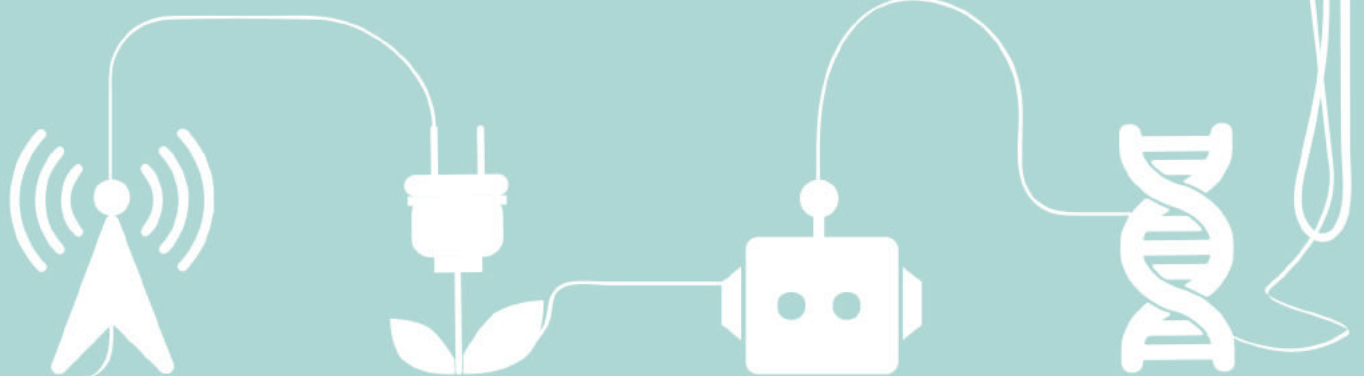
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Thank you for your interest in the innovations of CUHK.

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

創新科技中心
促進中大技術轉移

作為一所具前瞻性的研究型綜合大學，香港中文大學(中大)擁抱熱誠追求卓越的創新科研。創新科技中心樂意與您分享其中部份的最新研究成果，它們來自中大多個不同部門及充滿熱情的研究團隊。

創新科技中心作為隸屬於中大工程學院的技術轉移部門，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。

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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

Biomedical Sciences

生物醫藥科學

Environmental & Green Technologies

環保和綠色技術

Information & Communication Technologies

信息和通訊科技

Robotics & Automation

機械人及自動化技術

Biomedical Sciences
生物醫藥科學

Interactive Virtual Anatomy System
互動式虛擬解剖系統

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

A medical education device that allows user to navigate human body slices easily and intuitively
讓用戶透過簡單直觀的操作方式查看人體切片圖像的醫學教育設備

心臟　肝臟　胃　空腸
額竇
尾狀核
丘腦
小腦蚓　肺　膽囊　豎脊肌
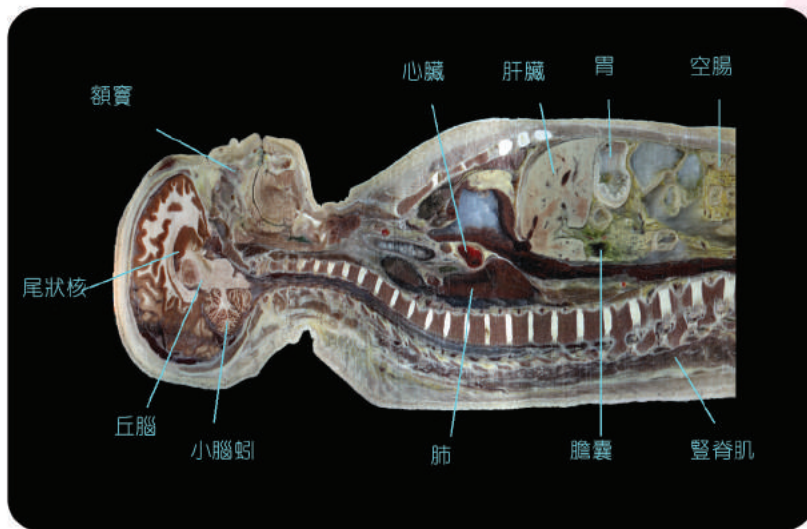
Displaying label information of organs at the same time as the controller is navigating on the model
在模型上移動控制器同時顯示人體器官和組織的標註信息

Navigating human body slices at different positions and angles in real time using handheld controller
利用控制器實時查看不同位置和角度的人體切片圖像

- The system makes use of the high-resolution CVH image data set
- The slice images are rendered in real-time using Graphic Processing Unit (GPU)
- More than 900 organs and label information can be shown at the same time

- 基於高解像度的中國可視人資料庫
- 利用圖形處理器並行計算技術，實時顯示高解像度的人體切片圖像
- 可同時顯示超過900個人體器官和的標註信息

Chinese Visible Human (CVH) image is a huge data set with 3640 human body slice images, totaling more than 131GB. If we use conventional software to navigate the data set, the loading process will be very slow. Moreover, these images are usually in a constant direction and are lack of labels. Our developed system, CVH-Slicer, consists of a human body model, a sensor and navigation system. Users can navigate human body slices at different positions and angles in real time simply by moving the handheld controller around the model.

中國可視人(Chinese Visible Human)資料庫有3640個人體切片圖像，合共超過131GB數據。如果單單用軟件查看，載入圖像過程將非常緩慢。而且軟件往往只顯示一個方向的切面，又沒有圖像標註。CVH-Slicer配備人體模型、感應器和導航儀，用戶只需把控制器在人體模型上移動，即可實時看到不同位置和角度的人體切片圖像。

Virtual Acupuncture System
虛擬針灸系統

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

An interactive platform for learning human body acupoints systematically
讓用戶有系統地學習人體穴位的交互式平台
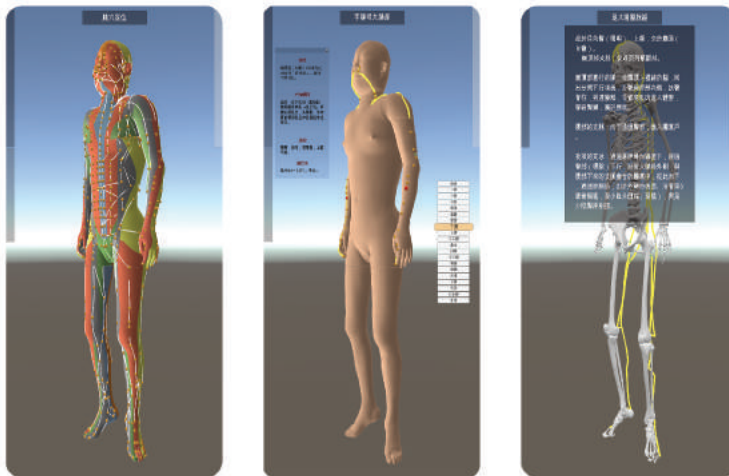
Not only demonstrate the position of the acupoints, but also the anatomy and clinic treatment information
一併顯示穴位的位置及有關的解剖信息和臨床治療信息

Easily operated on touch-screen
簡易觸控屏幕式操作

- The system is easily operated on a 55-inch multi-touch screen.
- Users can understand the 3D structure of the meridian-collateral system in detail simply by rotating and scaling the human model on the touch screen.
- The system not only demonstrates the position of the acupoints, but also the anatomy and clinic treatment information.
- Mobile version is also available for iOS and Android platform.

- 透過55吋多點觸控屏幕操作，簡單易用。
- 用戶可透過觸控屏幕旋轉及縮放人體模型，詳細地了解經絡的3D結構。
- 不僅可顯示穴位的位置，有關的解剖信息和臨床治療信息亦會一併顯示。
- 同時提供安卓及蘋果移動設備版本。

The system consists of two parts, allowing users to understand the human meridian-collateral system, acupoints distribution, and acupuncture clinic treatment etc.:

1. Meridian-collateral system:
   Demonstrates the circulation and distribution of the meridian-collateral with individual explanations
2. Acupoints anatomy system:
   Checks the distribution and location of each acupoint

系統分為兩部分，讓用戶學習人體經絡的組成、穴位分佈及針灸臨床治療等知識：

1. 經絡系統：展示經絡的循環路徑，並解釋說明各經絡
2. 腧穴系統：查看人體系統各個穴位的分佈及位置

Integrated Development Platform for Intelligent Ultrasound Medical Systems
智能醫學超聲系統的綜合開發平台

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

The first comprehensive software toolkit that provides advanced medical ultrasound image processing algorithms for the rapid development of intelligent medical ultrasound measurement, diagnosis and intraoperative guidance systems
首個提供前沿醫學超聲算法以快速
開發智能醫學超聲測量、診斷和術中
引導系統的完備軟件工具包
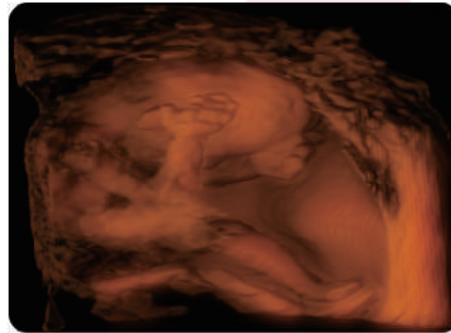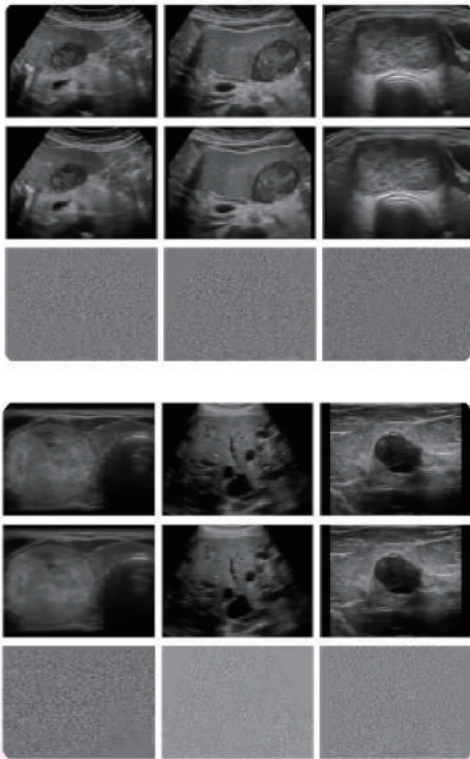
3D fetal ultrasound visualization system
三維胎兒超聲可視化系統

- Provide more reliable evidence to doctors for diagnosis and treatment
- Combine long-term research and development experience of Hong Kong and Shenzhen experts in this field
- Provide examples to demonstrate how to use the algorithms: Intelligent fetal ultrasound detection and measurement system, 3D fetal ultrasound visualization system, Intelligent ultrasound-guided mastectomy training and planning system

- 為醫生的診斷和治療提供更多可靠的依據
- 結合了香港和深圳專家在這範疇多年的研究及開發經驗
- 提供算法的示範應用：胎兒超聲智能測量系統、三維胎兒超聲可視化系統、乳房腫瘤切除智能超聲引導系統

Ultrasonography is widely used in clinical practice. However, due to the limitations in current imaging technology, the quality of ultrasound images is often affected by artifacts and speckle noise. The weak penetration capability of ultrasound through bone and gas also makes deep tissue imaging difficult. We employ intelligent information processing technology to enhance the quality and content of ultrasound images, and set up a software toolkit for the development of different ultrasound medical systems.

醫學超聲被廣泛應用於臨床診斷和治療。然而，受成像技術的限制，圖像質量往往受偽像、雜訊等影響，而由於超聲對骨質和氣體的穿透性弱，要獲取人體深層組織影像較困難。我們利用智能資訊處理技術增強超聲圖像的品質和內容，並建立可以開發不同智能醫學超聲系統的軟件工具包。
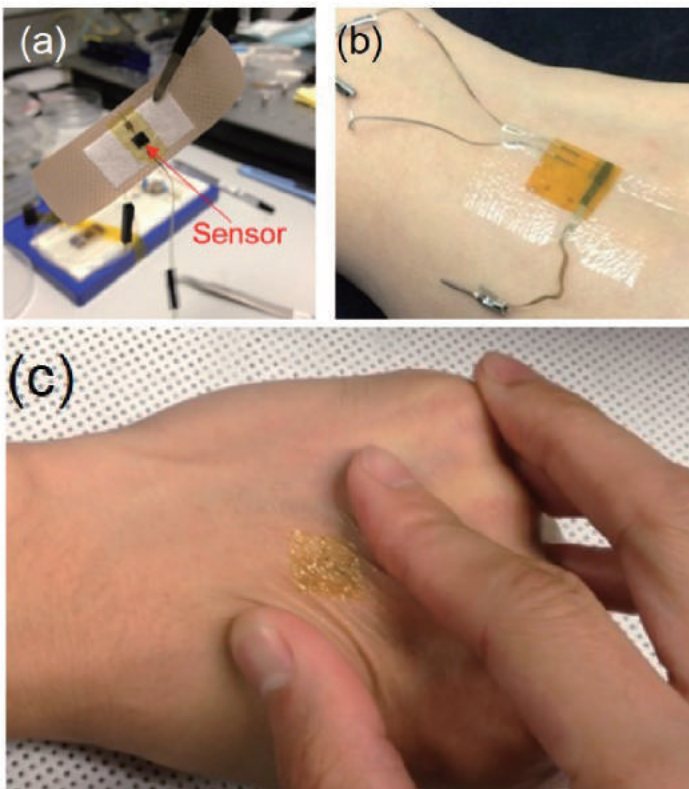
Wearable Sensors For High Accuracy Blood Pressure Monitoring
穿戴式高精度血壓感測器

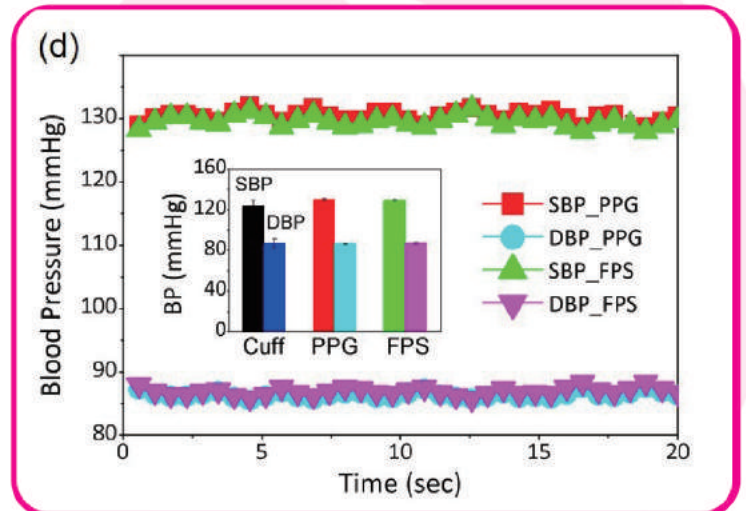Prof. ZHAO Ni
Department of Electronic Engineering
電子工程學系
趙鈮教授

Unobtrusive sensors for real-time, continuous and precise Blood Pressure measurements
無擾、實時、持續且精確的血壓測量

(a) Sensor

(b)

(c)

The small sensors can fit comfortably to skin, providing continous BP monitoring
感測器細小，可舒適地緊貼皮膚，持續地監測血壓

(d)

Comparison between Flexible Piezoresistive Sensor (FPS)-based and conventional PhotoPlethysmoGram (PPG)-based cuffless BP measurement
基於柔性壓力傳感器與傳統光體積脈搏波的無袖帶血壓測量方法的比較

- Our sensors are extremely flexible, thus can form comfortable and seamless contact with the skin, minimizing measurement errors caused by motion artifacts.
- By combining optical and mechanical probing, we can develop a multimodality BP monitoring system, enhancing significantly the measurement accuracy.

- 柔性感測器可舒適且無縫地貼緊皮膚，將運動偽影所造成的測量誤差減至最低
- 我們可結合光學和力學探測以建立一個綜合的血壓監測系統，大大提高測量精度

The fast aging population underscores the urgency to develop personal healthcare systems that can frequently collect physiological parameters of patients during their daily life, thus allowing early disease detection and timely treatments. Our wearable sensors allow around-the-clock measurement of ambulatory and nighttime Blood Pressure (BP), which have been shown to be superior risk predictors for the prevalent cardiovascular diseases.

隨著高齡人口迅速增長，我們逼切需要發展能夠在日常生活中收集病人生理參數的醫療保健系統，以及早檢測疾病及提供適時治療。心血管疾病愈趨普遍，日間和夜間血壓是其重要的風險指標。我們的穿戴式感測器可持續且精確地測量血壓，對健康監測十分重要。
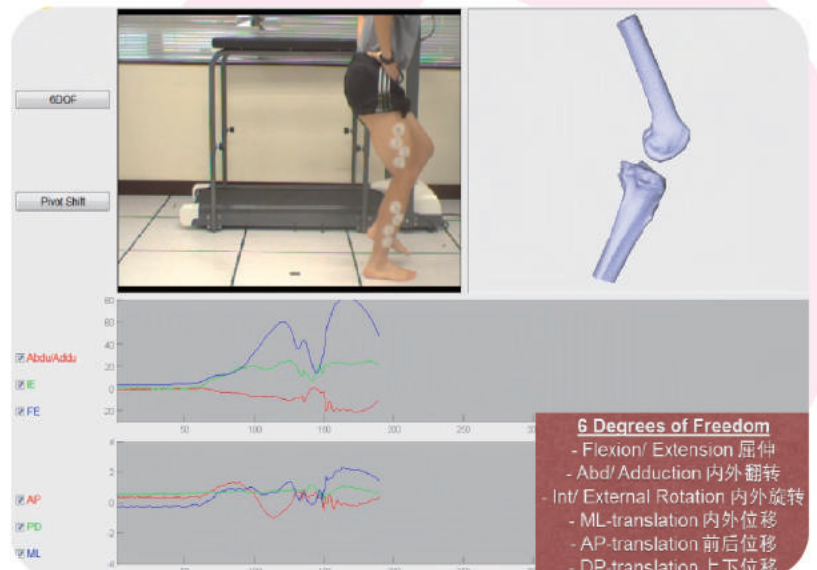
Motion Tracking System for Dynamic Assessment of Knee Function
評估膝關節動態功能的動作追蹤系統

A novel system for assessing ACL function during dynamic knee movements
透過追膝蹤關節的動態運動評估前交叉韌帶功能之新型裝置

Prof. CHAN Kai Ming
Department of Orthopaedics and Traumatology
矯形外科及創傷學系
陳啟明教授

6 Degrees of Freedom
- Flexion/ Extension 屈伸
- Abd/ Adduction 內外翻转
- Int/ External Rotation 內外旋轉
- ML-translation 內外位移
- AP-translation 前后位移
- DP-translation 上下位移

- Simple calibration protocol
- Objective and reliable
- Non-invasive measurement of knee joint kinematic data (rotation and translation)
- Compact and space-saving design with 2 integrated and adjustable infrared cameras and a high-speed camera that simultaneously record both kinematics and visualized data during dynamic knee motions .

- 校準程序容易
- 客觀而且可靠
- 非侵入性地測量膝關節動態（包括旋轉及位移）
- 設計省空間 –由兩個可調校的集成紅外攝像機和一個高速攝像鏡頭組成，可同時記錄膝關節的運動影像及動態數據

Anterior cruciate ligament (ACL) injury is a common sports injury, which results in an unstable knee. Current clinical examinations on knee laxity are easily influenced by examiners' experiences and skill; while only limited information on static and passive anterior-posterior translation can be obtained with current knee assessment devices. Our clinician-friendly motion tracking system offers dynamic assessment over the knee joint, as well as a standardized clinical testing protocol. The system can be used in diagnosis and prognosis of ACL-deficient patients, and comparisons of different surgical and rehabilitative regimes.

膝關節前交叉韌帶(ACL)損傷是常見的運動創傷，會降低膝關節的穩定性。目前針對膝關節鬆弛度的臨床檢查較易受檢驗者的經驗和技術影響，而現有的檢測裝置只能測試膝關節在靜止和被動的狀態下的矢狀位移。我們研發出能評估膝關節動態功能的簡易裝置，並制定臨床標準測試方案，可應用於ACL損傷的診斷和預後，及比較不同手術和康復方案的效果。
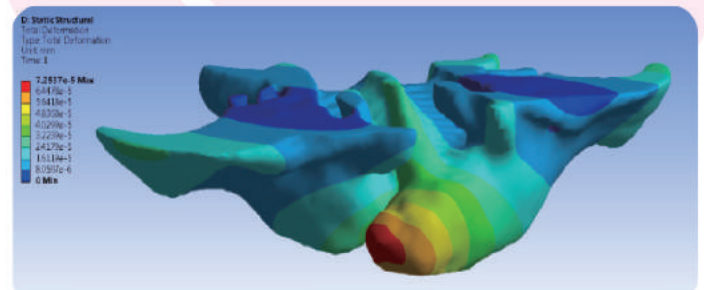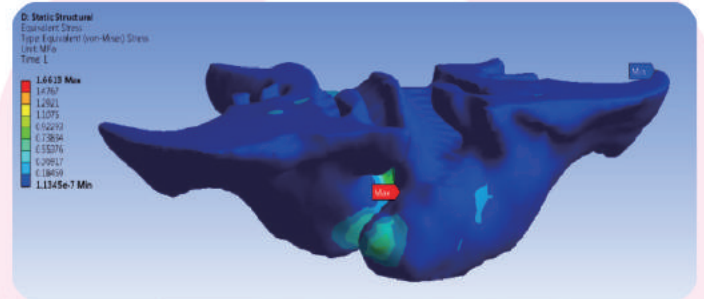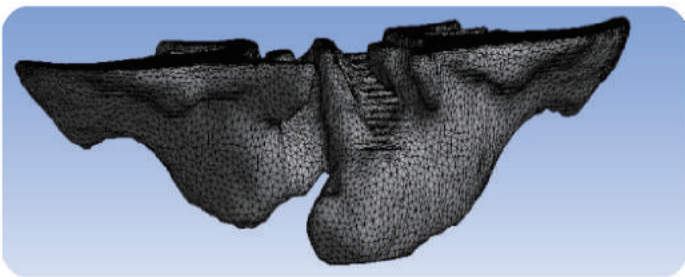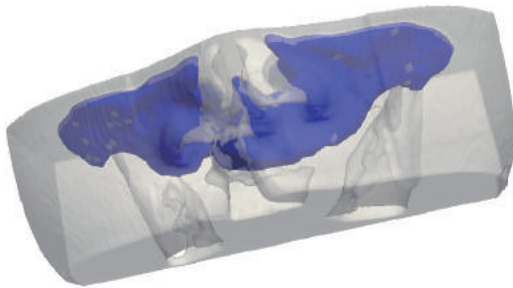
Computerized Simulation of Cleft Lip and Palate Surgery Outcome
電腦模擬唇顎裂手術效果

Simulation of the post-operation facial deformation of Cleft Lip and/or Palate patients based on 3D medical images and Finite Element Method (FEM) theory
透過三維圖像和有限元理論模擬患有唇顎裂（俗稱兔唇）的兒童術後之口腔上頜骨生長

Prof. WANG Defeng
Department of Image and
Interventional Radiology
影像及介入放射學系
王德峰教授

- Provide credible data for oral maxillary surgeons to determine the best strategy and time for operations
- Help patients and their families to better understand the surgery outcome
- Have great significance in CLP clinical practice and research as it is the first systematic analysis of the influencing factors of post-op instauration based on biomechanical modelling

- 為口腔矯形外科醫生提供可信的數據，以確定治療的最佳方案和時機
- 讓患者及其家人更了解術後的效果
- 首次有系統地從生物力學仿真角度分析影響唇顎裂患者術後康復效果的因素，對臨床診斷和科學研究具重大意義

Cleft lip and/or palate (CLP) is one of the relatively common diseases in newborn congenital anomalies. The repair surgery comprises a number of operations at different stage as the child grows. However, there is no sound evidence base for the selection of treatment protocols due to the striking diversity of surgical care practices. It is also hard to forecast the post-op facial deformation. Surgeons and patients' families could find it hard to determine the best surgical plan. This project will build an individualized biomechanical model of the upper lip and palate based on 3D medical images and finite element method (FEM) theory for the prediction of the patient's post-op instauration.

唇顎裂是嬰兒先天性畸形中最常見的病症之一，患童需要於成長不同階段接受多次修復手術。但手術治療方式有很多種，而且欠缺完善的選擇指引，術後的臉形變化亦難以預測，醫生和家長難以決定最好的治療方案。本項目基於三維圖像和有限元理論，構建個人化的口腔上頜生物力學模型，預測患者的術後康復效果。
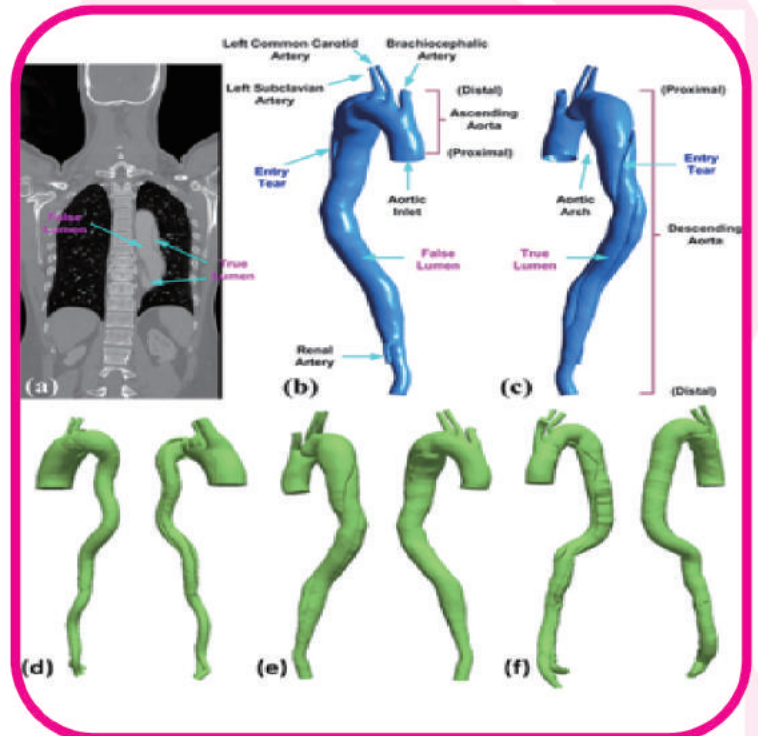
Computer Platform for Noninvasive Diagnosis of Abnormal Vasculatures
無創式血管異常結構診斷電腦平台

Prof. WANG Defeng
Research Center for Medical Image Computing
Department of Image and Interventional Radiology
影像及介入放射學系
醫學影像計算研究中心
王德峰教授

Allow doctors to study hemodynamic conditions based on 3D medical images and computational fluid dynamics
利用三維醫學影像和血液流動學讓醫生評估血流狀態

- Noninvasive and minimal examination procedures
- Promote early detection of vascular diseases
- Allow doctors to better understand the patient's condition and provide personalized medication
- Improve the prevention and diagnosis of related diseases

- 無創式，並減少檢查的次數
- 有助及早檢驗血管疾病
- 幫助醫護人員了解病人血管結構，以提供個人化的治療
- 改善相關疾病的預防及診療機制
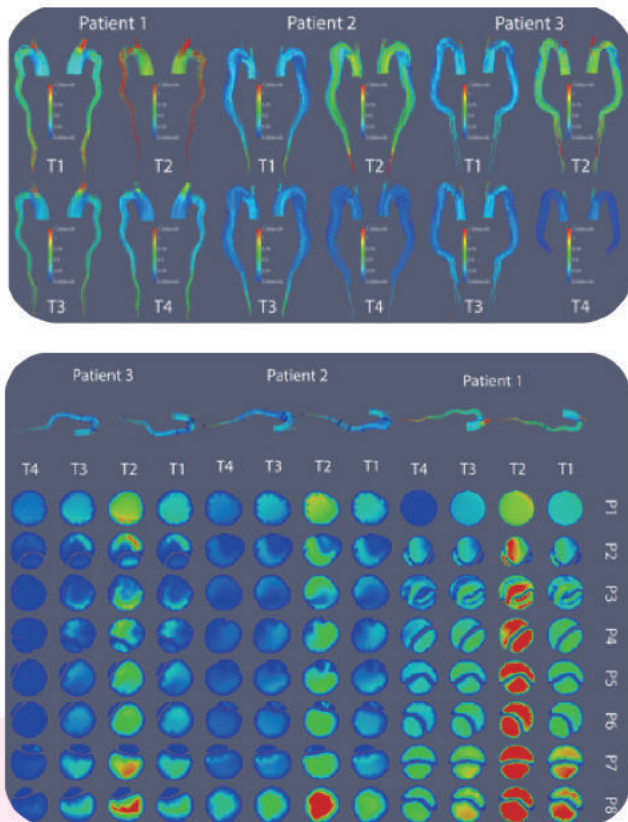
Vasculature Abnormality refers to the unnatural growth of blood vessels that leads to osculate blood flows. The lack of nutrients and oxygen supplies would lead to serious damage to body cells. At present, doctors can only assess the severity of the conditions by angiography, ultrasound or invasive operations, causing extra exam time, cost and physical harms to patients. Thus, we developed a computer platform which allows doctors to study patients' hemodynamic conditions based on 3D medical images from Computerized Tomography (CT) and Magnetic Resonance Imaging (MRI) and the techniques of computational fluid dynamics.

血管結構異常是指血管出現異變或栓塞，令到血液不能正常流動，導致身體細胞因缺乏養份和氧氣供應而受損。目前，醫生只可透過血管造影、超聲波或其他侵入式方法去評估血管異常生長的嚴重程度，繁複的檢查加重了病人的經濟負擔，亦加長了他們的復原時間。故此，我們開發了一個電腦平台，透過電子掃瞄和磁力共振影像，以及自動化血液流動學，讓醫生獲取病人的血流狀態。

Glasses-free 3D Visualization Suite for Medical Images
為醫學診斷和手術而研發的 實時立體影像顯示設備

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

Real-time 3D image display unit for diagnosis and surgery
為醫學診斷和手術而研發的實時立體影像顯示設備

- Glasses-free 3D display units allow medical professionals to realize and understand the 3D inter-relationship more efficiently than conventional 2D monitors.
- Medical professionals can assess the information from CT/MRI/US images easily, which helps to reduce diagnosing time.
- Surgeons can understand the spatial relationships of the organs from the 3D images more accurately, and use it as guidance during operations.

- 新式的自動化立體顯示屏毋須特殊眼鏡輔助，較傳統的平面顯示方法更能讓醫療人員準確地閱讀及理解立體圖像的三維關係。
- 有助醫療人員輕易地從電腦掃瞄、磁力共振及超聲圖像中獲取所需信息，縮短臨床診斷時間。
- 輔助外科醫生從立體圖像中準確獲取病灶的空間位置，作術中導航。

Medical images are indispensable for studying the anatomic structure of patients in vivo. The images, which are commonly visualized with 3D computer models, provide abundant spatial and time-dependent information for diagnosis and surgical planning. Our glasses-free 3D visualization suite is equipped with a GPU-accelerated volume rendering algorithm, enabling real-time interactive and responsive visualization of 3D medical images.
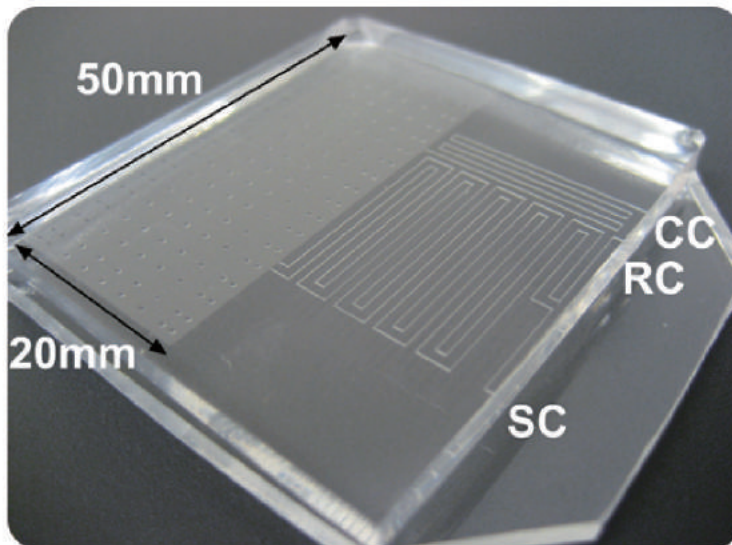
醫療影像對醫護人員了解病人的生理結構十分重要，這些影像常以立體的方式顯示，以提供時態及空間數據讓醫護人員為病人診斷及設計手術。我們的裸眼立體顯示設備，配備圖像處理晶片運算加速技術，能夠產生實時的互動式立體醫學影像。
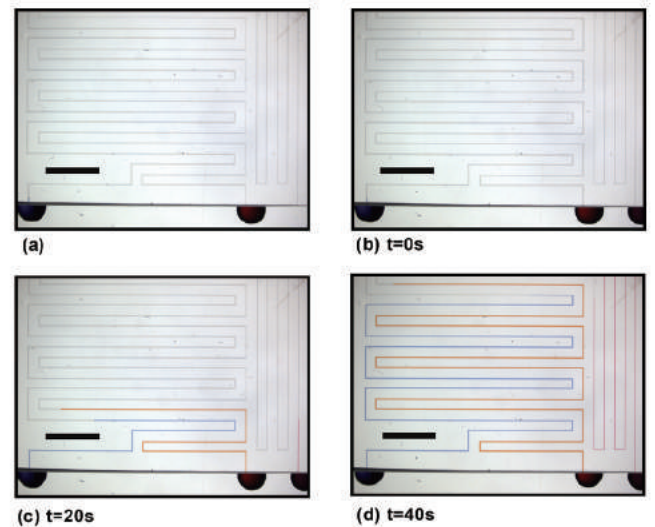
Microfluidic Device for Measuring Blood Viscosity
血黏度測量微流裝置

Prof. ZHENG Bo
Department of Chemistry
化學系
鄭波教授

Low-cost high-efficiency measuring device for blood viscosity
量度血黏度的低成本高效方法

The microfluidic device is about 50mm x 50mm large only; can be made portable for point-of-care tests
微流裝置約只有細50毫米 x 50毫米, 可造成便攜式, 進行定點照護檢驗(POCT)

(a) (b) t=0s (c) t=20s (d) t=40s

Blood viscosity can be obtained by comparing the flow rate of the sample and the reference fluids.
只需比較樣本和參考液的流速, 就可計算出血液的黏度。

- Low fabrication cost and disposable
- Reduced sample amount comparing to using conventional blood viscometers
- Small and can be made portable
- Point-of-care testing (POCT) is viable with a simple mobile application to take time-lapse photos and calculate flow rate

- 製造成本低, 可用完即棄
- 相比一般血黏度計使用更少血液
- 體積細小, 可製成便攜式
- 配合流動裝置應用程式拍攝照片及計算流速, 就可做到定點照護檢驗(POCT)

High blood viscosity has been shown to link with the major cardiovascular risk factors, including high blood pressure, elevated LDL cholesterol, low HDL cholesterol etc. It is therefore a good indicator of potential cardiovascular disease. By introducing just one small drop of blood in our uniquely designed microfluidic device, we can measure blood viscosity simply by taking time-lapse photos of the flowing blood sample and the reference fluid, and then comparing their flow rates.

高血黏度與主要的心血管疾病風險因素(例如高血壓、高低密度膽固醇、低高密度膽固醇等)有著直接的關係。因此, 血黏度是評估心血管疾病的一個很好的指標。只需把一滴血液放入我們特別設計的微流裝置, 然後拍攝血液和參考液流動時的照片並對比它們的流速, 就可計算出樣本的黏度。

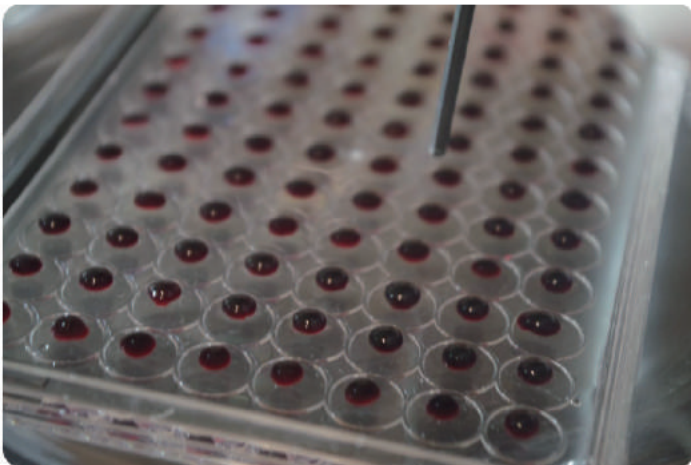# Protein Microarrays with Ultra-low Background Signal
超低背景雜訊的蛋白質芯片

Novel high-efficiency substrate for bioanalysis and clinical diagnosis
用於分析及診斷的全新高效能基底

Prof. ZHENG Bo
Department of Chemistry
化學系
鄭波教授

Droplets on the microarray substrate after the paraffin oil being removed
移除石蠟油後微陣列基片上的小滴

Deposition of the droplets on the microarray substrate immersed in the paraffin oil
浸在石蠟油中的微陣列基片上的液滴沉積
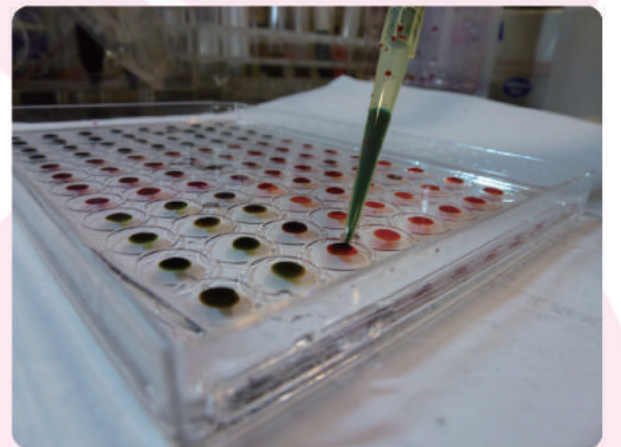
Mixing of the droplets on the microarray substrate immersed in the paraffin oil
混合浸在石蠟油中的微陣列基片上的液滴

- Extremely low background noise
- Low fabrication cost
- Reduced consumption of samples and reagents
- Resolve the common issue of coffee-ring morphology of the spots
- No complicated surface treatment nor special printing solution is required as in traditional substrates

- 背景雜訊低
- 製造成本低
- 減少樣本及試劑的用量
- 解決陣列點上的咖啡環問題
- 不需如傳統基底般作複雜的表面處理或使用特別的點樣溶液

The substrate in a microarray platform is critical to the analysis result in terms of signal consistency and detection sensitivity. We developed a novel substrate using fluorinated ethylene propylene (FEP) membrane, which provides many advantages over traditional substrates such as glass and nitrocellulose. We will focus on applying the protein microarray to early diagnosis of cancers and autoimmune diseases.

在微陣列檢測平台中，基底的選擇直接影響檢測結果的一致性和靈敏度。我們研發使用氟化聚乙烯丙烯（FEP）製造的新型基底，比玻璃、硝化纖維等傳統基底令檢測更有效率。我們將集中將這蛋白質芯片應用於癌症和自身免疫性疾病的診斷。

Environmental &
Green Technologies
環保和綠色技術
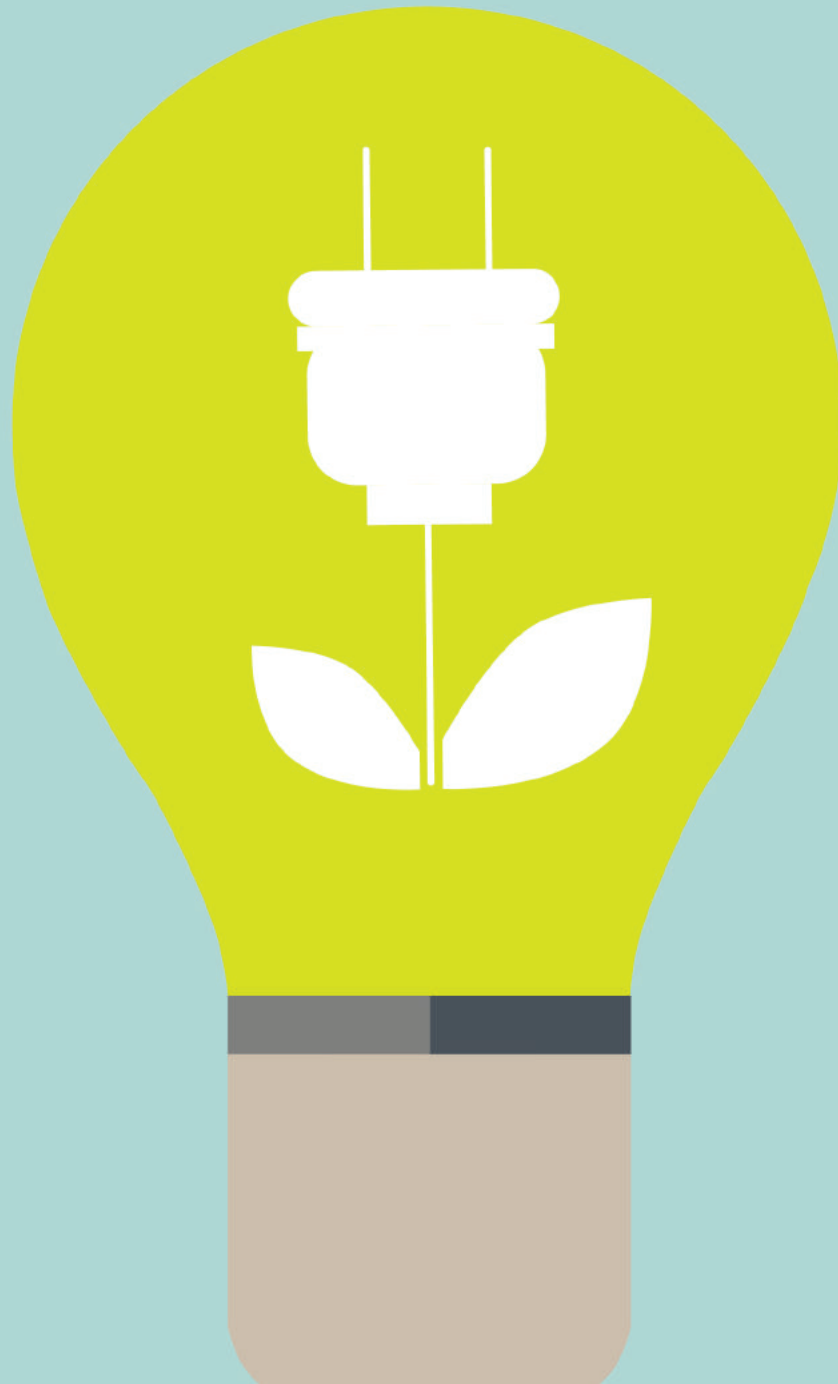
Portable Air Pollution Monitoring System
便攜式空氣污染監測系統

Prof. REN Wei
Department of Mechanical and Automation Engineering
機械與自動化工程學系
任偉教授

An ultra-sensitive, wide-dynamic-range, low-cost and portable gas sensing system
高靈敏度、寬動態範圍、低成本、可便攜的氣體檢測儀

The portable air pollution monitoring system is as small as 10cm x 10cm x 10cm
便攜式空氣污染監測系統的體積只有約10厘米x 10厘米x 10厘米

Acoustic Signal Measurement Device
聲波訊號測量器

Laser Source
激光源

Quartz Tuning Fork
石英音叉

Air pollution is a great concern for the public's health and the society's economy. Precise measurement of air pollutants is one key step to tackle the problem. Current commercial trace gas detectors make use of expensive photodetector for light intensity measurement. They have large system size, limited dynamic range and high cost. Taking advantage of the cutting-edge quartz-enhanced photoacoustic spectroscopy (QEPAS), we developed a portable gas sensing system using a low-cost quartz tuning fork to detect the acoustic signals generated during laser adsorption.

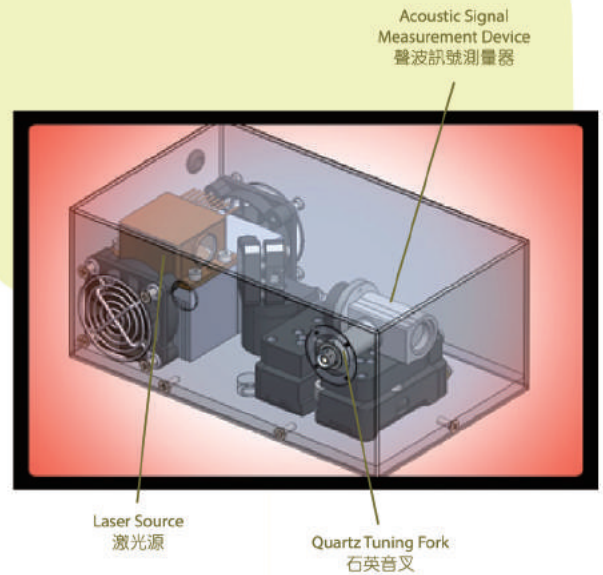- Portable: Air pollution monitoring is made feasible at almost any locations; coupled with smart and remote data processing and transfer, the system can even be delivered by unmanned drones to remote locations for data collection
- Low cost: 50-100 times cheaper than current systems
- Ultra-sensitive: Ppb level sensitivity
- A nitric-oxide detector has been developed; can be easily adapted for other air pollutants such as formaldehyde, hydrogen peroxide, ozone, and hydrogen chloride by employing different laser sources

- 便攜式：可以在幾乎任何地點進行空氣污染監測；配合智能遠程數據處理及傳輸，更可用無人機將系統送到偏遠地點收集數據
- 成本低：比現有系統便宜50-100倍
- 高靈敏度：十億分之一（ppb）測量精度
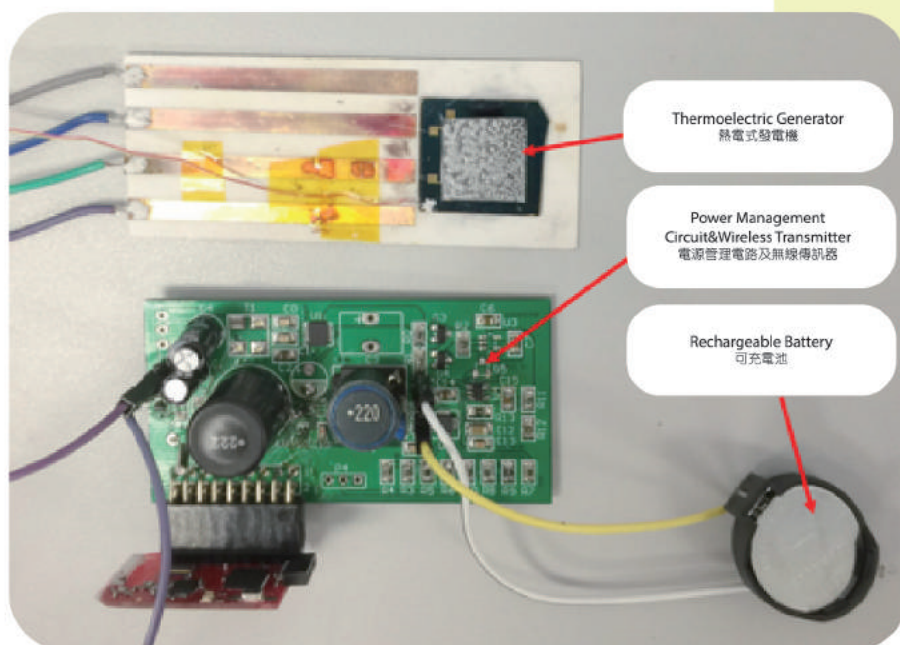- 已成功開發一氧化氮檢測樣機，只需簡單替換激光源，就可以應用到甲醛、過氧化氫、臭氧以及氯化氫等污染物質

空氣污染對公眾健康和社會經濟帶來損害，準確測量空氣中的污染物，是解決空氣污染問題的重要關鍵。現有的氣體分析儀使用高成本的光檢測器測量光強度，系統體積巨大，測量動態範圍有限，且價格昂貴。我們基於石英增強光聲光譜技術，利用非常便宜的石英音叉檢測因激光吸收而產生的聲波信號，從而研發出可攜式的氣體檢測儀。

Thermal Energy Harvesting and Storage for Wireless Sensor Networks
用於無線傳感器網絡的 熱能收集與電存儲系統

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汪正平教授

Prof. Yang SHAO-HORN
Prof. Carl V. THOMPSON
Department of Materials Science and Engineering
Massachusetts Institute of Technology
麻省理工學院
材料工程學系
邵陽教授
Carl V. THOMPSON教授

Converting low-grade heat to electricity for sustainable autonomous wireless sensor networks (WSNs)
將低端熱能轉化為電能以持續供電予自主無線傳感器網絡(WSNs)

Thermoelectric Generator
熱電式發電機

Power Management Circuit&Wireless Transmitter
電源管理電路及無線傳訊器

Rechargeable Battery
可充電池

- Novel technology from the development of thermoelectric device and rechargeable battery, to the design of power management circuit
- Improve the system reliability of WSNs
- Reduce the labor and cost associated with replacing hundreds or thousands of batteries used in the WSNs
- Enhance overall building efficiency by transforming waste heat into useful power source

- 創新的熱電器件、可再充電池及能源管理電路設計
- 提升WSNs系統的可靠性
- 減低更換WSNs內成千上萬電池的人力物力及成本
- 廢熱開發轉為有效能量能夠提升整體建築效能

WSNs are widely applied in our daily life, e.g. area monitoring, health care monitoring, air pollution monitoring etc. Replacement of WSNs' batteries can be difficult as they are often of large-scale and it may also disrupt the continuity. Therefore, we develop an integrated technology that can convert low-grade heat that naturally exists in buildings (eg. solar heating, pipe lines, generators) to electricity to sustainably power autonomous WSNs.

無線傳感器網絡(WSNs)廣泛應用於我們的日常生活當中，例如環境監測、健康監測、空氣污染監測等。要更換WSNs的電池是一項艱鉅的工作，因為多數WSNs都很大型，而且更換時亦可能中斷了監測的連續性。我們開發出一種集成技術，將建築物內自然存在的低端熱能（例如太陽能加熱、熱管道、發電機餘熱等等）轉化為電能，以供自主無線傳感器網絡持續使用。
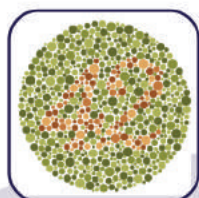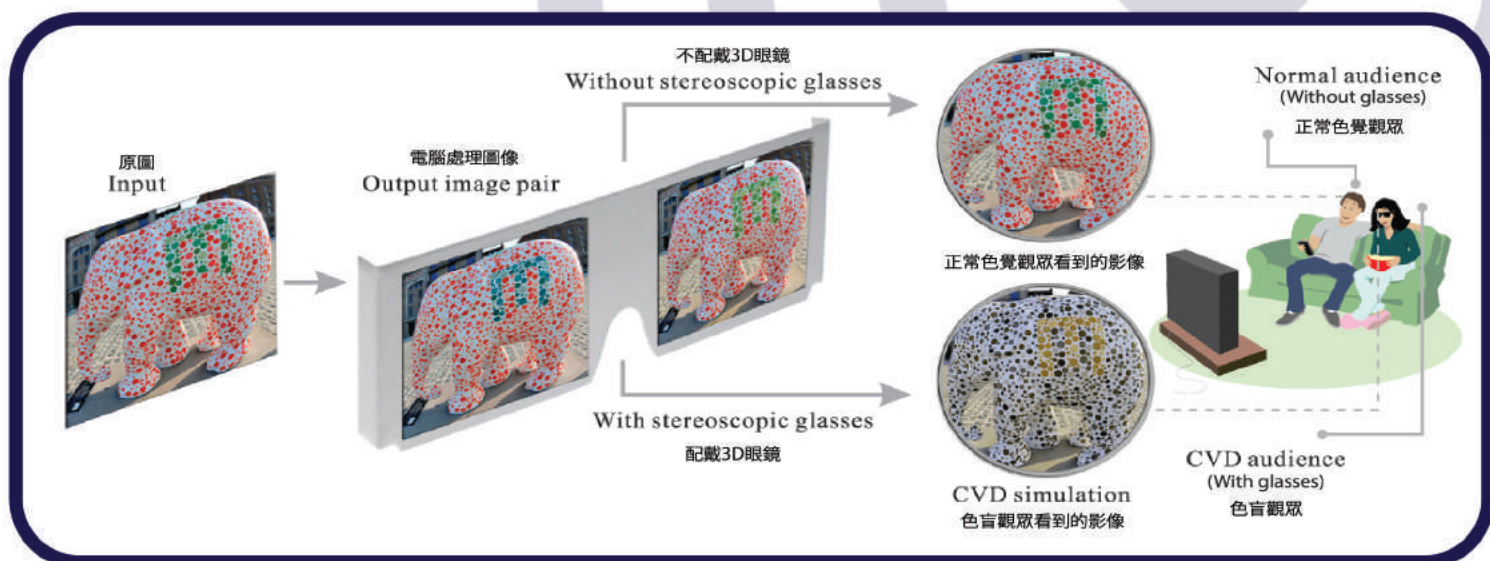
Information &
Communication Technologies
信息和通訊科技

Seamless Visual Sharing with Colour Blind People
色盲人士視覺共享系統

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Department of Computer Science and Engineering
計算機科學與工程學系
黃田津教授

Allow individuals with Colour Vision Deficiency (CVD) to share the same visual content with normal-vision audiences simultaneously
讓色盲人士與正常色覺人士共享視覺內容

不配戴3D眼鏡
Without stereoscopic glasses

原圖
Input

電腦處理圖像
Output image pair

With stereoscopic glasses
配戴3D眼鏡

Normal audience (Without glasses)
正常色覺觀眾

正常色覺觀眾看到的影像

CVD simulation
色盲觀眾看到的影像

CVD audience (With glasses)
色盲觀眾

Input
原圖
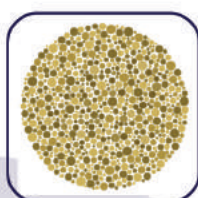
Original visual of CVD audience
色盲人士原本看到的效果
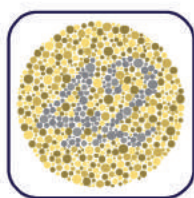
Visual of CVD audience after image processing
色盲人士看到處理後的效果

- CVD audiences wearing stereoscopic glasses will be able to distinguish the originally indistinguishable colours when presented with computer synthesized binocular images
- When normal-vision audiences (without stereoscopic glasses) view the monocular images, there is visually no difference from the original image
- Can be applied in all 3D visual display device e.g. home TVs, movie theaters, mobile screens
- Our method is extensively evaluated via multiple quantitative experiments and user studies, with convincing results obtained in all test cases

- 色盲人士透過3D眼鏡觀看由電腦產生的雙目影像，就可以分辨原本分辨不到的顏色
- 正常色覺人士不配戴3D眼鏡直接觀看屏幕上的單目影像，會看到和原圖沒有色彩差別的圖像
- 可應用於各種3D顯示設備，例如家庭影院、電影院以及手提設備等
- 量化評估及用戶測試證明我們的技術提供穩定滿意的效果

Approximately 250 million people suffer from colour vision deficiency (CVD). There exist methods that help colourblind people to distinguish colours via changing the colours in the original images/videos. It is, however, not practical in sharing scenario where there are both CVD and normal vision audience. Making use of stereoscopic display which offers users two visual experiences (with and without wearing stereoscopic glasses), we propose the very first system that allows CVD and normal-vision audiences to share the same visual content simultaneously.

世界上有大約兩億五千萬的色盲人士，現存一些協助色盲人士區分顏色的技術，但都需要改變原圖的顏色，當觀眾裡同時有色盲人士和正常色覺人士，這些技術就不適用了。我們利用了3D顯示器的兩個不同觀影模式（戴上3D眼鏡和不戴3D眼鏡），開發了首個讓色盲人士和正常色覺人士共享視覺內容的系統。

Automatic Toon Tracking
自動化卡通追蹤

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Department of Computer Science and Engineering
計算機科學與工程學系
黃田津教授

Automatically identify designated objects/regions from an animation sequence for automating animation modification
自動從動畫的幀與幀之間辨識出指定物件或區域
以作自動化動畫編輯

- Consistently outperform the state-of-the-art methods when evaluated with various animation sequences
- No manual assistance needed
- May convert a 2D cartoon into stereo or convert a black-and-white cartoon into coloured version via depth/color propagation
- New inbetweening frames can be created by morphing, producing high-quality smooth-motion animations without increasing labor cost

- 我們的算法在不同的動畫測試中一致地比現有算法優勝
- 不需手動修正
- 可以通過深度擴散將二維動畫轉為立體動畫，或通過顏色擴散將黑白動畫轉為彩色動畫
- 可以自動創建新的中間幀，在不需增加成本的情況下生產更高質量的動畫
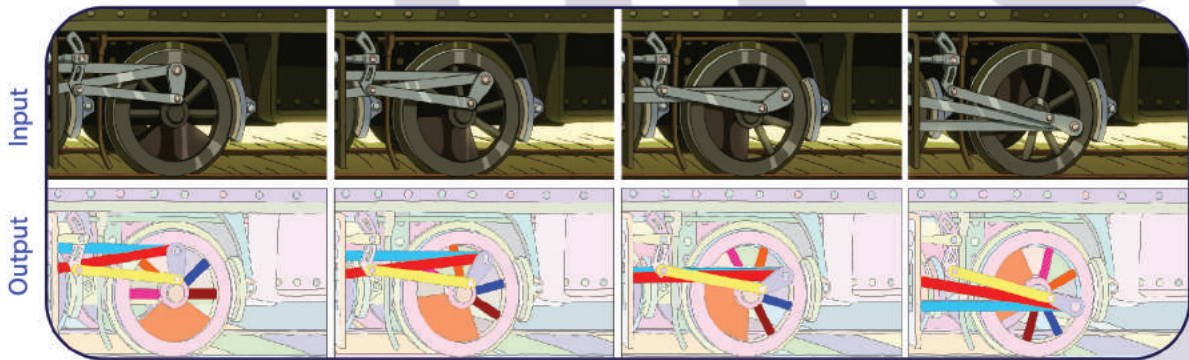
Correspondence identification is to identify objects or region correspondences between consecutive frames of a given hand-drawn animation sequence. It enables automating animation modification tasks such as sequence-wide recolouring or shape-editing of a specific animated character. Existing methods heavily rely on appearance features, and fail to correctly identify correspondences when there exist occlusions, multiple similar/same objects, or split/merged regions. Manual assistance is often required. Our novel approach incorporates motion analysis and analyzes correspondences in a global manner, resolving the abovementioned complex scenarios.

「動畫對應關係辨識」是指分析手繪動畫中幀與幀之間物件或區域的相應關係。這技術令動畫編輯能夠自動化 - 例如自動更改指定角色的顏色或形狀。現有的動畫對應關係分析算法都僅僅依賴物件的外表特徵，以至未能在一些複雜的場景下（例如：物件互相遮擋、場景中有多個相似/相同的物件、區域之間存在分離/融合等）辨識出正確的對應關係，需要手動修正。我們的嶄新技術加入了區域運動軌跡分析，全局地分析對應關係，解決了以上複雜場景的問題。

Optimized 3D Images
3D視覺影像優化

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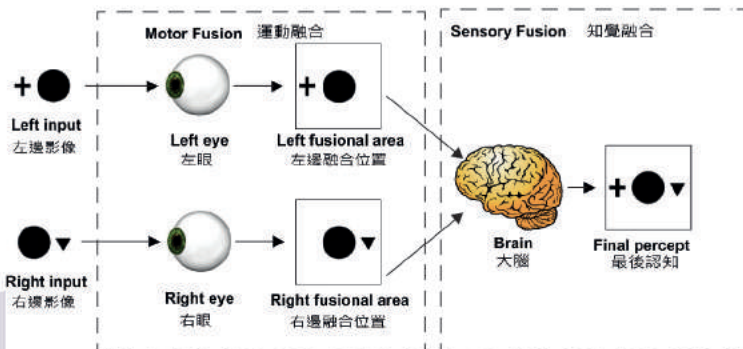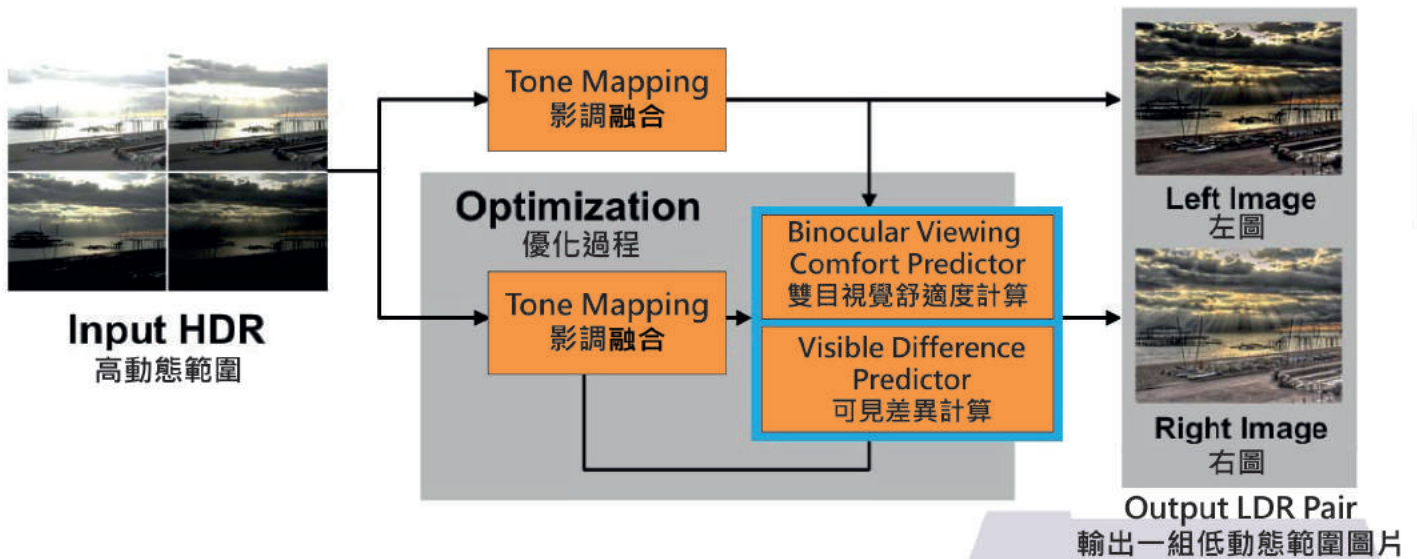Department of Computer Science and Engineering
計算機科學與工程學系
黃田津教授

Enrich contrast and fine details of 3D images using the phenomenon of "Binocular Single Vision"
利用雙目影像融合的原理令三維影像的
色彩和細節更豐富

Input HDR
高動態範圍

Tone Mapping
影調融合

Optimization
優化過程

Tone Mapping
影調融合

Binocular Viewing Comfort Predictor
雙目視覺舒適度計算

Visible Difference Predictor
可見差異計算

Left Image
左圖

Right Image
右圖

Output LDR Pair
輸出一組低動態範圍圖片

There is in fact always some minor difference between the visions of our left and right eyes. For example, there will be disparity of an object if it is viewed from our left and right eyes respectively. We seldom notice such difference because our brains can naturally fuse the two different views. During 3D image processing, either contrast or fine details will be sacrificed when the Low-Dynamic Range (LDR) image is produced from the High- Dynamic Range (HDR) image. Based on the binocular single vision phenomenon, we developed a novel computational technique to generate a pair of LDR images which preserves the contrast and the fine details respectively. Visuals with good contrast and details will be resulted when viewers perceive the left and right images through 3D devices.

- The very first attempt in computer graphics area to enrich visual experience with binocular single vision
- A computational model is developed to predict the limit of image difference such that no visual discomfort will be caused
- Can be widely applied in 3D movies, 3D video games, Virtual Reality (VR) etc.

- 這是首個利用雙目融合原理去增強和豐富視覺體驗的技術
- 技術會計算出圖像差異的閾值，確保不會因兩張圖像差異過大而引致視覺不適
- 可以廣泛應用於3D電影、3D遊戲、虛擬實境等

人的左眼和右眼的視野其實經常存在些微的差異，例如左眼和右眼分別看同一個物件時，位置會因距離而有少許的位移。我們平常並不察覺，是因為大腦會自然把兩個影像融合。一般的3D圖像，會在由高動態範圍（HDR）圖片轉化成低動態範圍（LDR）圖片的過程中，失去對比度或局部的精密細節。我們利用雙目融合的視覺現象，透過獨有的電腦算法將HDR圖片轉化成兩幅LDR圖片，分別保留對比度和圖像細節，觀眾通過3D顯示設備接收左右兩個圖像，就可看到對比度和細緻度都更豐富的影像。

21

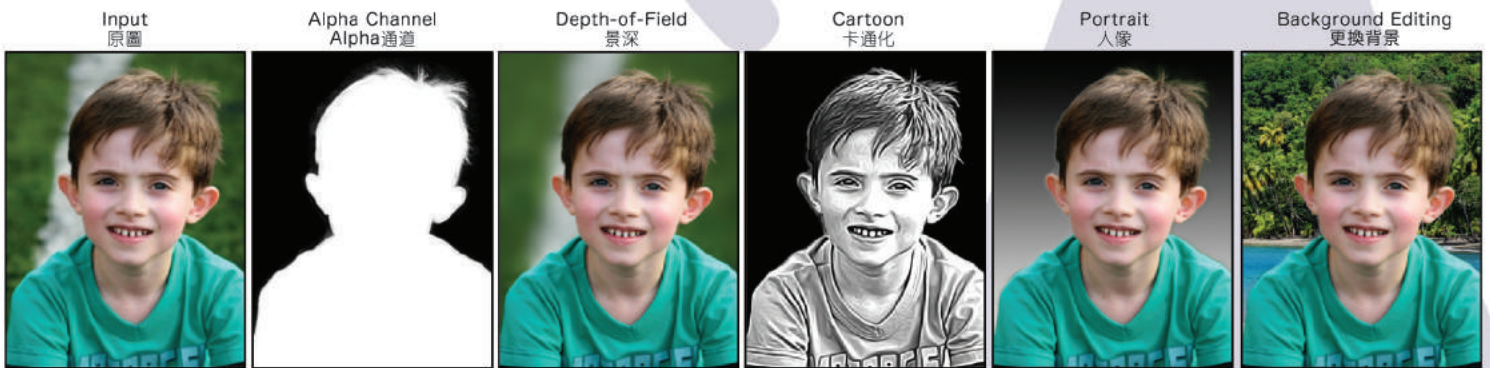# Deep Automatic Portrait Segmentation and Matting
深度學習自動人像提取技術

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

A deep learning system for fully automatic image segmentation and matting
一個基於深度學習的全自動圖像分割和提取系統

Our approach produces satisfying results without any manual input and takes only 0.6 seconds
我們的方法在無任何人手操作的情況下輸出令人滿意的結果，並只需要0.6秒的計算時間

Input 原圖	Alpha Channel Alpha通道	Depth-of-Field 景深	Cartoon 卡通化	Portrait 人像	Background Editing 更換背景

Applications of automatic portrait segmentation and matting
自動人像分割和提取技術的應用

- Fully automatic: Large-scale image editing is feasible with tedious manual input eliminated
- High performance: Conventional applications require users' interactions for several seconds to a few minutes while ours takes less than one second without any user interactions
- High quality results: Trained with a large dataset with human labeled ground truth, our system outputs satisfying results and continues to advance

- 全自動：省卻了繁複的人手操作，大規模的圖像編輯變得可行
- 高效率：現行應用軟件需要幾秒至幾分鐘的用戶操作，而我們的系統在無需任何人手操作下，只需少於一秒就可完成工作
- 高質量效果：我們收集大量有人類標註的數據來訓練該深度學習系統，達至令人滿意的輸出效果，質量更不斷提升

With the prevalence of smart phones and self-portrait photography, i.e., selfie, image enhancement software is getting popular for portrait beatification and stylization. Image segmentation and matting, which plays an important role in these editing applications, require tedious interactions from users to separate the image's foreground and background. Even with the users' input, it is difficult to output satisfying results. To address this issue, we propose a convolutional neural networks (CNNs) based deep learning system for automatic portrait segmentation and matting.

隨著智能手機的普及，愈來愈多人喜歡「自拍」，能把圖像美化、風格化的修圖軟件應運而生。圖像分割和提取是這些應用軟件的重要技術，但這需要用戶透過繁複的操作去分開圖像的前景和背景，而且往往難以達到令人滿意的效果。有見及此，我們提出了一個基於卷積神經網絡的深度學習自動人像分割和提取系統。

MemEC: Erasure Coding for Small Objects in In-Memory Key-Value Storage
處理在記憶體鍵值資料庫中小物件的糾刪碼

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

Specially designed for workloads dominated by small objects
特別為以小物件為主的工作負載而設計

YCSB workloads used in experiments

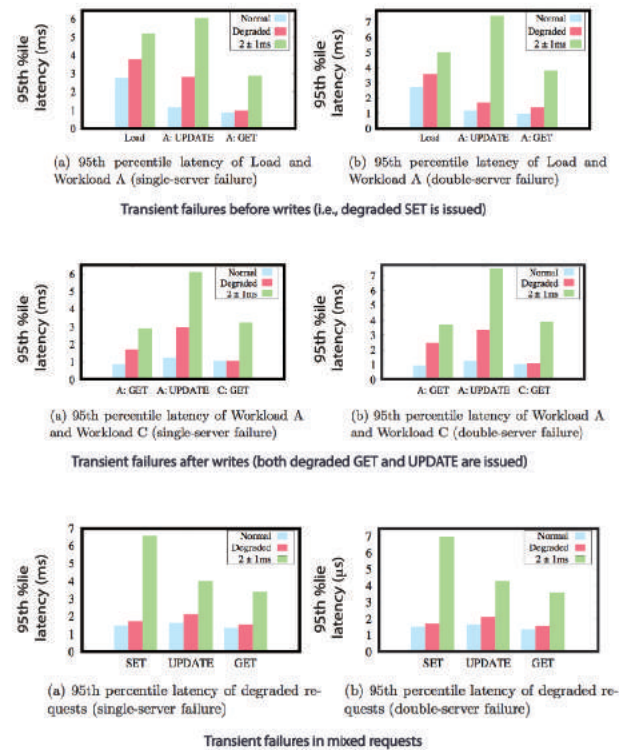| Workload	Proportions of requests
A (Update heavy)	50% GET, 50% UPDATE
B (Read mostly)	95% GET, 5% UPDATE
C (Read only)	100% GET
D (Read latest)	95% GET, 5% SET
F (Read-modify-write)	50% GET, 50% read-modify-write (i.e., GET and UPDATE)

Performance in normal mode

(a) Aggregated throughput

(b) 95th percentile latencies for SET in the load phase, UPDATE in Workload A, and GET in Workload C
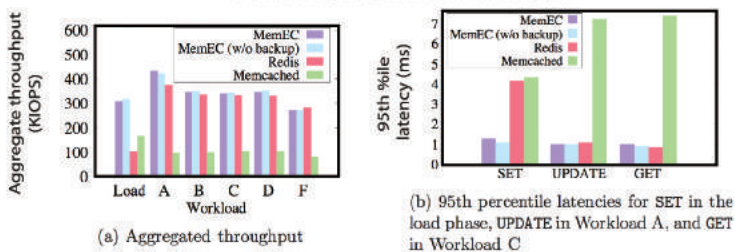
Comparisons of MemEC, Redis, and Memcached

Performance in degraded mode

(a) 95th percentile latency of Load and Workload A (single-server failure)

(b) 95th percentile latency of Load and Workload A (double-server failure)

Transient failures before writes (i.e., degraded SET is issued)

(a) 95th percentile latency of Workload A and Workload C (single-server failure)

(b) 95th percentile latency of Workload A and Workload C (double-server failure)

Transient failures after writes (both degraded GET and UPDATE are issued)

(a) 95th percentile latency of degraded requests (single-server failure)

(b) 95th percentile latency of degraded requests (double-server failure)

Transient failures in mixed requests

- Encode objects in entirety, and incurs 60% less storage redundancy for small objects than existing replication- and erasure-coding-based approaches
- Support graceful transitions between decentralized requests in normal mode (i.e., no failures) and coordinated requests in degraded mode (i.e., with failures), so as to maintain both availability and consistency
- Can serve for different purposes: 1. a read cache for fast reads in read-heavy workloads (e.g., Facebook); 2. a write cache for update-heavy workloads (e.g., in enterprise server environments and machine learning applications with iteratively updated learning models); 3. a persistent store (e.g., RAMCloud) that provides long-term in-memory storage via erasure coding etc.

- 可以對整個物件進行編碼，冗餘數據量比起現有基於複製或糾刪碼的方法少60%。
- 支援由正常模式（即沒有錯誤）下的分散式請求過渡至降級模式（即有錯誤）下的協調式請求，以確保數據的可用性及一致性。
- MemEC 可以用作不同功能：1. 讀出快取，以支援以讀取為主的工作負載（例如Facebook）；2. 寫入快取，以應付以更新為主的工作負載，（例如企業伺服器環境及包含迭代更新的學習模型的機器學習應用）；3. 持久式儲存（例如RAMCloud），以通過糾刪碼提供長期的記憶體儲存

Erasure coding has been widely adopted in distributed storage systems for fault-tolerant storage with low storage redundancy. However, real-life key-value storage workloads (e.g. Facebook) are dominated by small objects, whose keys and values are of small sizes; whereas erasure coding cannot be directly applied on an extremely small object, and cannot provide low-latency while maintaining the correctness of ongoing requests. We therefore propose our new all-encoding data model, MemEC.

糾刪碼一直被廣泛應用於分布式儲存系統，以提供容錯的數據儲存平台，並保持低限度的冗餘數據。但現實的鍵值儲存系統（例如Facebook）的工作負載以小物件為主，它們的鍵和值所佔用的空間都很小，糾刪碼並不能夠直接對非常小的物件進行編碼，且不能同時保持低延遲的數據存取及維持進行中的請求的正確性。因此，我們提出一個新的「全編碼」數據模型 – MemEC。

Temporal Network Data Management and Analytic System
時序網絡數據管理及分析系統

Prof. CHENG James
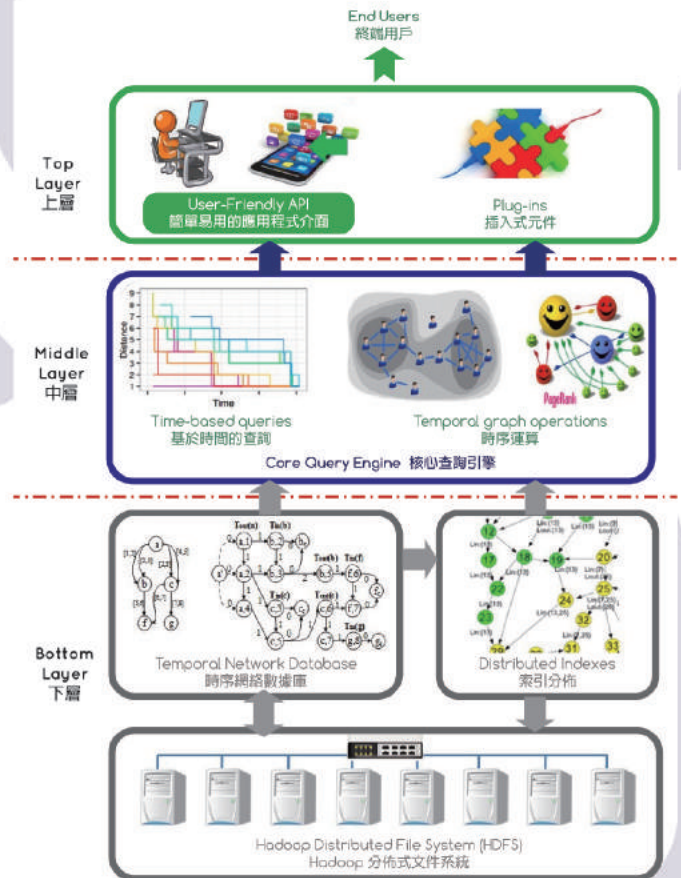Department of Computer Science and Engineering
計算機科學與工程學系
鄭尚策教授

An effective system for companies to discover values in their temporal network data
讓企業有效地從時序網絡數據中提取有價值的信息

- Efficient processing of temporal network data for analysis such as online shopping (e.g. transaction time), marketing campaign (e.g. time of advertisement/promotion), internet usage behavior(e.g. time-ordered sequence of web search and visit) etc.
- User friendly Application Programming Interface (API) that allows companies to design analysis that suits their needs and purposes
- Support small-scale companies with a single PC to a few PCs, to large-scale companies with hundreds to thousands of computers

- 高效處理時序網絡數據作各項分析, 例如網上購物(交易時間)、市場推廣(宣傳廣告/活動的時間)、互聯網使用行為(搜尋及瀏覽網頁的時序)等
- 簡單易用的應用程式介面, 讓企業可以因應自己的需要和目標去設計數據分析
- 同時適用於只有一部或幾部家用電腦的小型公司, 以至擁有幾百甚至幾千部電腦的大型企業

Big data analysis is now a trend for companies to plan their business. Current techniques focus on the analysis of non-temporal network data, but are inadequate and inefficient in processing temporal network data, which often contain much richer and higher value information. In view of this, we develop an efficient temporal network data management and analytic system.

不少企業會分析大數據以作商業策劃, 目前市場都集中針對處理非時序式的網絡數據, 對時序網絡數據的處理技術有欠成熟, 但時序網絡數據往往埋藏著更豐富而且更有價值的信息。因此, 我們開發出一個高效能的時序網絡數據管理及分析系統。

Husky: The Next-Generation Big Data Platform
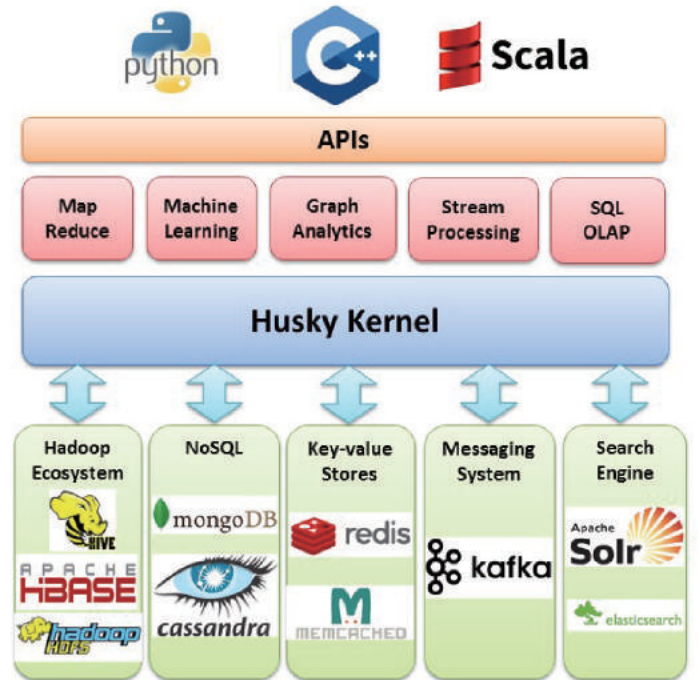# Husky: 新世代大數據平台

Prof. CHENG James
Department of Computer Science and Engineering
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鄭尚策教授

Super powerful big data engine for end-to-end business solutions
超強「大數據」引擎提供一站式商業解決方案

One unified platform, multiple purposes

Husky is a general-purpose platform that empowers big data applications and enables flexible end-to-end business solutions with a rich suite of the most advanced data management and data analytics tools including large-scale machine learning, OLAP, stream processing, MapReduce, graph analytics, etc. It is faster and uses less computing resource than any existing general-purpose big data platforms, enabling companies to effectively and efficiently manage and to find value from their data. We have proven the flexibility and simplicity of Husky in developing high-performance big data solutions for a number of sizeable industrial projects.

- High performance: 10-100 times faster than Spark for iterative jobs and 2-10 times faster for non-iterative jobs, and with better scalability due to low resource consumption
- General and expressive: naturally supporting machine learning, map-reduce, graph analytics, stream processing, SQL, etc., in one unified framework
- User-friendly: offering Python, Scala and C++ API, and working well on a laptop or a large distributed cluster
- Smooth integration/connection with existing systems (e.g., Hadoop ecosystems, NoSQL, key- value stores, etc.)

- 高性能：進行反覆工作比Spark快10-100倍，非反覆工作則快2-10倍；而低資源消耗亦提供了更好的擴展性
- 極高的通用性和表現力：統一的框架支持機器學習MapReduce、圖數據分析、流動數據處理、SQL等
- 簡單易用：提供Python、Scala和C++ API，能在筆記本電腦以至大型分佈式電腦群組上運作
- 與現有系統無縫結合/連接（e.g. Hadoop ecosystems, NoSQL, key-value stores等）

Husky是一個多用途平台，應用大數據實現靈活的點對點業務解決方案，並具有最先進的數據管理和數據分析工具，包括大規模機器學習、OLAP、流動數據處理、MapReduce、圖數據分析等。Husky比任何現有的通用型大數據平台更快及使用更少資源，使企業能夠有效地管理數據並從中提取有價值的信息。我們經已進行數個大型業界項目，證明了Husky開發高性能大數據解決方案的靈活性和簡單性。

EduVenture® - VR (Virtual Reality)
EduVenture® - VR（虛擬實境）

A user-friendly web-based composer for teachers to produce VR (Virtual Reality) and AR (Augmented Reality)-based immersive fieldtrips
讓教師製作加入虛擬實境(VR)和擴增實境(AR)的戶外考察教材的簡易網上編寫工具

Prof. JONG Siu Yung Morris
Mr. LUK Tsun Hin Eric
Mr. CHEUNG Kelvin
Mr. POON Siu Ki Sunny
Edputation Lab
Centre for Learning Sciences and Technologies
Department of Curriculum and Instruction
Faculty of Education
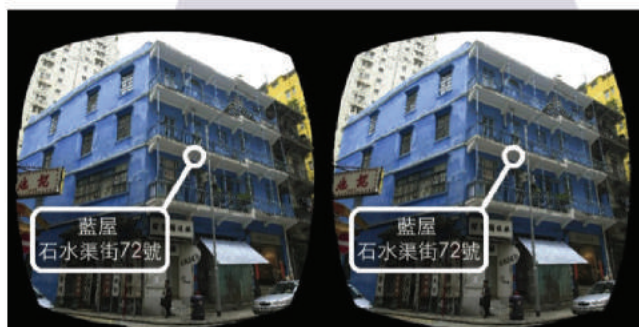教育學院
課程與教學學系
學習科學與科技中心
Edputation 實驗室
莊紹勇教授
陸晉軒先生
張展瑋先生
潘兆麒先生

- Promote students' learning motivation: Allow teachers to integrate learning and teaching contents into the VR world, making classroom activities a lot more enjoyable
- Practical: Some real-life fieldtrips which are costly, difficult and impractical are now made feasible in the virtual world (e.g. overseas fieldtrips or when target learners are physically disabled)
- Economically viable: Low equipment cost (e.g. Google Cardboards)
- Resourceful: Teachers can share all resources at EduVenture® VR resource bank, building a teacher EduVenture® VR community

- 提升學生學習興趣: 讓教師可以輕易將教學內容加入虛擬世界，令教室裡的活動更有趣
- 容易實踐: 一些在真實世界裡昂貴、艱鉅或難以實行的戶外考察(例如海外考察或當教學對象是傷健學生時)，在虛擬世界裡變得可行
- 符合成本效益: 器材成本低 (例如使用Google Cardboards 進行EduVenture® VR 課堂)
- 教材資源豐富: 教師可以在EduVenture® VR 的資源庫裡分享教材，建立一個教師EduVenture®-VR 社區

EduVenture® VR, the newly developed sub-system of EduVenture®, adopts affordable interactive 360° spherical VR and AR technologies for supporting teachers to produce VR-based immersive fieldtrip learning videos that capture real-world environments layered with AR-based pedagogic scaffolds. Students can go on the virtual fieldtrip via mouse, touch pad, mobile device, Google Cardboard or other HMDs (head-mounted displays).
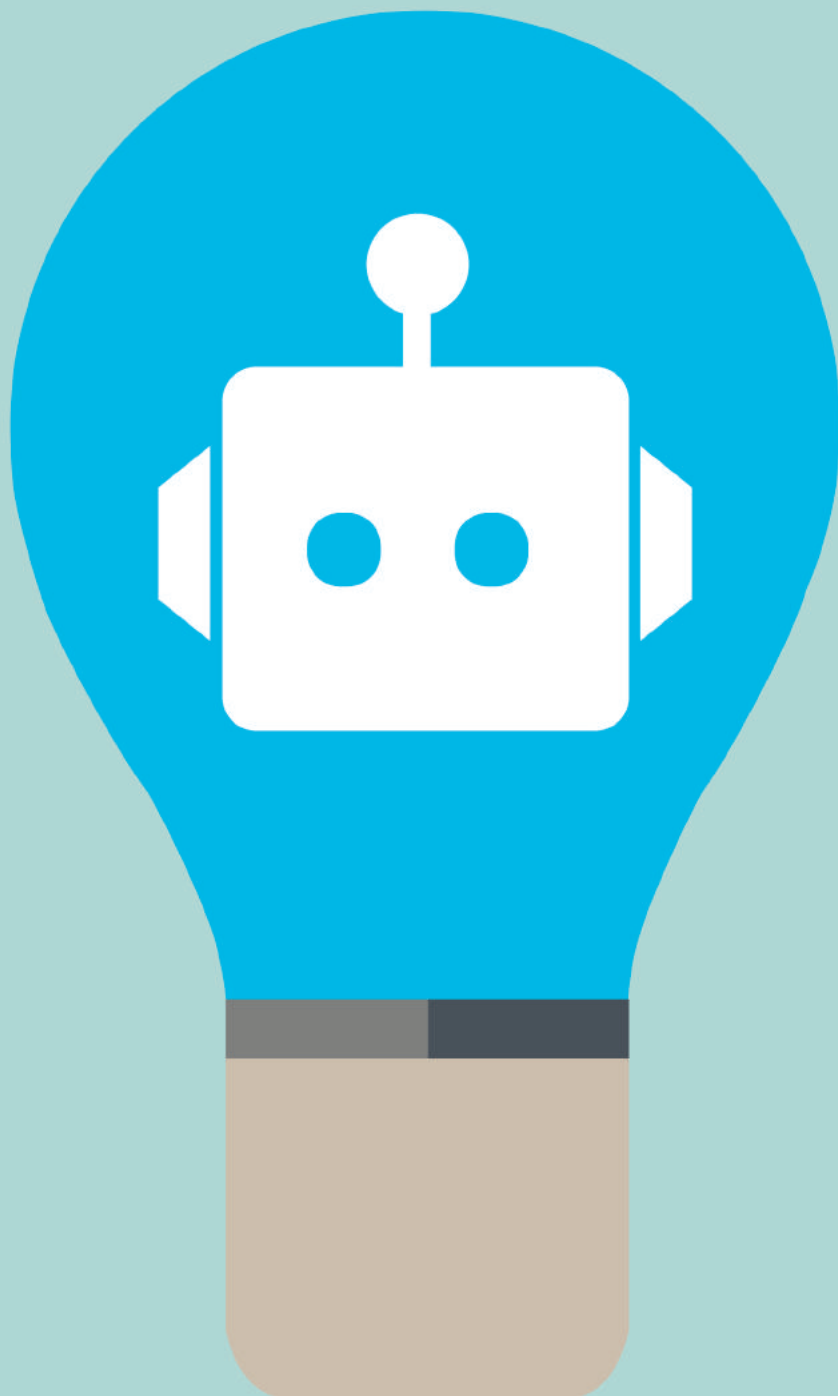
最新開發的EduVenture®VR是EduVenture®的子系統，讓教師能夠利用低成本、互動的360度全景VR及AR技術製作VR虛擬戶外考察學習影片，以及結合真實場景的AR教學鷹架。學生可透過滑鼠、平板電腦、移動設備、Google Cardboard (谷歌紙盒眼鏡)或其他頭戴式顯示設備體驗虛擬戶外考察。

Website 網址 ： http://ev-cuhk.net/
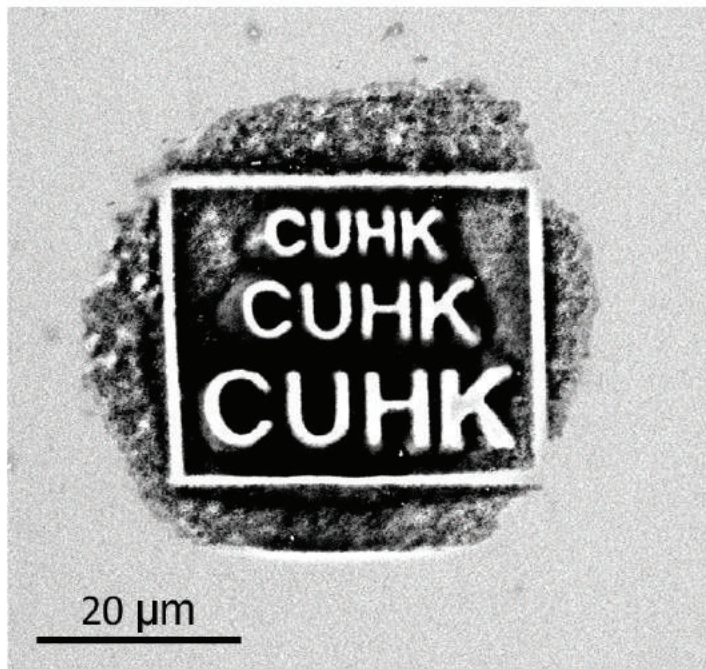
Robotics & Automation
機械人及自動化技術

3D Resolved Parallel Laser Machining and Metal Additive Manufacturing
三維並行激光加工及金屬快速成型系統

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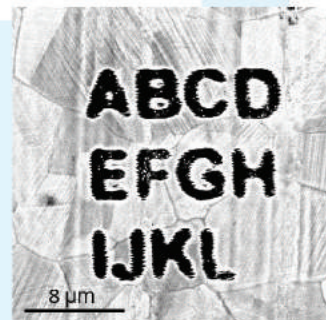Department of Mechanical and Automation Engineering
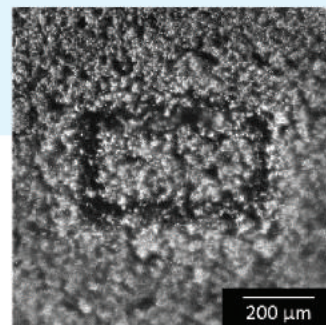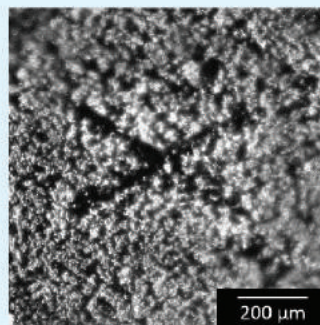機械與自動化工程學系
陳世祈教授

Ultrahigh throughput and ultrahigh precision micromachining
高通量的超精密微加工技術

Direct area micro-machining results on a nickel target (Processing area: ~50 x 50 μm^2)
直接將整個面積圖案微加工上鎳 （加工面積：~50×50 平方微米）

A set of alphabets were micromachined on the nickel target with a resolution approaching the diffraction limit (i.e. 500nm)
在鎳上微加工的字母，精度接近衍射極（即500納米）

Parallel laser sintering/melting results with a resolution of approximately 30-50 μm - substantially better than the current SLS and SLM processes which typically have a resolution of 100s microns
約30-50微米精度的並行激光燒結／熔化成果，而現有的選擇性激光燒結／熔化一般只有數百微米的精度

- Superior resolution and throughput
- Perform various additive and subtractive processes 10,000x to 100,000x faster than the state-of-the-art commercial systems
- Create micro-/nano-scale patterns on/inside all types of materials, e.g. quarts, semiconductors or metals
- Can work in a non-cleanroom environment

- 高精度、高通量
- 增材和減材過程比現有最先進的加工系統快 10,000 至100,000倍
- 可以在任何物料上／內加工微米／納米級別的圖案，如石英、半導體或金屬等
- 可以在非無塵室環境內使用

Ultrashort pulse lasers have been extensively used in micromachining. However, its throughput is largely limited by the sequential point-scanning processes. Making use of temporal focusing, our system creates a light sheet of high pulse energy of 50-400μm diameter, achieving direct area patterning and hence substantially increasing the throughput. The technology is further adopted to develop a metal additive manufacturing system, which will have superior resolution and throughput over current commercial systems.

超短脈衝鐳射被廣泛應用於微加工，但產量大大受制於其列點掃描過程。本系統利用時域聚焦原理形成50-400微米直徑的高脈衝能量光片，直接進行一個面積的圖案加工，通量因此顯著提升。我們進一步採用此技術開發出金屬快速成型系統，大大超越現有系統的精度和通量。

Powered Ankle-Foot Prosthesis
動力膝下義肢

Help below-knee amputees to restore a normal gait
幫助膝下截肢者恢復正常步態

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劉炎南先生

Prof. CHAN Kai Ming
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Dr. LAW Sheung Wai
Department of Orthopaedics and Traumatology
矯形外科及創傷學系
陳啟明教授
秦嶺教授
羅尚尉醫生

- Assistive power: The prosthesis provides amputees with assistive power so as to reduce their efforts in walking.
- Lightened battery: The prosthesis is designed based on the human ankle kinematics and parallel spring mechanism to reproduce human ankle dorsiflexion stiffness. Negative mechanical energy therefore can be stored and released for improving system energy efficiency. The battery can hence be lightened.
- Downsized motor: Due to the same reason as in above point, both the actuator torque and power requirement are reduced. The motor can hence also be downsized.

- 輔助動力：義肢為截肢者提供輔助動力，減輕他們走路時的負擔。
- 減輕電池重量：義肢根據人體行走時的動力學特徵以及並聯彈簧機制設計，能夠模仿人腳踝背屈曲時的剛度，實現機械負功的儲存與釋放，提高能量效率，電池重量因此能大大降低。
- 減小馬達體積：因以上相同原理，驅動力矩和功率需求降低，馬達的體積亦可以減小。

Commercially available ankle-foot prostheses are often passive in nature, that is, they cannot provide extra mechanical energy to assist amputees to walk. This is physically demanding for the amputees and they often have to walk slower than normal. One of the major technological challenges for powered ankle-foot prostheses is that it is difficult to build a prosthesis that is small and light enough while able to provide sufficient assistive power for walking. In view of this, we propose a novel powered ankle-foot prosthesis, which is shown to help amputee to walk in close to normal gait during clinical trials.

現有的膝下義肢一般都是被動式的，即是不能夠為截肢者提供額外的步行動力。這樣對截肢者的體能需求很大，而且他們需要以較慢的速度走路。設計動力膝下義肢有一項重要的技術挑戰，就是很難在符合體積和重量限制的同時又能提供足夠的步行動力。因此，我們設計出一個全新的動力膝下義肢，並且已在臨床試驗中證明能夠幫助截肢者以接近正常步態行走。

Social Robots for Children with Autism Spectrum Disorders (ASD)
為自閉症兒童設計的社交機械人

Prof. SO Wing Chee
Department of Educational Psychology
教育心理學系
蘇詠芝教授

Use robots to teach children with ASD gestures for communication
利用機械人教導自閉症兒童透過手勢溝通

Robots are an effective technological tool for teaching children with ASD to use gestures
機械人是教導自閉症兒童手勢的有效工具

Social robots model gestures for children with ASD, teaching them to express their needs and feelings
機械人為自閉症兒童模擬手勢，讓他們學習表達自己的需要或感受

- The gestures taught enable children with ASD to easily express their feelings and needs in various circumstances (e.g. covering both ears with hands means the environment is noisy)
- These gestures are easily understood by others as they are commonly used in daily lives for communication
- Parents or teachers can easily perceive the feelings and / or needs of the children, thereby taking prompt actions to prevent incidences of challenging behaviors

- 此項目所教導的手勢讓自閉症兒童容易地在不同的情況下表達感覺和需要（例如：雙手掩耳表示環境嘈吵）
- 這些手勢亦常用於日常生活中，所以十分容易讓人明白
- 父母和老師容易察覺自閉症兒童的感覺和 ／ 或需要，從而採取及時行動以防止問題行為的發生

Children with autism have difficulties in communicating what they need, leading to frustration and also challenging and self-injurious behaviors, and in long terms, social exclusion, as well as limited educational and vocational opportunities. Gesture is an effective communication channel for these children to express feelings and needs; while it is found that among different learning media, they prefer robot-like toys to non-robotic toys and human beings. We therefore aim to use social robot to teach children with autism relevant gestures to effectively communicate their needs and feelings, so as to reduce their challenging behaviors and improve their physical health.

自閉症兒童不太懂得表達自己的需要，因此會導致挫敗感、問題行為和自傷行為，長遠會造成社會排斥、有限的教育及就業機會等後果。對於自閉症兒童傳達感覺和需要而言，手勢是一種有效的的溝通渠道。此外我們發現在不同的學習媒介中，他們喜歡機械人玩具多於非機械人玩具和人類。因此，我們旨在利用社交機械人教導自閉症兒童透過手勢表達他們的需要和感受，從而減少問題行為的發生以及改善他們的健康。
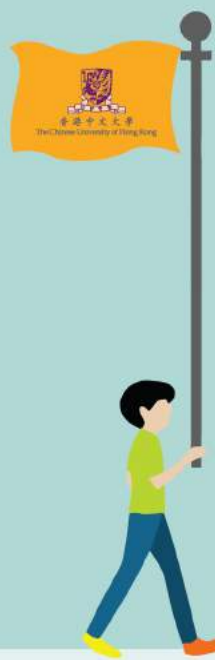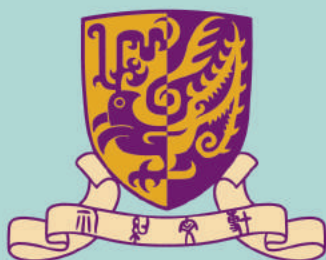
香港中文大學
The Chinese University of Hong Kong

If you are interested in any of the projects listed in the booklet

Please contact

Centre for Innovation and Technology
The Chinese University of Hong Kong

如閣下對本刊內任何科研項目有興趣

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