香港中文大學
The Chinese University of Hong Kong

PREFACE
序言

Being a forward-looking comprehensive research university, The Chinese University of Hong Kong (CUHK) pursues excellent innovative research with passion. In this booklet, we compiled some of the latest CUHK research results including thirteen award-winning projects in the 47th International Exhibition of Inventions of Geneva from various departments.

Centre for Innovation and Technology (CINTEC), a technology transfer arm of CUHK under the Faculty of Engineering, is pleased to share with you the innovative research work of our university. We serve as a bridge between the university and the industry, and facilitate open communications and industrial collaborations.

An electronic version of this booklet is also available online: exhibition.cintec.cuhk.edu.hk/-exhibition. Moreover, should you have any enquiries, please do not hesitate to contact us by phone: (852) 3943 8221 or email: enquiry@cintec.cuhk.edu.hk.

Thank you for your interest in the innovations of CUHK.

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

作為一所具前瞻性的研究型綜合大學，香港中文大學（中大）致力追求卓越與創新。本刊編修多個來自中大不同學院及研究單位的最新科研成果，當中包括於第四十七屆日內瓦國際發明展獲獎的十三個項目。

創新科技中心專注中大工程學院的技術轉移工作，目的是向大眾推廣中大的最新研究成果。與此同時，中心積極連繫大學與業界，並以促進中大研究團隊與業界的交流與合作為己任，推動科技轉移。

本刊的電子版本亦同時上載於：exhibition.cintec.cuhk.edu.hk/exhibition，供大家瀏覽。此外，如有任何查詢，請與我們聯繫，電話：(852) 3943 8221電郵：enquiry@cintec.cuhk.edu.hk。

謹此感謝各位對中大創意及科技的關注。

香港中文大學
創新科技中心主任
黃錦輝教授

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B

BIOMEDICAL SCIENCES

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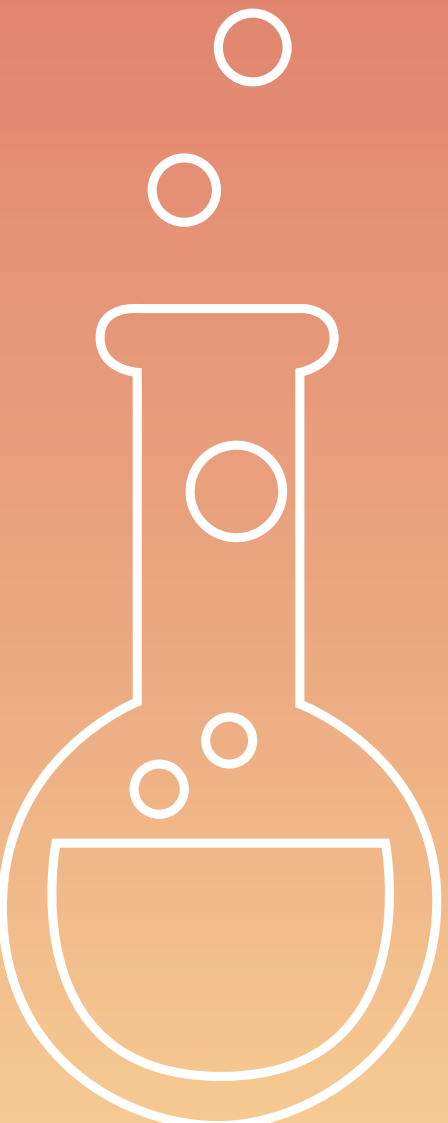
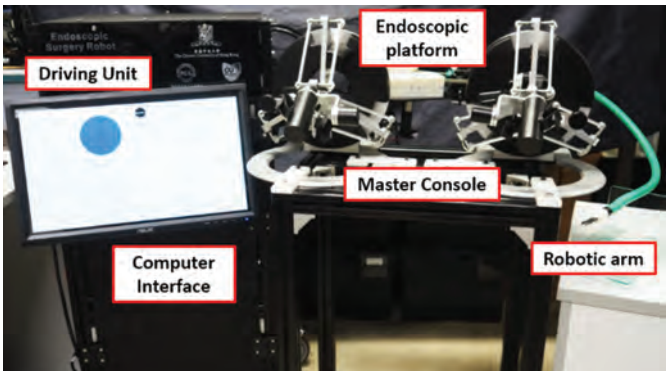


ENDOSCOPIC SURGICAL ROBOTIC SYSTEM

內鏡手術機械人

Flexible endoscopy has emerged as a technique not only to inspect gastrointestinal (GI) disorders but also to provide therapeutic management to early GI cancers and other digestive diseases. CUHK has developed a high maneuverability two-arm endoscopic surgical robotic system for digestive diseases, which will enable surgeons to perform sophisticated surgical procedures with high accuracy and thus increase surgical safety and success rate. Surgical procedures can be performed by introducing flexible tools through the working channel of an endoscope to reach the site of interest without the need for creating an opening in the patients' body, greatly reducing the pain and speeding up recovery.

軟管式內鏡技術不但可以用作檢查胃腸道疾病，更可用來治療早期消化道癌及其他消化系統疾病。中大研發出具有高靈活性的消化道疾病內鏡兩臂機械人手術系統，讓醫生可以更精準地進行複雜的手術程序，增加手術的安全性及成功率。進行內鏡手術時，手術工具可通過內鏡的工作管道伸進患者體內，免卻了開刀的需要，因而能大大減輕病人的痛楚以及加速康復。



Prototype of endoscopic surgical robot
內鏡手術機械人之原型

- We propose smart and flexible technologies in three technical areas:
  1) smart sensors and actuators for flexible robots
  2) intelligent robotic control systems
  3) bio-inspired suturing protocols
- Our developed two-arm robotic system is able to complete surgical procedures such as tissue retraction.
- Our control system has a high maneuverability.
- The design is compatible with existing platforms and endoscopes.

- 我們針對三個技術層面，研發高端靈活的科技:
  1) 內鏡機械人的智能感應器和執行器
  2) 智能內鏡機械人的操作系統
  3) 仿生機械人內鏡縫合器
- 我們研發的兩臂機械人手術系統能夠完成精細的外科手術步驟，例如把器官組織拉高。
- 我們的操作平台具有很高的靈活性。
- 設計能與現有的平台和內窺鏡兼容。

Prof. CHIU Wai Yan Philip
趙偉仁教授
Department of Surgery
外科學系

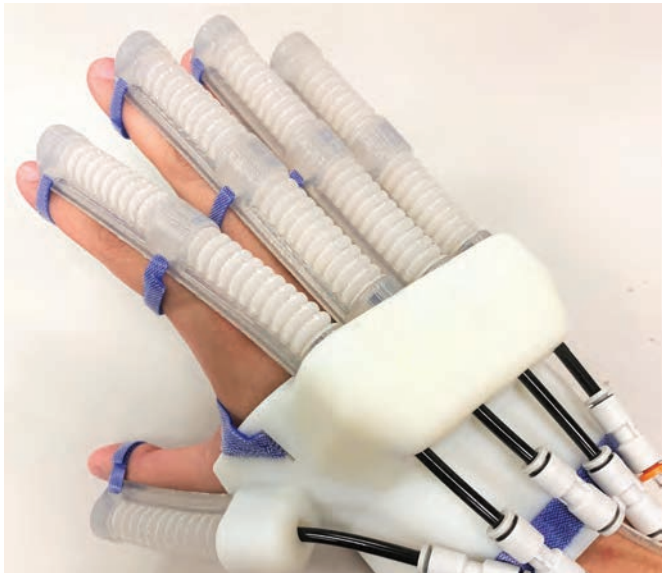
Prof. YAM Yeung
任揚教授
Dr. LAU Ka Chun
劉家駿博士
Department of Mechanical and Automation Engineering
機械與自動化工程學系

Gold Medal with Congratulations of the Jury, 47th International Exhibition of Inventions Geneva
第47屆日內瓦國際發明展評判嘉許特別金獎

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

3D-PRINTED SOFT ROBOTIC HAND FOR REHABILITATION

3D打印軟體復康機械手



Soft Robotic Hand
軟體復康機械手

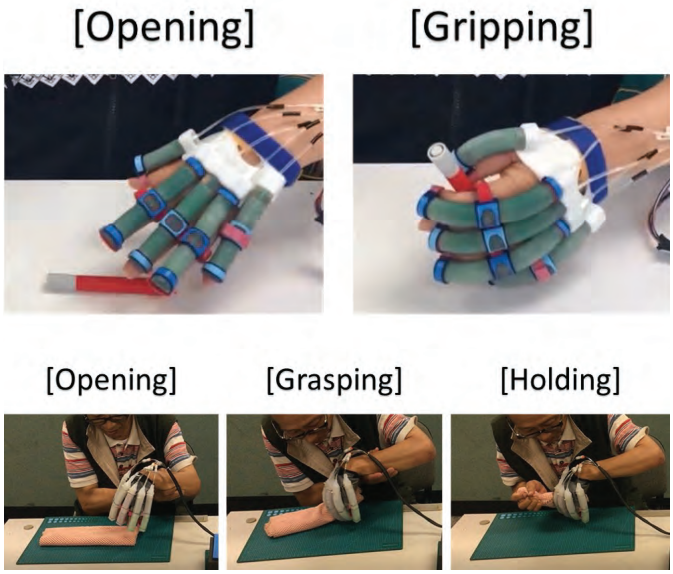
- Soft Robotic Hand can be personalized for patients, from children to adults, according to the size of their fingers and palms
- Making use of the latest silicone printing technology, our soft elastomer-based actuators support patients to control their hand muscles and effectively facilitate hand function recovery
- To facilitate the relearning of upper-limb function, the Hand is intention-driven using electrogram signals from the brain to the muscles
- 軟體機械手根據患者手指和手掌的尺寸度身訂造，不論兒童或成年患者均可使用
- 結合最新矽膠列印技術，我們的軟膠製驅動器能輔助患者控制他們的手部肌肉，有效協助手部機能復康
- 使用肌電意念控制技術，軟體機械手會因應患者的活動意欲協助完成手部動作，讓患者重新學習如何使用大腦控制手部肌肉，促進上肢活動的康復

Silver Medal, 47th International Exhibition of Inventions Geneva
第47屆日內瓦國際發明展銀獎

Funded by CUHK Research Fund and T Stone Robotics Institute of CUHK
由香港中文大學研究基金及香港中文大學天石機械人研究所資助

Stroke has been the leading cause of disability around the world. Almost every 40 seconds there will be a new stroke case. The 3D-Printed Soft Robotic Hand is designed for stroke-induced disability and hand disability rehabilitation. It can be tailor-made to fit each patient's hand. This light-weight robotic hand facilitates both flexion and extension of fingers with spasticity and assist the hand function rehabilitation training. It provides a personalized and affordable solution for stroke rehabilitation training.

中風是全球引致殘障的主因之一，每約40秒便有一個中風個案。3D打印軟體復康機械手是專為中風人士和手活動障礙人士設計的復康工具，可根據患者手部尺寸度身訂造。這款輕巧的軟性機械手可以協助患者屈曲和伸展手指，幫助患者改善手部活動能力，為患者提供一個可個人化和價格實惠的復康訓練方案。



A stroke survivor grabbing pen and towel with 3D-Printed Soft Robotic Hand
中風患者使用3D打印軟體復康機械手抓筆和毛巾

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Department of Biomedical Engineering
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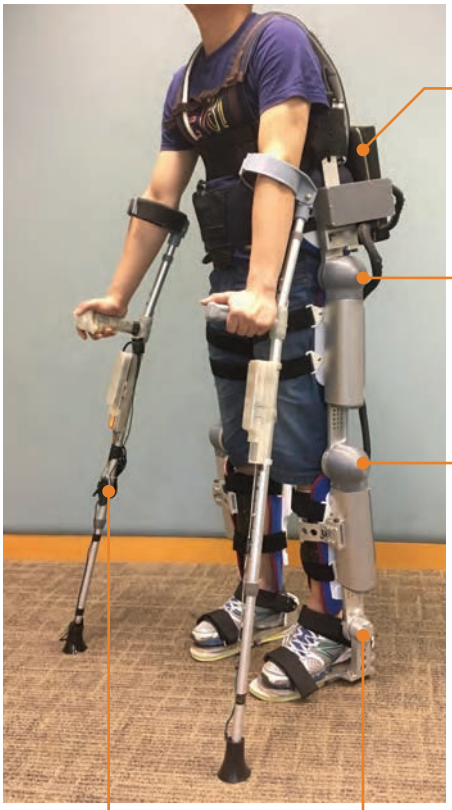
Department of Surgery
外科學系

WEARABLE EXOSKELETON FOR MOTION ASSISTANCE

用於步行輔助的穿戴式外骨骼

Patients suffering from lower extremity paralysis, which can be caused by stroke, spinal cord injury or other diseases, have to rely on wheelchairs for locomotion. In long term, it will increase the risk for several secondary medical consequences of paralysis. To improve the health and the quality of life of paralyzed patients, we have developed an exoskeleton suit, which is a wearable robotic device designed to aid paralyzed patients to stand and walk. The overall exoskeleton design includes ergonomics and body mechanics, actuators, multi-sensor systems, embedded control and user interface.

不少病人因中風、脊髓損傷等疾病而下身癱瘓，需要使用輪椅代步，但長期使用輪椅會誘發其他疾病。為了改善癱瘓病人的健康和生活質量，我們研發出一個外骨骼套裝，即一種能夠幫助癱瘓病人站立和行走的穿戴式機械人裝置，當中包括人體工學與生物力學、驅動器、多傳感器系統、嵌入式控制以及使用介面的設計。



- Novel multifunctional magneto-rheological actuators and unique spring-driven mechanism are designed to improve energy efficiency and avoid foot-drop problem.
- Gait analysis and motion control algorithms have been developed so that the system can recognize the wearer' s motion intention based on body posture and center of gravity, and provide the desired thrust accordingly.
- Patients suffering from total loss of lower extremity strength can stand and walk with the suit; while for patients who have partial lower extremity strength, it can automatically adjust the level of assistance and hence encourage patients' active participation for rehabilitation.
- 採用了多功能磁流變驅動器和獨特的彈簧驅動結構設計，有效減少能量消耗和避免足下垂問題。
- 通過步態分析和運動控制，基於人體姿態和重心變化而識別使用者的步行意向。
- 外骨骼套裝不但能幫助完全失去下肢力量的病人站立與行走，同時亦能自動調節輔助水平，從而鼓勵還有一部分下肢力量的病人使用自己的力量行動，幫助他們康復。

Silver Medal, 47th International Exhibition of Inventions Geneva
第47屆日內瓦國際發明展銀獎

Prof. LIAO Wei-Hsin
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Department of Mechanical and Automation Engineering
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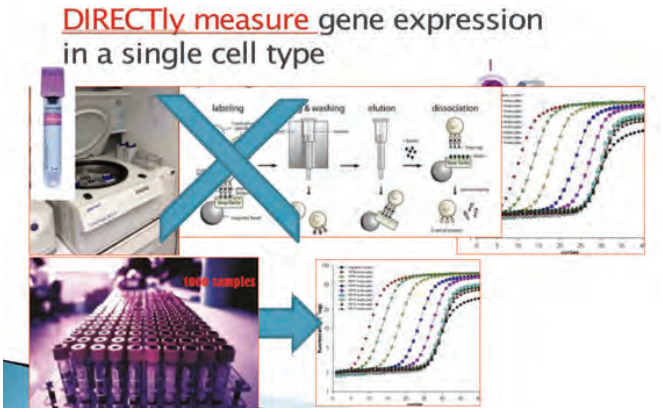
Funded by Innovation and Technology Commission and Research Grants Council of Hong Kong
由創新科技署及香港研究資助局資助

Collaboration with Department of Orthopaedics and Traumatology of CUHK, Prince of Wales Hospital and Tai Po Hospital
合作夥伴為香港中文大學矯形外科與創傷學系、威爾斯親王醫院及大埔醫院

SINGLE CELL POPULATION GENE EXPRESSION BIOMARKERS: AS EMERGING ROUTINE BLOOD TESTS

單細胞群基因表達生物標誌物：新興的常規血液檢測

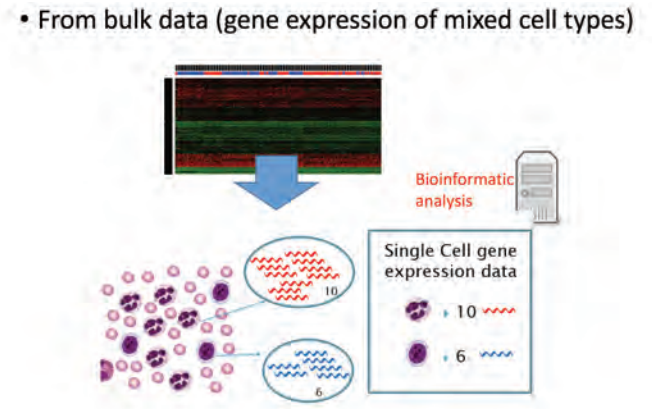


This is an assay to determine gene expression level of a specified cell-type subpopulation (e.g. T cell) by direct analysis of a whole blood sample without the need of prior separation of the component cell populations. The assay can be performed by real time qPCR, microarray or RNA-seq platforms. Applications are huge as it enables gene expression tests to be used in routine medical setting.

我們研發了創新的常規血液檢測方法，不同於傳統方法中需要預先進行細胞分選，通過直接分析血液便能檢測特定細胞類型（例如：T細胞）的基因表現水平。此血液檢測方法可以通過定量即時聚合酶鏈鎖反應、微陣列或核糖核酸測序平台進行，能廣泛應用在常規醫療環境中的基因表達測試。

- Proof of concept with Direct LS-TA (leukocyte subtype-transcript abundance) assay for T cell specific gene expression in whole blood samples
- Can be used in qPCR platform with as little as 2 gene markers
- Avoid labour-intensive cell separation procedures not feasible in hospital service laboratory
- Applications in infectious disease and immunological diagnosis, e.g. renal transplant patients on immunosuppressant therapy

- 已使用Direct LS-TA (leukocyte subtype-transcript abundance) 檢測血液中的T細胞基因表達作概念驗證
- 只需2個基因標誌物便可用於定量即時聚合酶鏈鎖反應平台
- 避免了因人手需求大而不會在醫院實驗室進行細胞分選程序
- 應用於傳染病和免疫學診斷，例如：腎移植患者接受的免疫抑制治療



Bronze Medal, 47th International Exhibition of Inventions Geneva
第47屆日內瓦國際發明展銅獎

Prof. TANG Leung Sang Nelson
鄧亮生教授

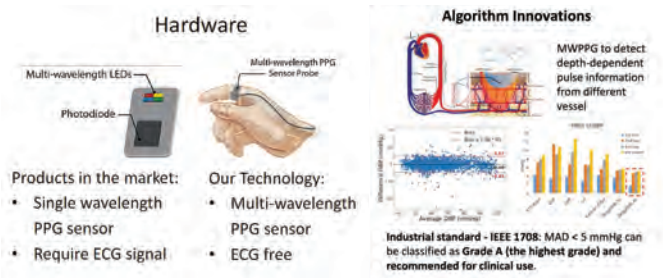
Department of Chemical Pathology
化學病理學系

UNOBTRUSIVE SMART HEALTH-MONITORING TECHNOLOGIES FOR ELDERCARE AND PREVENTION OF DEMENTIA

用於長者護理及預防腦退化症的無干擾智能健康監測技術

Most of the wearable devices in the market are consumer fitness tracker for recording heart rate, sleep behavior and step count etc. Even though some devices can monitor the blood pressure (BP), which only provide a snapshot measurement. They cannot serve as medical devices to perform long-duration and high accuracy monitoring of vital signs for daily-use, especially cardiovascular-related vital signs. It is important to measure BP continuously for nighttime monitoring and accurate diagnosis of different cardiovascular disease symptoms and vascular dementia for elderly. In view of this, CUHK team develops an unobtrusive health-monitoring system combining multimodality sensing and machine learning technologies by integrating novel sensor designs, signal generation and processing methods (included multi-wavelength photoplethysmogram and multi-sensor coordination) in a medical wearable platform, in order to achieve early detection of cardiovascular diseases, effective remote health monitoring and prevention of dementia for the elderly.

市面上的可穿戴設備大多為消費類電子健身追踪器，主要用於記錄心率、睡眠活動及行走步數，即使有檢測血壓功能，都只能作單次測量，不能作為長期、準確地監測生命表徵的日常可穿戴醫療設備，特別是針對心血管疾病的生命表徵。為老年人於夜間持續量血壓，為不同心血管疾病症狀以及血管性癡呆提供準確的診斷數據是非常重要的。有見及此，中大團隊研發一種結合多模態感測和機器學習技術的無干擾式健康監測系統，將新型傳感器設計和信號產生與處理方法（包括多波長光體積變化描記圖法和多傳感器協作）整合到一個可穿戴的醫療器件平台，應用於檢測早期心血管疾病、遠程監測老年人健康及預防腦退化症。



Our innovative hardware design and high accuracy algorithm are developed by CUHK

我們嶄新的硬件設計和高精度算法，皆為中大原創技術

Prof. ZHAO Ni
趙鈮教授

Department of Electronic Engineering
電子工程學系

Work flow of cardiovascular-related vital signs using our MWPPG-based wearable device. (Our wearable device collects signals via user' s finger or wrist and then transmits signals to mobile terminal and data center to generate a personalized health report containing the readings of cardiovascular-related vital signs.)

中大研發的多波長光體積變化描記圖法可穿戴設備產生心血管參數健康報告的工作流程。(用家使用這個可穿戴設備，在其手指或手腕處收集信號，然後傳輸到移動終端和數據中心，最後，利用我們的原創演算法產生顯示心血管相關生命表徵讀數的個性化健康報告。)

Uniqueness and Competitive Advantages:

1. High accuracy
2. Comfortable, portable and elderly-friendly
3. Unobtrusive and undisturbed
4. Continuous and real-time monitoring of the cardiovascular-related vital signs (e.g., heart rate, blood pressure, breathing rate, and blood oxygen level)

特點及優勢：

1. 準確度高
2. 舒適便攜、適合長者使用
3. 被動式監測、不妨礙日間活動和夜間睡眠
4. 持續實時監控血壓、心率、呼吸速率和血氧水平等心血管疾病生命表徵

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

Collaboration with Department of Medicine and Therapeutics of CUHK, Department of Mechanical and Automation Engineering of CUHK, Intelligent Sensing Limited, Chero Technology Co. Ltd. and ABB (Asea Brown Boveri) Co. Ltd
合作夥伴為香港中文大學內科及藥物治療學系、香港中文大學機械與自動化工程學系、智感科技有限公司、浙江智柔科技有限公司及ABB有限公司

CLINICAL EVALUATIONS AND APPLICATIONS OF INNOVATIVE OPTICAL COHERENCE TOMOGRAPHY IMAGING SYSTEM (OCTIS™) IN ENDOMETRIUM

創新光學相干斷層掃描成像系統 (OCTIS™) 於子宮內膜的臨床評估與應用

Optical Coherence Tomography Imaging System (OCTIS™)
光學相干斷層掃描成像系統

Half of the causes of women's infertility are related to the uterus, but the existing methods for examining the endometrium are external, and the resolution of the image is low, such as ultrasound, MRI, etc. Hence, doctors failed to distinguish whether the endometrium has inflammation, injury or defects etc., which may affect the chance of conception. Department of Obstetrics & Gynaecology from CUHK adopted the first Optical Coherence Tomography Imaging System (OCTIS™) for endometrium in the world. OCTIS™ incorporates catheter-based rotational and pullback probes with improved OCT technologies. It can be used in endoscopy for ductal organ imaging. CUHK team carried out comprehensive clinical evaluations of OCTIS™ in endometrium imaging for 20 women, and then tried to discover underlying cause of the disease. As a result, OCTIS™ can improve the pregnancy outcome in women with reproductive failure undergoing embryo transfer.

婦女不育成因，有一半是與子宮有關，但現有檢查子宮內膜的方法，都是外在的，而且影像的解析度低，例如超聲波、磁力共振等，未能仔細分辨子宮內膜是否有發炎、損傷或瘜肉等，可能影響受孕機會。中大婦產科學系使用全球首部檢查子宮內膜的光學相干斷層掃描成像系統（OCTIS™），利用導管式迴旋轉探頭，以及改進的OCT技術合併應用於內窺鏡作管道器官成像。中大團隊用OCTIS™為二十名婦女初步評估後，再對症下藥，結果可為當中接受胚胎移植婦女改善妊娠的機會。

OCTIS™ has two main advantages:

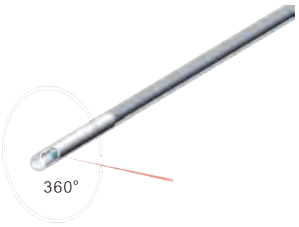
1. Less harmful to patients. It is because this system is minimally/non-invasive, and it uses near infrared non-ionizing radiation. Additionally, there is no side effects of hysteroscopy.

2. Better imaging. This system provides real-time imaging for pathological diagnosis. Those images are high-resolution, scanned cross-sectionally and longitudinally. Thus, we can obtain potentially microscopic structural and 3D reconstruction.

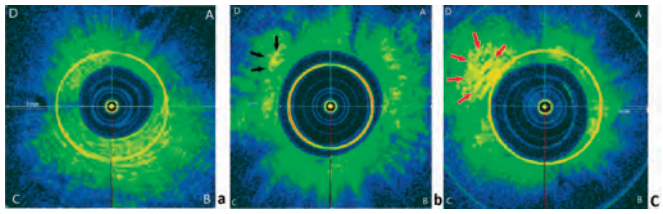
光學相干斷層掃描成像系統（OCTIS™）有兩大好處：

1. 對病人影響較少。因本系統是低/非侵入性的，並且使用近紅外光而非電離輻射，也沒有宮腔鏡檢查的副作用。

2. 有影像優勢。能為病理診斷提供即時成像，而那些影像都是高解析度、同時掃描橫截面和縱向面，因此有潛力看到微觀結構及重建3D影像。



Catheter-based rotational and pullback probe
導管式迴旋轉探頭



Left pic: A normal endometrium
Middle and right pics: Two different diseased endometriums
左圖：正常的子宮內膜
中圖及右圖：出現問題的子宮內膜

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

Collaboration with Tomophase Ltd. and Guangdong Winstar Medical Technology Co. Ltd.
合作夥伴為湯姆飛思(香港)有限公司及廣東永士達醫療科技有限公司

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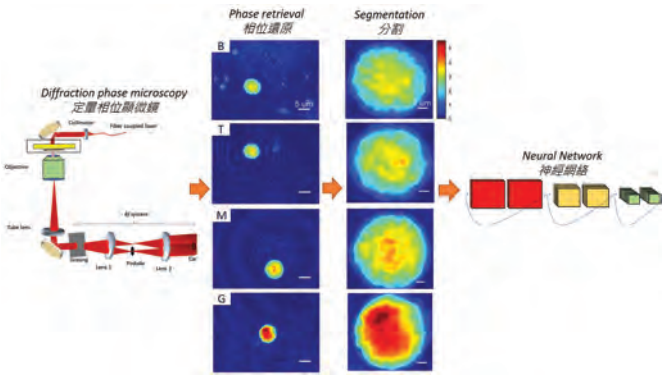
婦產科學系

AI-ENABLED PORTABLE QUANTITATIVE PHASE MICROSCOPE FOR BLOOD TESTING

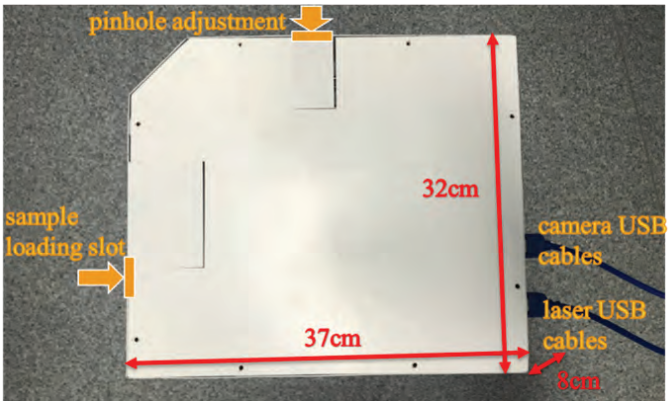
應用於血液檢測的人工智能便攜式定量相位顯微鏡

Through blood analysis, we can know the health condition in general. The increase or decrease in the number of immune-functioning leukocyte / white blood cell can reflect different diseases such as inflammation, infectious diseases and leukemia. Currently commonly used blood testing methods include manual observation on stained smears and fluorescence detection via flow cytometry, but the process is time consuming and labor intensive. Quantitative phase microscopy is a label-free imaging technology that has high imaging sensitivity and speed, but the instruments based on it are bulky and expensive. In order to provide high-precision blood testing technology in general clinics and underdeveloped areas, the CUHK team developed a low-cost artificial intelligent portable quantitative phase microscope to identify different types of human leukocytes based on quantitative phase imaging and deep learning. By learning the morphological features from thousands of cells in two-dimensional quantitative phase images, our learning model can distinguish monocytes, granulocytes, T-cells and B-cells from healthy volunteers' blood samples.

一般來說，透過血液分析已可知道身體的健康情況如何，單看具免疫功能白細胞數量的增加或減少，已可反映不同疾病，例如炎症、傳染病、白血病等。目前常用的血液檢測方法包括通過人工觀察染色塗片，以及用流式細胞儀進行熒光檢測，但過程耗時且費力。至於另一種毋須標記而又靈敏度高、成像快的定量相位顯微技術，市場上的產品都是體積龐大又昂貴的。為了讓普通診所及欠發達地區都有機會使用高精度的血液檢測技術，中大團隊基於定量相位成像和深度學習，開發了低成本的人工智能便攜式定量相位顯微鏡來識別不同類型的人類白細胞。通過在二維定量相圖像中學習數千個細胞的形態特徵，我們的學習模型可以分辨健康血液樣本中的單核細胞、粒細胞、淋巴細胞中的T細胞和B細胞。



Analysis Process
分析過程



AI-enabled portable quantitative phase microscope prototype
人工智能便攜式定量相位顯微鏡系統原型

Uniqueness and Competitive Advantages:

1. Low-cost
2. High sensitivity (~ 1 nm)
3. High range of lateral resolution (0.5 μm ~ 2 μm)
4. High throughput (field of view 50 μm ~ 200 μm)
5. High accuracy (92%)
6. High speed (a few minutes to get analysis result)
7. Compact in size and portable (37 × 32 × 8 cm with <5kg)
8. Easy to use (label-free)
9. Easily reconfigurable

特點及優勢：

1. 低成本
2. 高靈敏度 (~ 1 nm)
3. 高橫向分辨率 (0.5 μm ~ 2 μm)
4. 高效能 (視場 50 μm ~ 200 μm)
5. 高準確度 (92%)
6. 快速 (數分鐘有分析結果)
7. 輕巧便攜 (37 × 32 × 8 厘米、重量少於5千克)
8. 容易使用 (毋須標記)
9. 容易重新配置

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

Collaboration with Bay Jay Ray Technology Ltd.
合作夥伴為倍捷瑞科技有限公司

E

ENVIRONMENTAL & GREEN TECHNOLOGIES

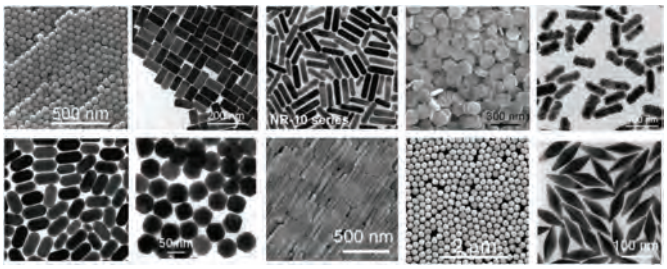
環 保 和 綠 色 技 術

NOBLE METAL NANOPARTICLE-BASED PLATFORM

貴金屬納米晶體檢測平台

The safety of food and other consumables has caught intensive attention worldwide for better quality of life. Raman spectroscopy is one of the most powerful methods in testing applications such as food, beverages, drugs, pollutants and explosives. We invented a new type of substrates for dramatically amplifying Raman signals and pushing the molecular detection limit down to the unprecedented level. The substrates are based on colloidal noble metal nanoparticles that are flexible in applications, diverse, upgradable and at low cost.

食品及消耗品的安全性是全球關注的迫切議題，各地對檢測食品中有害物質的要求愈來愈高。拉曼光譜分析法是檢測食品、飲料、藥物、污染物和爆炸物等的最有效方法之一。我們研發了一種用新型檢測平台，利用貴金屬納米晶體製成適用於拉曼光譜儀的納米芯片，能有效地增強被檢測物的拉曼信號，從而檢測當中有害物質的濃度，而且成本低廉。



- Molecular sensitivities down to the ppb level
- More than 10 types of products suitable for different application requirements
- Cost-effective detection of toxic ingredients in food and common drugs with high accuracy, such as malachite green, heroin, cocaine, amphetamine and ketamine
- Available for mass production at non-cleanroom environment
- Reduce the price by at least 50% in comparison to the existing products

Bronze Medal, 47th International Exhibition of Inventions Geneva
第47屆日內瓦國際發明展銅獎

- 分子靈敏度達到十億分率級別
- 超過10種類型的產品適合不同應用
- 提供高成本效益、高精確度的檢測方法去檢測食物中的有害物質以及社會常見毒品，例如孔雀石綠、 可卡因、海洛英以及安非他命
- 可在非無塵室環境中大量生產
- 價格與現有產品相比便宜至少50%

Prof. WANG Jianfang
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Department of Physics
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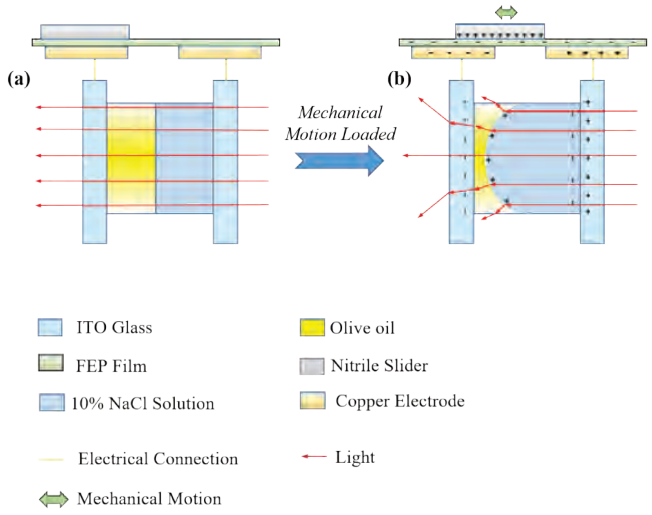
SELF-POWERED ELECTROWETTING OPTICAL SWITCH DRIVEN BY A TRIBOELECTRIC NANOGENERATOR FOR WIRELESS SENSING

用於無線網路感應的摩擦發電自驅動光學開關

The Internet of Things is widely applied in our daily live, such as smart sensing and recognition technologies, which contains thousands of sensors. Replacement of batteries for sensors is a difficult task and disposal of batteries may contaminate soil and water. By combining freestanding sliding mode triboelectric nanogenerator (FS-TENG) and electrically tunable liquid lens (ETULL) made of environmentally friendly materials, we develop a self-powered electrowetting optical switch (EOS) for wireless sensing networks.

物聯網廣泛應用於我們的日常生活當中，例如智能感知、識別技術等。當中使用的傳感器成千上萬，為傳感器更換電池是一項艱鉅的工作，廢棄電池亦會污染土壤和水源。我們結合摩擦納米發電機和使用環保物料製作的電調節液體透鏡，透過滑動摩擦納米發電機實現了自驅動光學開關，可供無線傳感器網絡使用。



Switching mechanism of the EOS, where the mechanical-electrical-optical signal conversion occurs
電潤濕光開關的切換原理，實現機械—電學—光學信號轉換

- Low cost, environmentally friendly
- ETULL was fabricated by conducting fluid, insulating oil, transparent cylindrical spacer and indium tin oxide (ITO) electrodes
- Switch controlled by voltage generated by the FS-TENG: light propagation through the ETULL; and light diverging by the concave lens due to electrowetting effect upon applying a voltage on the ETULL
- Our design can detect both initiation and termination of mechanical motions, while most of the current mechanical sensors can only monitor motion initiation
- Potential applications for environmental monitoring, building and infrastructure monitoring, wireless human machine interface, etc.

- 低成本、環保
- 電調節液體透鏡由導電液體、絕緣油、透明圓柱體和氧化銦錫電極組成
- 使用摩擦納米發電機在電調節液體透鏡兩端增加電壓，以控制開關：平常讓光通過的開啟狀態及電潤濕效應形成曲面的關閉狀態
- 大部分現有的機械傳感器只能偵測運作的啟動，我們的設計則可以檢測機械的運作和停止
- 可應用於環境監控、建築物安全監測、無線人機介面等

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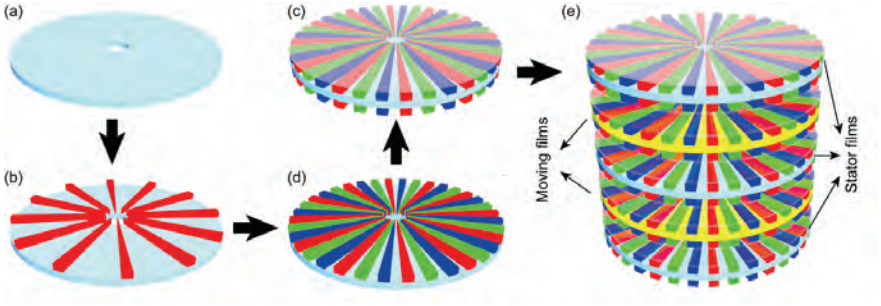
Department of Mechanical and Automation Engineering
機械與自動化工程學系

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

SELF-POWERED ELECTROSTATIC ROBOTICS ENABLED BY THREE-PHASED TRIBOELECTRIC NANOGENERATOR

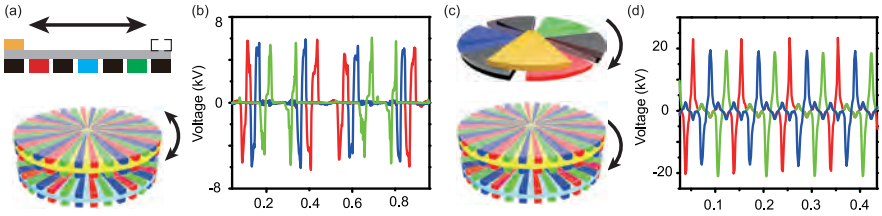
基於三相摩擦納米發電機的自驅動靜電機器人

Flexible and ultra-thin robots can work in special environment, such as industrial use, cleaning systems and medical operations. However, powering micro robot systems is still a challenge. We develop a three-phased triboelectric nanogenerator (TENG) that can convert mechanical energy in the environment into electrical energy, and hence produce a self-powered electrostatic robot. Potential applications include cleaning robot for home, thrombolytic therapy for severe blood clots, etc.

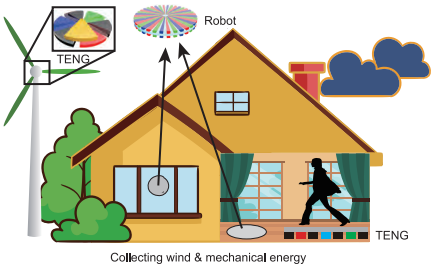


Fabrication process of the electrostatic robotics
靜電機器人的製作過程

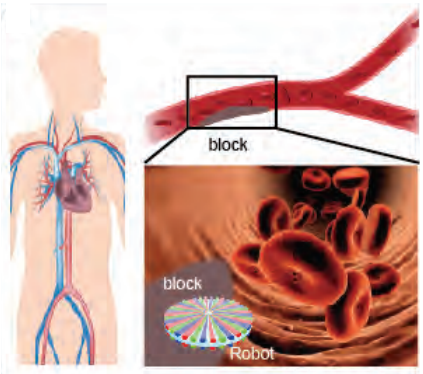
柔軟超薄的機器人可以在狹窄等特殊環境下工作，如用於工業用途、清潔系統和醫療服務。然而，為微機器人系統提供穩定電能仍然是一個挑戰。我們開發了一種三相摩擦納米發電機，能夠將環境中的機械能轉換為電能，從而為靜電機器人提供能量。自驅動靜電機器人可應用於家用清潔機器人、血栓疏通機器人等。



Electrostatic robotics powered by three-phased triboelectric nanogenerator
由三相摩擦納米發電機驅動的靜電機器人



Collecting wind energy and mechanical energy to power a cleaning robot
收集風能和機械能為清潔機器人提供動力



Collecting mechanical energy from blood to power a micro surgical robot
收集血液中的機械能為微型手術機器人提供動力

- Flexible and ultra-thin system
- Three-phased TENG can convert mechanical energy in the environment into electrical energy
- Self-powered system does not require an external power supply
- Energy can be remotely transmitted and the movement of the robot can be precisely controlled
- 柔軟超薄的系統
- 三相摩擦納米發電機收集環境中機械能並轉化為電能
- 自供電系統，無需外部電源
- 能夠遠程傳輸，精確控制機器人系統的運動

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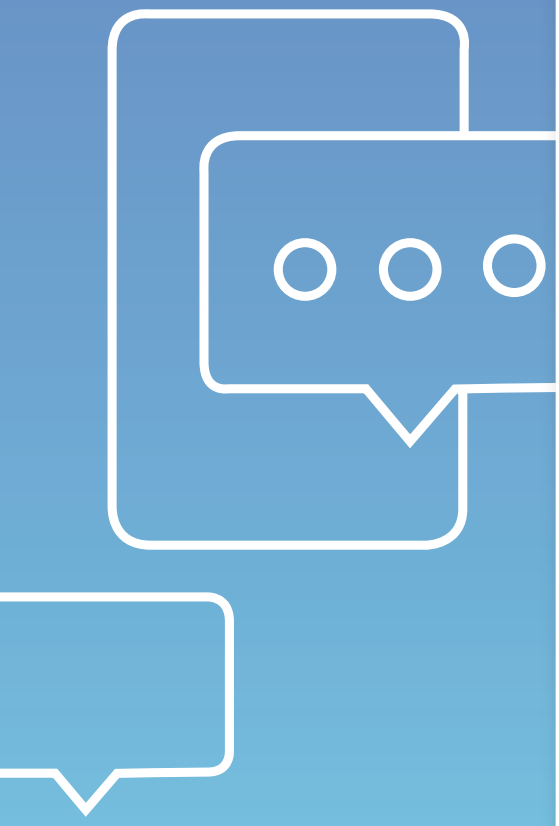
機械與自動化工程學系

Collaborated with Harvard University and Southern University of Science and Technology
合作夥伴包括哈佛大學及南方科技大學

I

INFORMATION & COMMUNICATION TECHNOLOGIES

信 息 和 通 訊 科 技



BATS: A NOVEL NETWORK CODING TECHNOLOGY

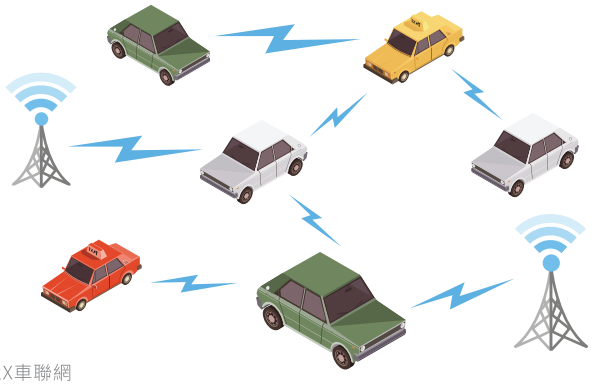
全球首創網絡編碼技術BATS

ENABLING THE NERVOUS SYSTEM OF SMART CITIES

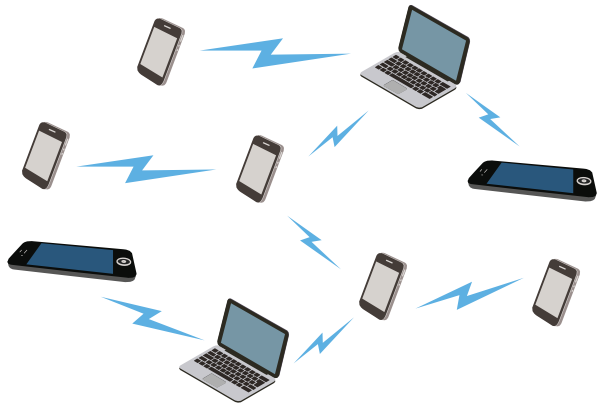
推動智慧城市發展

In recent years, there has been great advancement in wireless communication technologies. Multi-hop communication arises in many application scenarios where information needs to be transmitted to the receiver through a number of intermediate nodes. For existing technologies, however, the transmission cannot sustain more than a few hops due to channel noise and interference. BATS is a proven and patented network coding technology that solves this longstanding problem. BATS provides an efficient and ready solution for communication in Internet of Things (IoT), Vehicular-to-Everything (V2X), wireless mesh networks, etc. It paves the way for massive deployment of various smart cities devices and applications.

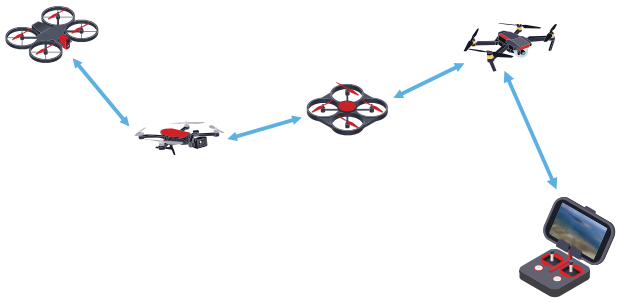
近年無線通訊科技發展迅速，具有多個中繼節點的無線多跳網絡廣泛應用在生活中。然而，現時的技術由於雜訊和干擾影響，若超過數個中繼節點便會有嚴重數據流失的情況。分批稀疏編碼（BATS）是一項可提供高速和穩定數據傳輸的專利技術，不但克服了數據流失的問題，還能為物聯網（IoT）、車聯網（V2X）、無線網狀網絡等通訊提供了有效、快速的解決方案，是實現智慧城市關鍵的一環。



V2X車聯網



Mobile Ad Hoc Networks 隨建即連網路



Drone Networks 無人機網絡

- BATS offers high-speed and stable data transmission
- The bandwidth provided by BATS is guaranteed (100 times higher than LoRa; 20 times higher than NB-IoT) which can enable services like real-time video transmission
- BATS provides a city-friendly and efficient solution for building a smart city

- BATS提供高速和穩定的數據傳輸
- BATS提供高頻寬的無線通訊（比LoRa快100倍；比NB-IoT快20倍），有助實時傳輸影片
- BATS為大規模建設智慧城市提供了一個方便、高效的解決方案

Gold Medal with Congratulations of the Jury, 47th International Exhibition of Inventions Geneva

第47屆日內瓦國際發明展評判嘉許特別金獎

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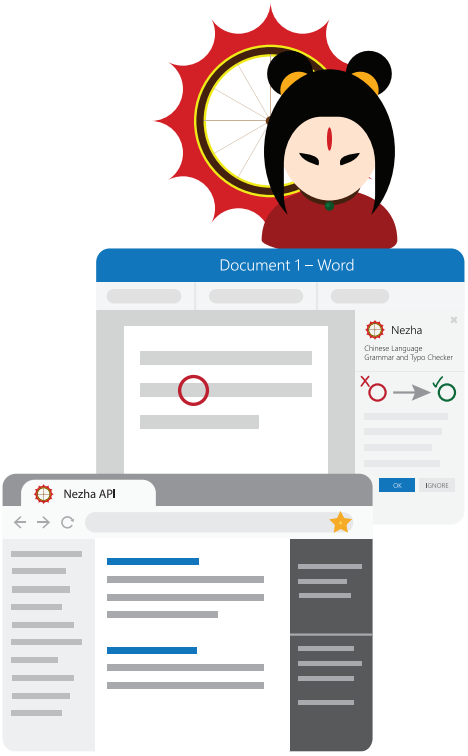
楊偉豪教授

Department of Information Engineering
信息工程學系

Collaboration with Prof. YANG Shenghao, The Chinese University of Hong Kong, Shenzhen
合作夥伴為香港中文大學（深圳）楊升浩教授

NEZHA – CHECKBOT FOR PROOFREADING CHINESE LANGUAGE

「哪吒」– 中文校對機器人



Nezha is an AI-driven Chinese language Checkbot. It helps users proofread Chinese. In Nezha's lexicon, there are billions of Chinese vocabulary (more than 100GB) built from advanced natural language processing (NLP) technology. No dictionary in the market contains such a huge volume of vocabulary. This makes Nezha highly accurate. Nezha also possesses a proprietary data analytic algorithm which helps speed up the time required to analyse the text against the lexicon.

「哪吒」是一個人工智能驅動的中文校對機器人，採用先進的自然語言處理技術，可以幫助使用者校對中文。在「哪吒」的詞典中，有超過十億個中文詞彙（超過100GB），現時市場上並沒有詞典產品包含如此龐大的詞彙數量。「哪吒」擁有專有的數據分析算法，有助加快分析、對比文本與詞典所需的時間。

Major Features:

- Accurate: Nezha's lexicon has billions of Chinese vocabulary. No existing dictionary has such among of data.
- Fast: With Nezha' s proprietary data analytic algorithm, it takes less than a second to proofread a newspaper article.
- Straightforward: Nezha conducts its work on the cloud. There is no need to install any bulky app.

主要特點：

- 準確：「哪吒」有數十億個中文詞彙，現有詞典產品中沒有這樣大量的數據。
- 快速：擁有專有的數據分析算法，校對報紙文章只需不到一秒鐘時間。
- 直接：透過雲端進行檢測，無需安裝任何應用程序。

Gold Medal, 47th International Exhibition of Inventions Geneva
第47屆日內瓦國際發明展金獎

Dr. FUNG Pui Cheong Gabriel
馮沛璋博士

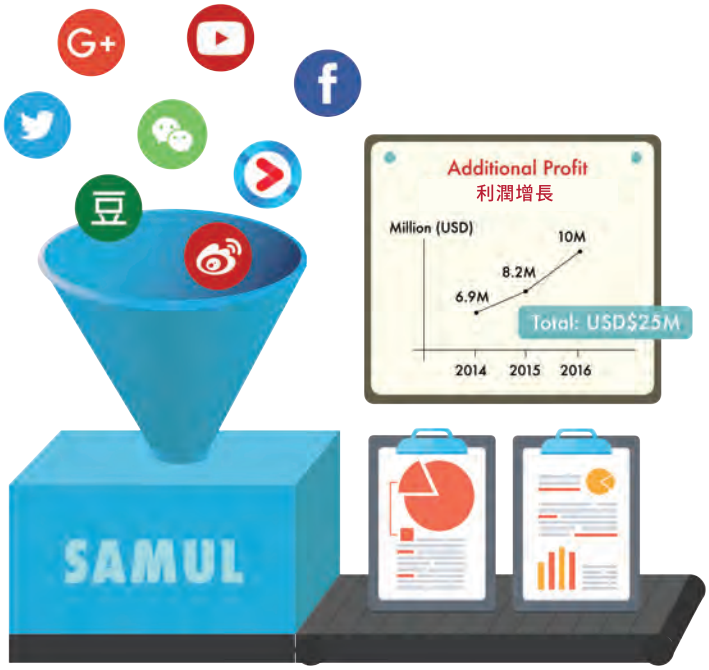
Department of Systems Engineering and Engineering Management
系統工程與工程管理學系

SAMUL - A TOOLKIT FOR SENTIMENT ANALYSIS IN MULTI-LANGUAGE

「深媒」- 多語言訊息分析工具包

SAMUL is a multilingual sentiment analysis toolkit to empower business intelligence in e-commerce. Given a specific topic, SAMUL will search, analyse, organise and report the related information from the designated social media and websites using natural language processing (NLP) and big data analytic technology. It is protected by five patents (three accepted and two pending).

「深媒」是一個多語言訊息分析工具包，用於增強電子商務中的商業智能。用戶只需輸入主題，「深媒」便會從指定的社交媒體和網站，使用自然語言處理和大數據分析技術，搜尋、分析、綜合及報告相關訊息。「深媒」已獲五項專利保護（當中三項已批，其餘兩項待批）。



Major features:

- Extract credibility, content and mood of the author of a message/ microblog
- Identify trending topics in social media
- Understand Cantonese, Mandarin and English currently, but can be extended to other alphabetic languages
- Accumulated revenue boosts of USD$25 million based on surveying six of major clients during 2014 to 2016

主要特點：

- 提取訊息的可信度、內容及作者的情緒等
- 辨別社交媒體中的熱門話題
- 現時可以閱讀廣東話、普通話和英語，並可以擴展至其他語言
- 根據對六個主要客戶的調查，「深媒」於2014年至2016年累計收入增長為2,500萬美元

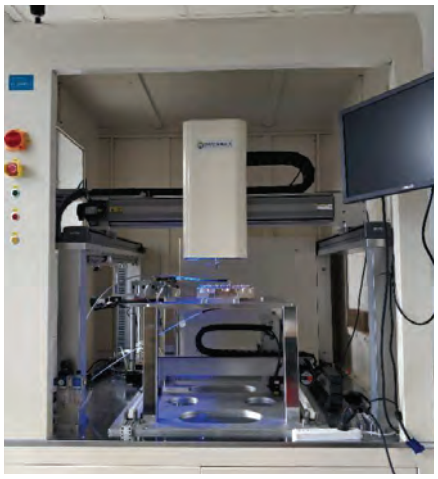
Prof. WONG Kam Fai
黃錦輝教授

Department of Systems Engineering and Engineering Management
系統工程與工程管理學系

Prize of the Ministry of Scientific Research and Innovation – Romania and Silver Medal, 47th International Exhibition of Inventions Geneva
第47屆日內瓦國際發明展羅馬尼亞創新科技協會特別大獎、銀獎

AN INTELLIGENT ROBOT SYSTEM FOR ADAPTIVE TUNING OF 5G MICROWAVE FILTERS

5G微波過濾器自我調整智能機器人調試系統

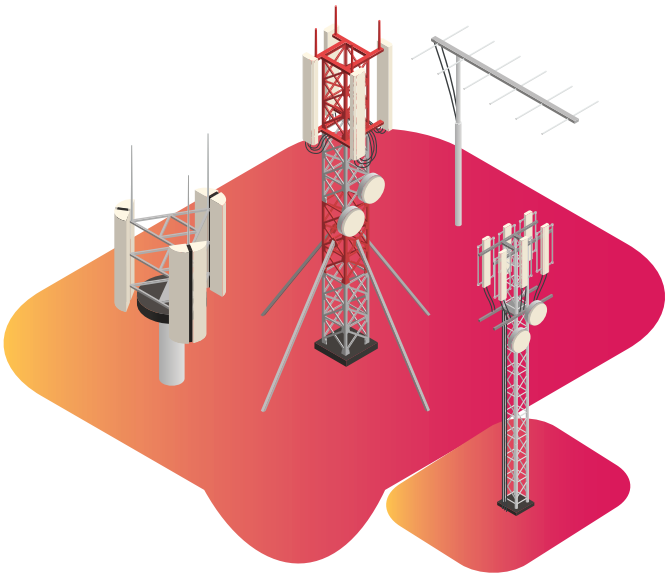


With the fast evolution of mobile communication systems, microwave filters are needed in unprecedented large quantities. Slower tuning speed and the lack of experienced filter tuning technicians are two major obstacles that lead to low production capacity. This intelligent robotic filter tuning system, which employs the analytic circuit model extraction theory and guided by the adaptive optimizers, can automatically tune filters with 2-5 times tuning speed of the manual tuning process. With the combination of the advanced filter tuning algorithm and the precise mechanical tuning platform, the system will revolutionize the filter industry.

流動通信技術的快速發展需要大量微波過濾器。然而，由於人手調試需時及缺乏具經驗的技術人員，導致微波過濾器產量不足。我們研發的智能機器人調試系統由自適應優化器引導，根據電路模型提取理論自我調整，調試速度比較人手快2至5倍。透過結合先進的調試算法和精確的機械調諧平台，系統將革新微波過濾器生產行業。

- 2-5 times faster than manual tuning process, no manual intervention needed
- One-stop solution from the filter tuning process to full inspection for every filter
- Unique in compensating the hysteresis effect of the tuning screws and tighten filter tuning screws to meet the final filter specifications
- Unique in diagnosing manufacturing and assembling defects of each filter during the tuning process and giving explicit instructions on how to fix the problem
- Applications in 5G and future microwave cavity filters in base stations

- 比手動調整過程快2至5倍，無需人手操作
- 從調整過濾器到全面檢測的一站式解決方案
- 獨特的調試系統：能補償調整螺絲的滯後效應，以符合過濾器成品的規格
- 獨一無二的品質管制系統：在調試過程中進行檢查，如有製造和裝配上的瑕疵，系統會明確指示解決的方法
- 應用於5G和未來的基站微波腔體濾波器



Silver Medal, 47th International Exhibition of Inventions Geneva
第47屆日內瓦國際發明展銀獎

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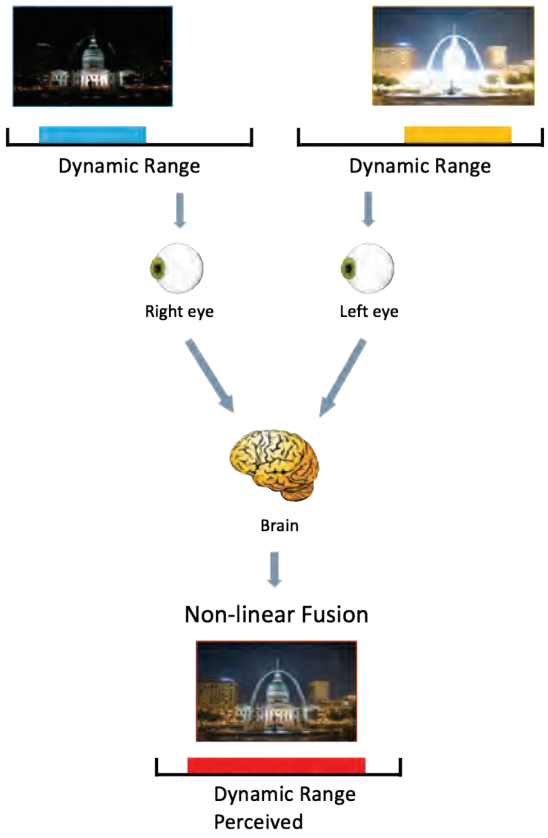
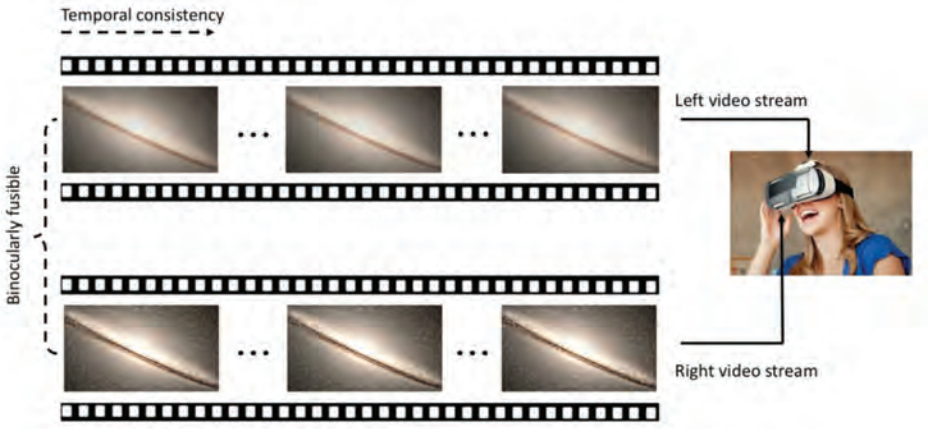
BINOCULAR SINGLE VISION FOR MEDICAL AND ENTERTAINMENT APPLICATIONS

雙目視覺在娛樂和醫療的應用研究

Human eyes are capable of fusing two displaced images, even those with differences in details, contrast and luminance, as up to a certain limit. This phenomenon is binocular single vision, based on which we developed the world's first Binocular Video Tone Mapping (BVTM) framework. Our proposed BVTM framework can be adopted in Hollywood 3D film-making industry by generating videos that quality, vividness, realism and other attributes are beyond what is currently possible. In ophthalmologic examinations, our technology can be applied for Amblyopia (Lazy Eye) treatment by engaging the idle eye with more visual depth and details.

人類的雙眼擁有自然融合能力：即使左眼和右眼看到的影像有一定程度的差異，例如由距離所產生的位移、細節、對比度和亮度等，大腦亦會自然地把兩個存在差異的影像合併，產生單一的整體感覺。我們基於雙目視覺原理開發了首個雙目視頻影調融合(Binocular Video Tone Mapping)技術，可於娛樂和醫療系統中使用。雙目視頻影調融合技術可提供高質素的3D畫面，增強亮度和對比度，應用於3D電影、3D 遊戲、3D可視化及其他數碼影像和娛樂行業。同時，我們的技術可有助治療弱視(懶惰眼)。





- An easy-to-use, low cost and high efficiency system
- Visual vividness improvement and innovative treatment
- Applications in movie, game and medical industry
- 易於使用、低成本和高效率的系統
- 提升畫面質量和創新治療方法
- 可廣泛應用於電影、遊戲和醫療行業

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Silver Medal, 47th International Exhibition of Inventions Geneva
第47屆日內瓦國際發明展銀獎

SMART LANDSLIDE DETECTION SYSTEM & SMART TRAFFIC CONTROL SYSTEM

智能山泥傾瀉監察系統 及 智能交通燈系統

SMART LANDSLIDE DETECTION SYSTEM
智能山泥傾瀉監察系統

Mountainous terrain covers 60% of the land area of Hong Kong, and landslides may happen under conditions of continuous rainfall. Civil Engineering and Development Department has been building rigid concrete barriers and flexible wire-mesh fence along the hillside to protect the residential area below. However, these barriers are often located at remote area, making it difficult to perform onsite checks for accumulation of debris and determine if debris exceed the capacity limit of barriers. Smart landslide detection system provides real-time monitor of water level, falling debris and build up, and real-time alerts to the authorities concerned.

香港有六成土地為天然山坡，在持續降雨的情況下有機會觸發山泥傾瀉。有見及此，土木工程拓展署在靠近民居的山坡上興建泥石壩或防護網，保護山坡附近居民的人身安全。然而，防護設備通常位處偏遠地方，難以進行實地檢視泥石堆積物會否超過防護設備的承受能力。智能山泥傾瀉監察系統可實時監察水位、掉落的泥石碎片及堆積情況，並向有關單位發出警告訊號。

- Low cost, durable, reliable and low power consumption system
- Effective real-time detection and monitoring system to protect lives and properties
- 低成本、耐用可靠及低耗能的監察系統
- 有效地保護市民生命和財產的實時檢測和監測系統

Collaboration with Civil Engineering and Development Department
合作夥伴為土木工程拓展署

SMART TRAFFIC CONTROL SYSTEM
智能交通燈系統

The Tai Tam Road (Dam Section) is part of the thoroughfare connecting Chai Wan and Stanley. Although it is only five metres wide, widening the road section is not possible as it is a declared monument. Congestion problems occur when larger vehicles use the road section. To solve this problem, we have developed a smart traffic control system, which has been commissioned since August 2018, by applying video analytic technology to collect real-time traffic information and adjust the duration of green signals.

大潭道水壩段是連接柴灣和赤柱的主要道路，路面僅寬約五米，若遇上大型車輛，車速均須減慢，其中一方甚或要停車讓路。由於水壩是法定古蹟，路面不可擴寬，交通擠塞的問題一直無法解決。因此，我們引入影像分析技術，研發出智能交通燈系統，並於2018年8月開始運作，收集實時交通數據，靈活調節燈號時間。

- Detection of vehicle types and dimensions for calculating the most effective green time
- Capture of images from a high angle to avoid weather, light and environmental impacts, and protect drivers' privacy
- 辨別車輛種類、長寬度等，計算出最有效的綠燈時間
- 探測器從車頂拍攝影像，避免受天氣、光線和環境影響，亦能保障車廂內人士的私隱

Collaboration with Transport Department
合作夥伴為運輸署

Silver Medal, 47th International Exhibition of Inventions Geneva
第47屆日內瓦國際發明展銀獎

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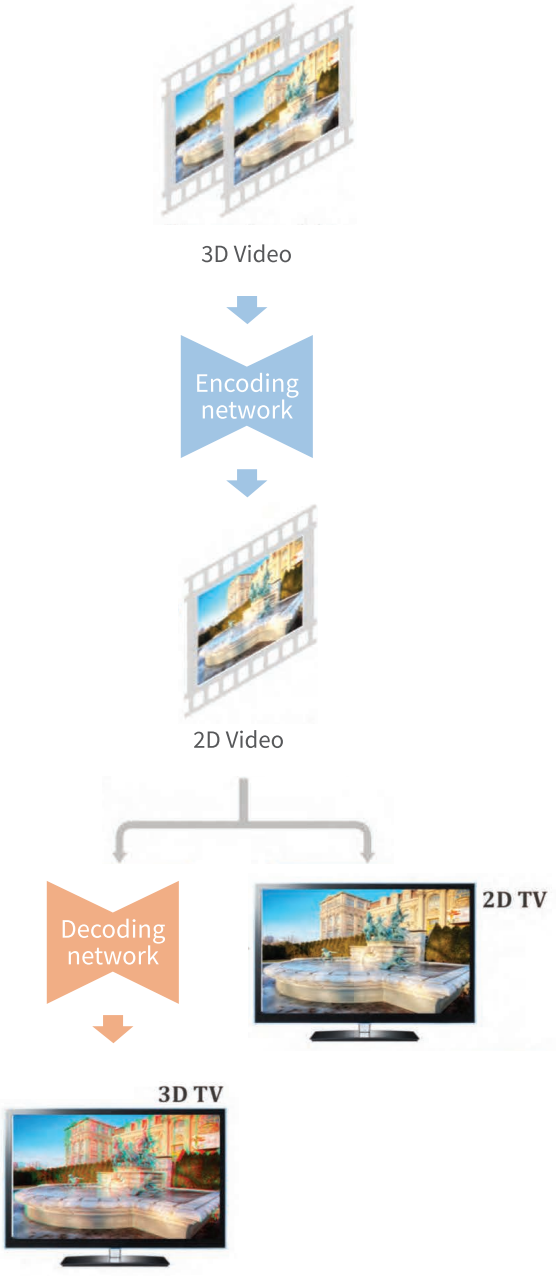
Director of Research and Technology Development, Logistics and Supply Chain MultiTech R&D Centre
物流及供應鏈多元技術研發中心研究及技術開發總監

REVERTIBLE 3D-2D VIDEO CONVERSION SYSTEM

3D-2D視頻轉換及恢復系統



Digital 3D films and TV shows consist of videos from two perspectives. Conventional 3D-to-2D conversion transforms a video from binocular to monocular by cropping one side of the video, and the converted 2D video is therefore unable to be reverted to a 3D video without loss of quality. To solve the problem, we develop a conversion and restoration process for videos and images based on deep neural network. It offers high quality conversion of 3D videos to 2D videos and a backward-compatible solution to recover 3D videos, almost without loss of quality, when 3D visual display is applied. This novel system enables transmission of videos containing stereo information in the existing distribution channels, such as TV and online media.

3D電影和電視節目包含左右眼兩個視角的視頻影像。傳統的3D-2D視頻轉換技術會把其中一個視角的視頻刪除，從而令立體視頻變為平面。因此，轉換後的2D視頻無法恢復為與原本視覺效果相同的3D視頻。為了解決這個問題，我們開發了一個基於深度神經網絡的創新3D-2D視頻轉換及恢復系統。不但可以把3D視頻轉換為高質量2D視頻，更能在應用3D顯示設備時，把轉換後的2D視頻恢復為與原視頻品質相若的3D效果。系統使含有3D信息的視頻能夠在現有的廣播渠道中傳播，例如：電視和線上媒體。

- Stereo information is encoded in the converted 2D video when a 3D video is being transformed, which can be decoded for stereo viewing if 3D visual display is applied
- Both converted 2D video and recovered 3D video are visually no difference from the original video
- Converted 2D videos, as ordinary single-view videos, are available for TV broadcasting and online streaming
- 立體信息會在3D-2D轉換過程中被編寫在2D視頻中；當使用3D顯示設備時，可以解碼這些隱藏的信息以回復3D效果
- 轉換出來的2D視頻和所恢復的3D視頻，與原視頻的視覺效果沒有區別
- 轉換後的2D視頻與普通的2D視頻一樣，可用於電視傳播和網絡傳輸

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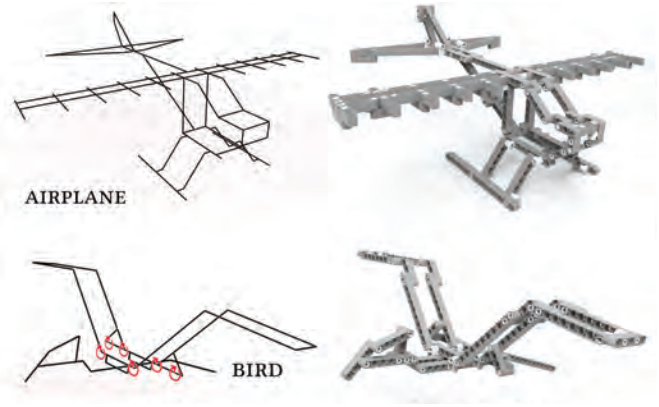
Funded by Innovation and Technology Commission and Research Grants Council of Hong Kong
由創新科技署及香港研究資助局資助

AI-POWERED DESIGN AND ASSEMBLY INSTRUCTIONS FOR INTERLOCKING BRICKS

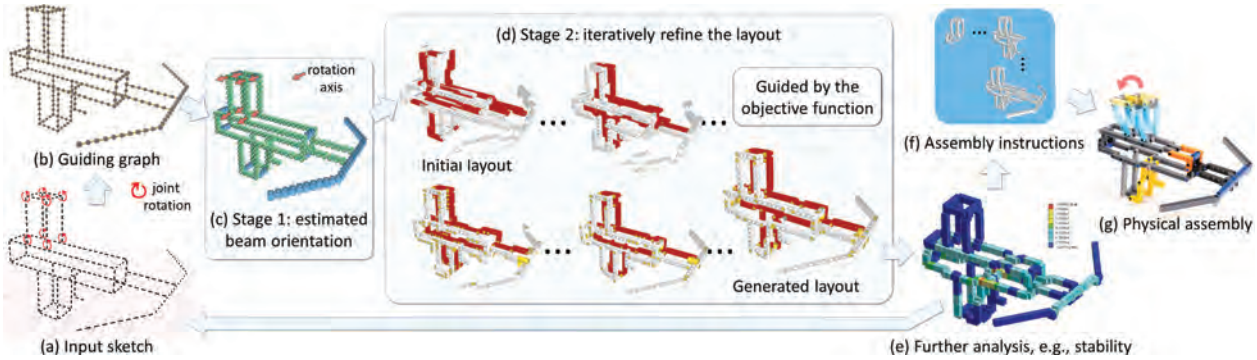
人工智能驅動的積木組件設計及組裝說明



Our method can automatically generate LEGO® Technic™ models (right) from sketches (left)
我們的方法可以從草圖 (左) 自動生成LEGO® Technic™模型 (右)

Building toys, including LEGO®, Erector Sets®, Lincoln Logs® and many other construction toys, contain interlocking bricks of different shapes to deliver high functionalities and fun. Currently, assembly instructions of models are typically designed by professional designers through months of efforts, trials and errors in choosing the types of bricks, connectedness, mechanical structures, etc. LEGO® Technic™ is one of the systems to build advanced models with real-life functions like gearboxes and bow. We have developed the very first AI-powered algorithm to automatically generate an optimized LEGO® Technic™ model with assembly instructions in only a few seconds from a simple sketch by the user.

許多建築玩具 (如LEGO®，Erector Sets®，Lincoln Logs® 等) 包含多種形狀的積木組件，以提供不同功能和增加趣味性。現時市面上的模型通常由專業設計師花費數月的時間，通過嘗試不同的積木種類、連接方式、機械結構等因素設計出來。LEGO® Technic™是其中一個高階模型系統，可構建具有工程機械結構及功能性的模型，例如：齒輪箱和弓。 我們提出首個人工智能驅動的自動生成算法，只需要幾秒鐘就可以把簡單的草圖變為優化的LEGO® Technic™模型，並配有組裝說明。



- A comprehensive system to design models with stability, symmetry, balance, connectedness and assembly instructions
- A system that helps children, ordinary people and professional designers to design LEGO® Technic™ models simply by sketching
- A computational method that can be extended to not only all kinds of interlocking blocks, but also architecture, bridge and mechanical design

- 可組成具有穩定性、對稱性、平衡性、連接性的模型，並自動生成組裝說明的全面模型設計系統
- 系統有助小孩、普通人以及專業設計師通過簡單的草圖來設計LEGO® Technic™
- 我們的算法不僅可以擴展到所有類型的積木組件，還可以應用於建築及工業設計上

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

Collaboration with Simon Fraser University
合作夥伴為西門菲莎大學

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SEMANTIC IMAGE-BASED CLOUD AUGMENTATIVE AND ALTERNATIVE COMMUNICATION (CLOUD AAC) SYSTEM

基於語義圖像的雲輔助和替代式通信系統

User interface of the system prototype of EasyDial and semantic recommendation function of AAC symbols
EasyDial系統原型的用戶界面及語義相關的AAC符號建議功能

People with complex communication needs, such as those with cerebral palsy, dementia, aphasia, developmental disorders, and those in acquired medical conditions, do not possess the necessary cognitive abilities and/or motor skills to conduct daily verbal communication. They often need to rely on augmentative and alternative communication (AAC) to express their thoughts, feelings, and needs. This project aims at enabling end users with complex communication needs to conduct real-time telephone-like conversations. We have developed the world's first-of-its-kind cloud AAC system, and piloted it with people with severe communication disabilities, so as to help developing and promoting their communication competence.

具有綜合溝通需求的人士，包括先天患有腦癱、認知障礙、失語症、發展障礙等及在後天醫療情況下的人士，往往欠缺所需的認知及/或運動能力去進行日常口語溝通。他們需要依靠輔助和替代式溝通(AAC)方法來表達思想、感受和需要。本項目旨在讓具有綜合溝通需求的使用者進行類似電話通話形式的實時對話。我們研發了全球首個雲輔助和替代式通信系統，並已在患有嚴重溝通障礙的使用者之間完成用戶測試，以幫助發展及提升他們的溝通能力。

- Successfully applied artificial intelligence and cloud communications to AAC to enable daily mobile communication in people with complex communication needs
- The system will gather anonymized AAC usage data, and can inform speech therapy practices with big data analytics
- The project technology will be transferred to SAHK and productized into EasyDial for usage in regular rehabilitation service
- 成功把人工智能及雲通信技術應用到輔助和替代式溝通上，讓具有綜合溝通需求的人士能夠進行日常移動通信
- 系統將會以不記名方式收集AAC使用數據，並可透過大數據分析為言語治療應用提供實質參考
- 項目內的技術將會轉移至香港耀能協會以發展成EasyDial系統於常規康復服務中使用

Users performing system trials under the facilitation by professional speech therapists from SAHK
使用者在香港耀能協會言語治療師的協助下為系統進行用戶測試

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

Collaboration with SAHK
合作夥伴為香港耀能協會

JOCKEY CLUB VR PROJECT FOR ENHANCING CHINESE LANGUAGE LITERACY

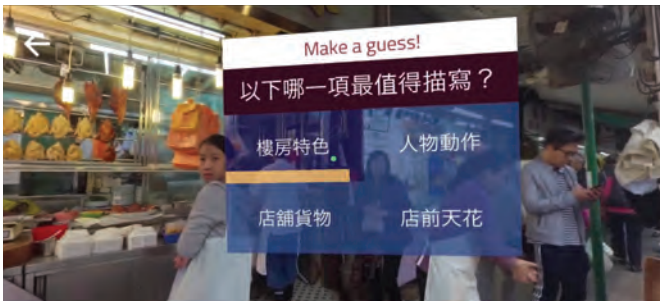
賽馬會「觸境生情」虛擬實境語文教學計劃

ENHANCING CHINESE LANGUAGE LITERACY THROUGH VIRTUAL REALITY (VR) IN EDUCATION

以虛擬實境(VR)教學提升學生語文素養

Secondary school students, restrained by their life experience and exposure, often show a shallow knowledge and understanding of the subject matters in the learning of Chinese language, and fail to express themselves with personal touch and sensation. The Jockey Club VR Project for Enhancing Chinese Language Literacy aims at harnessing virtual reality (VR) technologies to enhance the effectiveness of learning and teaching Chinese language. VR enables students to be exposed to scenarios outside classrooms without temporal and spatial limitation. Students will be able to "travel through" and observe in details places that they can hardly go in reality like sub-divided flats, the historical Hong Kong, etc. By immersing themselves in the environments, students will find it easier to build connection, develop affection, stimulate thinking and feelings, which are all valuable ingredients for Chinese writing. The Project helps strengthen students' Chinese reading and writing proficiency, literacy and sense of humanistic care.

中學生在學習中國語文時，受制於人生經歷和體驗，對許多事物的認識和理解流於表面化，亦難以把個人感受表達出來。賽馬會「觸境生情」虛擬實境語文教學計劃旨在運用虛擬實境(VR)科技，提升中國語文教與學的效能。虛擬實境讓學生不受時地限制，體驗各式場景。通過虛擬遊歷，學生可「走進」現實中難以到達的地方，例如劏房、昔日香港，作仔細觀察，這有助他們建立連繫和情感、刺激思考和感受，為中文寫作提供寶貴素材。計劃能提升學生的中文讀寫能力、文學素養及人文關懷。



Interactive questions to stimulate students' reflections
互動問題以激發學生思考反思

Students learning via VR field trips
學生透過虛擬遊歷進行學習

- Integrate e-Learning into Chinese language education
- Overcome the limitations of time, location, weather and number of students
- Base on local literature and landscapes in nine districts in producing VR teaching materials
- Help students to understand the community better and deeper, and reflect on social issues
- Bring depth to students' writing, broaden exposure, and enhance social awareness, connectedness and responsibility
- Provide Teacher Professional Development Programmes: open classes, VR workshops, school-based coaching

- 電子教學與中文教學結合
- 突破課堂時間、地域、天氣和人數等限制
- 以九個本港區域的地景文學製作虛擬實境教材
- 讓學生更加了解社區和反思社會問題
- 令學生寫作更有深度、擴闊經驗，提高社會觸覺、關懷和責任感
- 提供教師培訓：公開課、VR技術工作坊、共同備課、檢討

Project website 計劃網站：www.jc-vr-chinese.hk

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協作單位為香港中文大學香港文學研究中心、聖公會聖馬利亞堂莫慶堯中學及香港中文大學香港教育研究所

Supported by The Chinese University of Hong Kong Library
支持單位為香港中文大學圖書館

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Centre for Learning Sciences and Technologies
學習科學與科技中心

JOCKEY CLUB TOURHEART PROJECT ONE-STOP ONLINE PSYCHOLOGICAL SELF-HELP PLATFORM AND MOBILE APP

「賽馬會心導遊計劃」- 一站式網上心理支援平台及手機應用程式

- Quick mental health assessment via a simple 5-min online check-up
- Online self-learning courses to boost well-being on stress management, mindfulness and self-compassion
- Online guided self-help courses or one-on-one services, as needed, to alleviate distress, as needed
- Online mental health self-help tools easily accessible anytime and anywhere

- 簡單心理健康評估 — 5分鐘了解狀態
- 網上自學課程，包括：壓力管理、靜觀及善待自己
- 按需要提供網上指導自學課程或單對單服務去改善情緒困擾
- 能隨時隨地使用網上心理健康自助工具

For companies/organisations that are interested in delivering mental health services to their employees, we provide aggregate reports informing about employees' overall mental health status and service utilisation while keeping individual identities confidential for privacy protection
向有意為員工提供精神健康服務的公司和機構，以匿名保密方式，向僱主提供有關員工的整體精神健康及服務使用情況。

Online platform 網上平台: www.jctourheart.org

Download on the App Store

GET IT ON Google Play

Prof. MAK Wing Sze Winnie
麥穎思教授

Department of Psychology
心理學系

In Hong Kong, about 1 in 7 adults have experienced common mental disorders, such as anxiety, depression. Among them, only about 25% ever seek help. In view of the situations, the Jockey Club TourHeart Project aims to promote mental health and anti-stigma targeting working adults aged 18 – 45 in the community by developing the first one-stop online psychological self-help platform and mobile apps in Hong Kong, and organising a series of publicity events.

在香港，每7位成年人就有1位曾經歷焦慮及抑鬱等常見的精神病，其中只有25%人曾求助。有見及此，賽馬會心導遊計劃針對18至45歲的在職人士，建立全港首個一站式網上心理支援平台及手機應用程式，並定期舉辦公眾活動，向大眾推廣心理健康及反污名。

Funded by The Hong Kong Jockey Club Charities Trust
由香港賽馬會慈善信託基金捐助

Organized by The Chinese University of Hong Kong and New Life Psychiatric Rehabilitation Association
由香港中文大學及新生精神康復會主辦

Co-organized with StoryTaler
由《說書人》協辦

VIRTUAL TOUR OF COLONIAL ARCHITECTURE IN HONG KONG

虛擬香港殖民地時期建築之旅

USING VIRTUAL REALITY (VR) TECHNOLOGY TO ENHANCE STUDENTS' UNDERSTANDING OF COLONIAL ARCHITECTURE IN HONG KONG

以虛擬實境(VR)提升學生對香港殖民時期建築的認識

Visiting The Cenotaph via VR tour
透過VR參觀和平紀念碑

The colonial history plays an important role in the development of Hong Kong and reflects the city culture. This project aims to contribute in enhancing young generation's understanding of Hong Kong's past by transferring knowledge related to architecture, heritage conservation, and tourism development to students through an innovative approach – VR tour. Students are able to "visit" the architecture in the classroom, without time and geographic constraints. It is also an effective platform to conduct research, e.g. evaluation of the effectiveness of VR tours in promoting urban heritage tourism in Hong Kong.

殖民地時代是香港發展的一個重要時期,反映香港的文化。本項目旨在使用虛擬實境(VR)技術提供一個歷史建築現場的體驗平台予中小學生,讓新一代更了解香港歷史、建築特色、社會發展和古蹟活化等知識。虛擬歷史建築漫遊打破時地限制,讓學生在課堂中獲得猶如實地考察的體驗,令學校教學更具靈活性。同時,研究團隊亦會利用該平台進行研究活動,例如,邀請遊客使用並透過問卷評估平台在促進歷史建築旅遊的有效性。

- Audio guides are included in the tours to introduce users the architecture and heritages
- VR tour workshops will be provided for school teachers to utilise the VR platform in their courses
- Asia Society will use the VR video on our platform as a virtual tour guide for visitors

- 提供詳細語音介紹,使用者在VR體驗中可更了解歷史建築
- 供中小學教師使用平台素材教學,並提供工作坊引導教師開拓創新的教學模式
- 亞洲協會中心將使用我們平台上有關該協會的VR影片為遊客提供導賞服務

Quiz after viewing the VR videos
觀看後的知識測驗

Funded by CUHK Knowledge Transfer Project Fund
由香港中文大學知識轉移基金資助

Collaborated with Faculty of Education of CUHK, Centre for Learning Sciences and Technologies of CUHK and Asia Society
合作夥伴包括香港中文大學教育學院、香港中文大學學習科學及技術中心及亞洲協會香港中心

Dr. HOU Huiying Cynthia
侯慧瑩博士

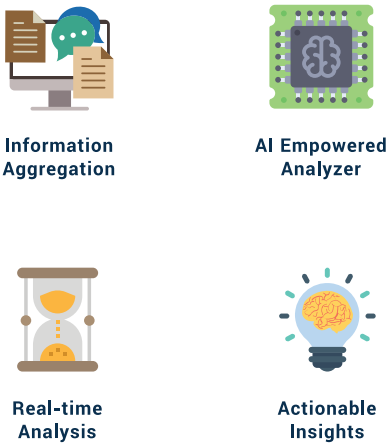
School of Hotel and Tourism Management
酒店及旅遊管理學院

ARIES – ARTIFICIAL INTELLIGENCE EMPOWERED STOCK ANALYZER

ARIES – 人工智能股票分析系統

The existing stock trading platforms only push massive amount of news to users. Stock traders can hardly digest the reports by themselves. When a stock analyst predicts that one stock price will rise while another analyst predicts the opposite, which news report is more reliable? ARIES (ARtificial Intelligence Empowered Stock-analyzer), developed by CUHK research team, uses AI technology to aggregate and analyze data from multiple sources in real-time to provide investors useful information.

現有的股票交易平台只會向投資者推送大量新聞和報告，並要求他們自行消化理解它們。可是，一般股票投資者是很難明白及理解這些新聞和報告的可靠性。當一位股票分析師預測某一隻股價將上漲，而另一位分析師則預測相反時，究竟哪個資訊更可靠？中大研究團隊研發的 ARIES 使用人工智能技術來實時聚合和分析來自多個來源的數據，以幫助投資者獲得有用的信息。



- ARIES is an automated AI tracing and surveying system that analyze news reports using big data, machine learning and natural language processing techniques.
- The system can automatically collect broker reports of stock analysts over the past few years, then determine from stock market records whether the predictions have been correct. Hence, it can analyze the reliability of a stock analyst's prediction.

- ARIES為全自動人工智能追溯及勘查系統，通過使用大數據、機器學習和自然語言處理技術來閱讀新聞報道。
- 系統可自動收集各股票分析師過去幾年的分析報告，然後從股票市場記錄中確定預測是否正確，從而分析股票分析師對某股票的預測的可靠性。

Dr. FUNG Pui Cheong Gabriel
馮沛璋博士

Department of Systems Engineering and Engineering Management
系統工程與工程管理學系

Funded by Cyberport Incubation Programme
由數碼港培育計劃資助

BBGUIDE

Early childhood years are fundamentally important for child's physical and intellectual growth. According to the statistics of Hong Kong Society for the Protection of Children and The Education University of Hong Kong, over 20,000 kindergarten students suffer from developmental disorders due to parents' lack of awareness. In view of this situation, we develop a mobile application, namely BBGuide, providing parents an all-round assessment tool for child development. Our contents are thoroughly evaluated by professional consultants, including speech therapist, occupational therapist, pediatrician and CUHK professor.

嬰幼兒階段對小朋友的身體和智力發展非常重要。根據香港保護兒童會及香港教育大學的統計數字，本港有超過20,000名幼稚園學生因父母缺乏兒童發展意識而有成長遲緩問題。因此，我們開發了一個流動應用程式「BBGuide」，為父母提供一個全面的兒童發展評估工具。BBGuide的內容均經過專業顧問的評估，顧問團隊包括言語治療師，職業治療師，兒科醫生和香港中文大學教授。

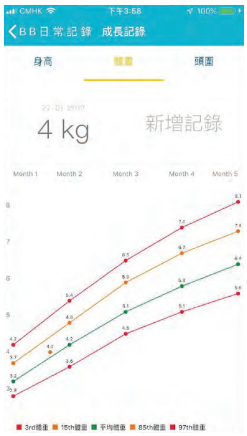
- We provide checklists for tracking child development progress based on 4 areas: (1) Motion, (2) Cognition, (3) Social, (4) Language.
- Parents can easily record child's height, weight and head circumference, and generate a health profile.
- Based on the child's age, data collected and user behaviors, we offer personalized recommendations, such as informative articles and interactive activities, updated weekly for parents to facilitate child development.
- Once a child is suspected having developmental problem, BBGuide will promptly alert the parents and recommend related specialists for further follow-ups.

- 提供(1)動作、(2)認知、(3)社交、(4)語言方面的成長歷程項目，讓父母評估孩子的發展進度。
- 父母可以輕鬆記錄孩子的身高、體重和頭圍，並取得詳細成長報告。
- 因應孩子年齡、收集的數據及用家習慣等，每週為用家提供個性化的建議，如：文章和親子運動等，協助孩子發展。
- 孩子一旦有發展遲緩的嫌疑，BBGuide會提醒父母並可轉介至相關專家作進一步跟進。

Mr. CHIU Tsz Lok
趙子樂先生
Ms. TSANG Hiu Tung
曾曉童女士

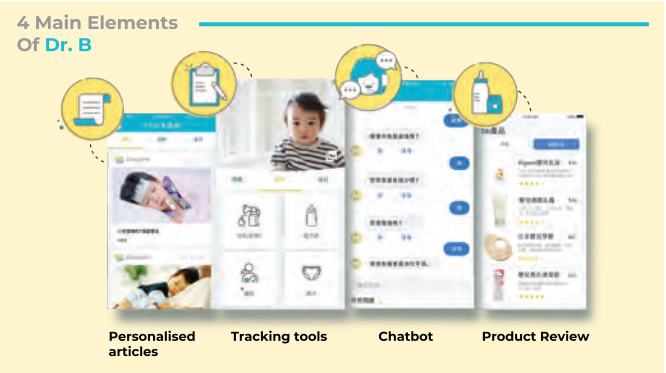
Department of Information Engineering
信息工程學系

DR. B



There are 60,000 local newborns on average each year. Expectant parents and parents with newborn always desire for information about pregnancy and newborn babies. Yet, information on the Internet is often overloaded and lack of credibility. It is time-consuming to search for reliable and useful contents needed. Dr. B is designed to help expectant parents and parents with newborn to overcome pregnancy and parenting challenges.

香港平均每年有60,000名初生嬰兒，準父母和新手父母總想得到更多有關懷孕或初生嬰兒的資訊，但網絡上的資訊過於零碎和欠缺公信力，往往需花費大量時間去尋找和整合所需要的資訊。Dr.B旨在幫助準父母和新手父母，解決他們在懷孕和養育子女時遇到的難題。



- Dr. B assists expectant parents and parents with newborn to track and record their daily health, such as weight and labor pain situation of mother-to-be as well as baby ‘s eating and excreting habits.
- By AI powered analysis on user behaviors and records, Dr. B will recommend suitable products and information.
- The very first chatbot in Hong Kong that helps diagnose baby illness with contents reviewed by pediatrician. Chatbot will list possible symptoms based on the information parents inputted, and suggest solutions. At the same time, inputted data will be collected for optimization to satisfy user needs.
- 協助用家記錄各項健康數據，例如：懷孕其間準媽媽體重、陣痛情況；寶寶進食、排洩的記錄。
- 通過人工智能分析用戶的習慣和各項記錄，建議合適的產品和資訊。
- 全港首創診斷寶寶病症的聊天機器人，所有訓練數據經由兒科醫生審批。透過與用戶聊天，列出有可能的病症，幫助新手父母照顧孩子。同時，系統會收集新的數據並加以分析，創建出最符合用家需求的聊天機械人。

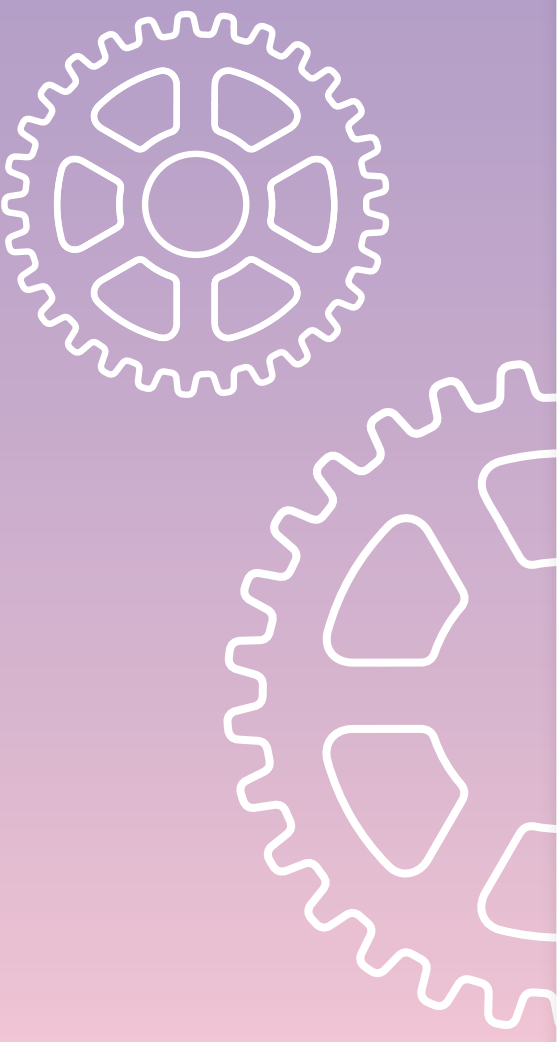
Mr. SO Wing Shing
蘇永誠先生
Mr. YAM Hing Yeung
任衍揚先生

Department of Information Engineering
信息工程學系

R

ROBOTICS & AUTOMATION

機械人及自動化技術

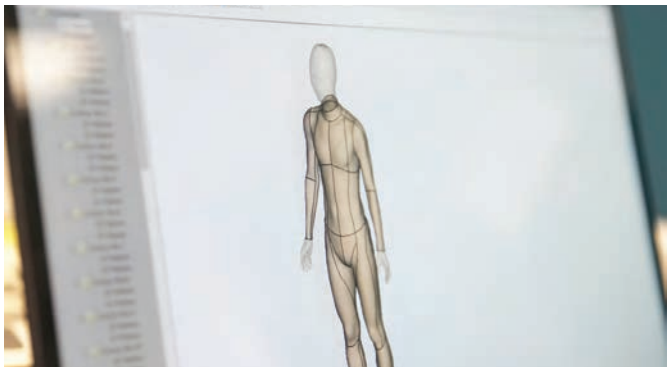


SHAPE DRIVEN TECHNOLOGY
形狀驅動技術

FACILITATE AUTOMATIC FABRICATION OF PERSONALISED WEARABLE PRODUCTS
有助自動化訂製個人化可穿戴產品

Traditional manufacturing of clothes and shoes requires pre-production of various sizes of products, which cannot match every individual's body shape. We provide digital human oriented solutions for intelligent design and advanced manufacturing to achieve the upgrade to Industry 4.0. By our patented AI-enabled Shape Driven Technology, we can change the current operation mode of the manufacturing industry to realize the direct customer-to-manufacturer (C2M) solution.

傳統服裝和鞋履製造業會預先生產不同尺碼的產品，但這些產品無法完全符合每個人的身形。我們為智能設計和先進製造提供基於三維人體模型技術的解決方案，有助製造業實現工業4.0。透過我們專利的形狀驅動技術，並結合人工智能，可以改變製造業現有的運作模式，實現Customer-to-Manufacturer（顧客對生產商）的直接解決方案。



3D human model with pre-designed wetsuit layout
三維人體模型上套用了預先設計的潛水服

2D flattened layout for final cutting and wiring
二維紙樣作剪裁及縫接

Prof. WANG Chang Ling Charlie
王昌凌教授

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

3D ultra-fitted wetsuit 超貼身潛水衣

- Our solution is equipped with the mature fast scanning, the big data and deep learning driven AI, and the digital knitting technology.
- A simple, fast and low cost system with intelligent design and auto-transfer technology is developed to fabricate customised clothes and shoes, and in the future, wearable products in all kinds of styles.
- Production time for a tailor-made cloth can be greatly reduced from 2-3 weeks to 2-3 days if the manufacturer is equipped with digital knitting machines.
- 配備成熟的快速掃描，人工智能範疇的大數據和深度學習，以及數碼編織技術。
- 簡單、快速及低成本的系統，配有智慧設計及自動轉移程序，用於訂製個人化服裝鞋履，及各種可穿戴產品。
- 如生產商已配備數碼編織機器，定制服裝的生產時間將由以往需時兩至三週大幅縮短至兩至三天。

Silver Medal, 47th International Exhibition of Inventions Geneva
第47屆日內瓦國際發明展銀獎

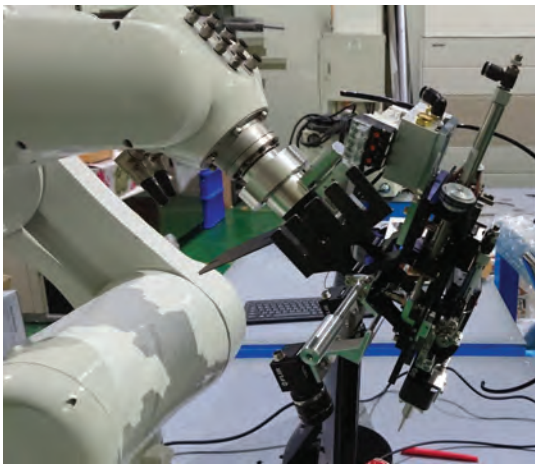
Funded by Technology Start-up Support Scheme for Universities
由大學科技初創企業資助計劃資助

ADVANCED VISION AND SENSING SYSTEM FOR NEXT-GENERATION MEDICAL ROBOTS

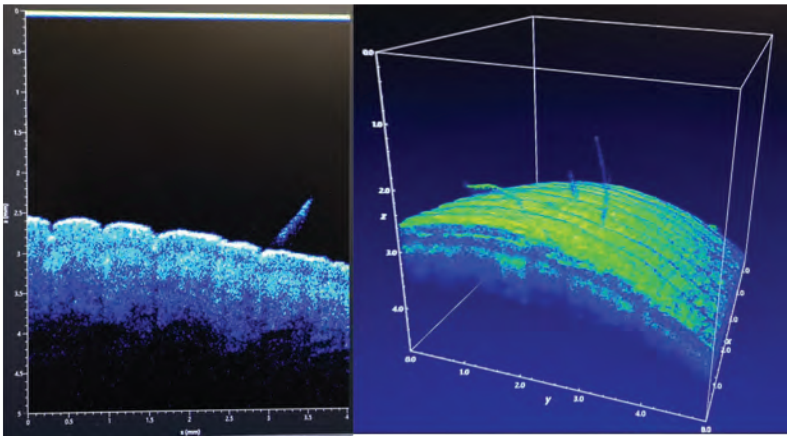
應用於下一世代醫療機器人的先進視覺和感知系統

With the advancement of technology, medical robots have been widely adopted in many hospitals in Hong Kong and around the world. More and more conventional open surgical processes are replaced by robot-assisted minimally invasive surgeries. However, due to the lack of significant haptic feedback, accidents of robotic surgical systems have been reported occasionally. CUHK research team develops an innovative compact imaging and sensing system that can be integrated to different robotic systems, such as da Vinci Surgical System, to improve accuracy, flexibility and safety. It may reduce these preventable incidents in the future.

醫療機器人近年發展迅速，已廣泛應用於全球和香港眾多醫院。越來越多的傳統開放式外科手術被輔助式微創手術機器人所取代。然而，由於缺乏實際觸覺反饋，機器人有時會意外切斷血管，造成醫療事故。中大研究團隊研發出一套創新的成像與傳感系統，可集成於不同的機器人系統上，例如：達芬奇外科手術系統，以提高精度、靈活性與安全性，減少可預防的醫療事故。



Hair transplant robot with OCTRVS
集成了OCTRVS的植髮機器人



OCTRVS images of human body skin surfaces (left);
sub-surface showing the hairs and follicles (right)
人體上表皮（左）和下表皮（右）的OCTRVS圖片，下表皮圖像清楚顯示頭髮及毛囊

OCTRVS integration with da Vinci surgical robot
OCTRVS與達芬奇手術機器人

- The system includes a miniaturized high-speed optical coherence tomographic robotic vision system (OCTRVS) and disposable high-sensitivity flexible tactile sensor.
- OCTRVS allows real-time visualization of sub-surface 3D blood vessels with depths of 2 – 5 mm
- Flexible tactile sensing technology provides high-sensitivity, real-time haptic feedback (pressure sensitivity of 2 kPa^{-1}; force measurement range of 0 – 10 N), emulating a real surgeon's haptic feedback on robot-end effectors.

- 系統包括小型化的光學相幹斷層掃描機器視覺系統 (OCTRVS) 及高靈敏度的柔性觸覺傳感器
- OCTRVS能夠實現深度在2 – 5毫米的實時下表皮3D血管成像
- 柔性觸覺傳感器則提供高靈敏度、真實、實時的觸覺反饋（壓力靈敏度為2 kPa^{-1}; 力量測範圍為0 – 10 N），反饋機器終端真實的觸感給外科醫生

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

Collaboration with Department of Surgery of CUHK, Bluestone Medical Technology Limited, ITE Engineering Limited, Massachusetts Institute of Technology and Semiconductor Equipment Manufacturing, Inc.
合作夥伴為香港中文大學外科學系、青石醫療科技有限公司、ITE Engineering Limited、麻省理工學院及欣憶電子股份有限公司

Prof. CHEN Shih Chi
陳世祈教授

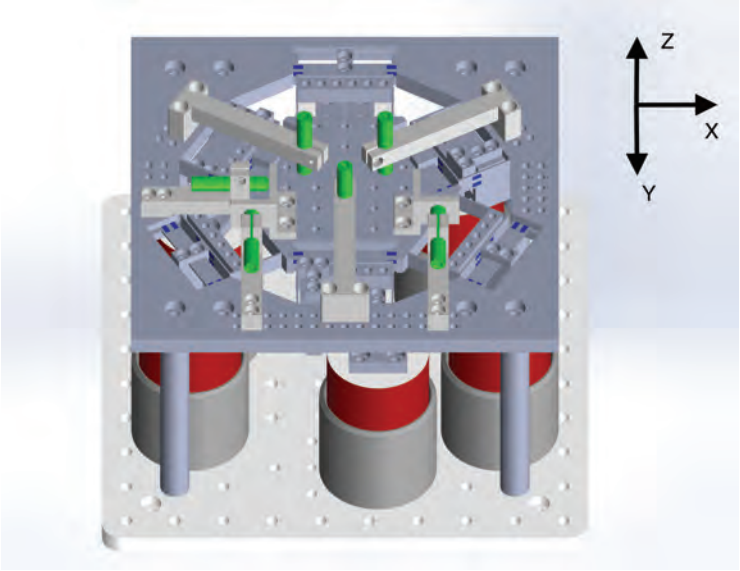
Department of Mechanical and Automation Engineering
機械與自動化工程學系

DEEP LEARNING FOR NEXT-GENERATION PRECISION MACHINE TOOLS AND MANUFACTURING

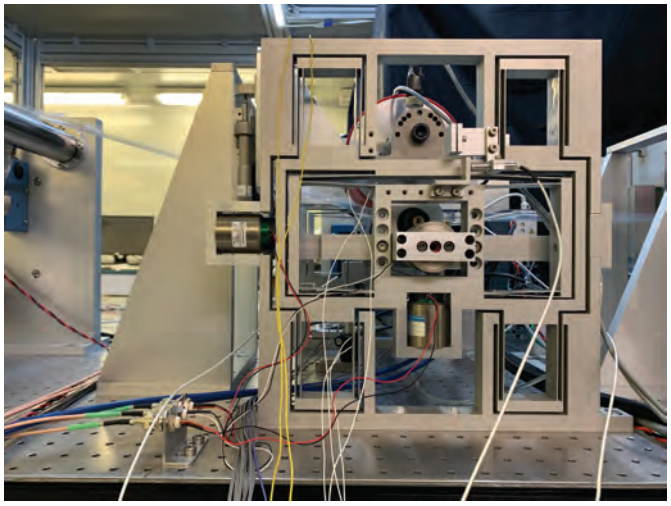
應用於下一代精密機械系統及製造產業的深度學習方法

Positioning and robotic technologies are essential elements for large-scale automated manufacturing. However, the existing robotic platforms only allow robots to perform routine and simple assembly processes with low precision (100s μm - mm scale), which sensors applied in these platforms are very expensive. Combining deep learning with precision engineering principles to improve efficiency and accuracy, we develop next-generation precision machines and robotic platforms for low-cost, high-precision manufacturing.

定位與機器人技術是大範圍自動化製造的基本要素。然而，現有的機器人平台僅能使工業機器人執行常規、簡單的裝配流程，且精度較低（在百微米至毫米的範圍），所使用的傳感器十分昂貴。我們將深度學習與精密工程理論結合以提高效率以及精度，發展新一代應用於低成本、高精度製造業的精密儀床與機器人平台。



Six-axis model mounted with low-cost strain sensor array instead of capacitance sensors
裝有低成本應變片的六軸平台以替代高成本電容式感應器



Roll-to-Roll system mounted with multiple stain sensor arrays to control X-Y directional movement
裝配有低成本應變片陣列的R2R 系統，以控制X-Y兩個方向上的運動

- We propose to use low-cost strain gauges to replace costly capacitance probes used in conventional systems.
- Deep learning algorithms enable learning and prediction of machine behavior. At the training stage, high-precision sensors are used as a reference to minimize position errors; while the number and location of sensor arrays and actuators are optimized through the deep learning model.
- Though effectively combining deterministic and statistical approaches, low-cost sensor arrays and actuators installed can predict machine behavior with 10s nm to submicron level precision.
- 現時的系統多使用昂貴的電容式感應器，我們提出使用低成本的應變片取代。
- 深度學習算法能夠實現機器行為的學習與預測，在訓練階段，使用高精度傳感器作為參照將定位誤差最小化；同時傳感陣列與致動器的數量及排列將通過深度學習模型進行優化。
- 通過有效結合確定性及統計方法，利用價格低廉的傳感器陣列預測機械運動並達到幾十納米至亞微米的精度。

Prof. CHEN Shih Chi
陳世祈教授

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

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

HANDHELD HIGH-RESOLUTION SHORT-WAVE INFRARED SPECTROMETER

手持式高分辨率短波紅外光譜儀

Spectrometers are widely used in many different aspects, such as food and environmental inspection etc. However, it is necessary to have a portable and high-resolution spectrometer for real-time on-site inspection at remote farm or factory. CUHK team invented two new technologies, which broke the traditional boundary. We develop a handheld high-resolution short-wave infrared (SWIR) spectrometer that enables real-time and on-site spectroscopic analysis in the 900–2800 nm wavelength range. Basing on our two technologies, the spectrometer can be fabricated via low-cost processes:

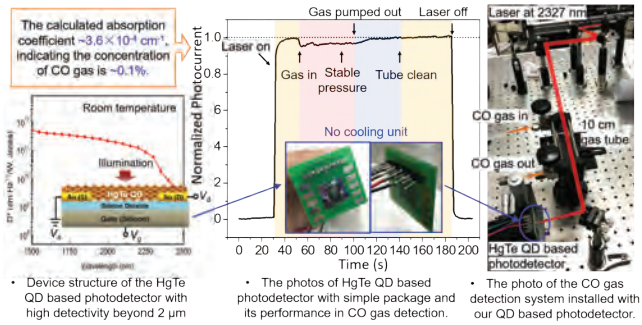
(1) vacuum-imprinted varied-line-space concave grating, which simultaneously miniaturizes the optical design and improves resolution

(2) HgTe quantum dot based detectors, which exhibit high room-temperature sensitivity beyond 2000 nm. This innovative spectrometer system developed by CUHK outperforms the current commercial products no matter in cost, size and performance.

光譜儀廣泛應用於多個不同領域，例如食品和環境檢測等，但要在偏遠的農場或工廠進行實地、實時的檢測，必須要有便攜又分辨率高的光譜儀。中大團隊研發的兩項新技術，突破傳統界限，開發出一款手持式高分辨率短波紅外 (SWIR) 光譜儀，可實現實時現場對900-2800 nm波長範圍信號進行光譜分析。結合使用的兩項新技術，都可通過低成本工藝製造：

(1) 曲面壓印技術，造出變柵距凹面光柵，此光學部件可同時實現色散和準直兩項功能

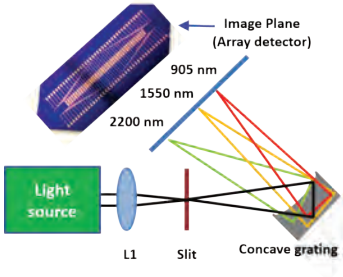
(2)通過碲化汞量子點光探測器技術，在室溫範圍也能達至2000 nm以上波長的高光敏度。中大研發的手持式SWIR光譜儀，無論從成本、尺寸和性能上，都超越了現時商用的同類產品。



- Device structure of the HgTe QD based photodetector with high detectivity beyond 2 μm
- The photos of HgTe QD based photodetector with simple package and its performance in CO gas detection.
- The photo of the CO gas detection system installed with our QD based photodetector.

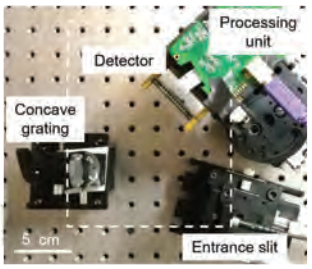
The room temperature-operated high sensitive HgTe QD based SWIR photodetector and its successful application in testing CO gas content

在室溫中工作、基於碲化汞量子點的高靈敏度短波紅外探測器，及其在一氧化碳氣體含量檢測實驗中的成功應用



Working mechanism

- Concave grating
  – collimation and dispersion
- QD detection array
  – sensitive and fast detection



The photography of the SWIR spectrometer system installed in our lab – the white box indicate the size of the system.

The working mechanism and the photography of CUHK's SWIR spectrometer system installed in our lab

中大的短波紅外光譜儀的工作原理以及系統照片

Uniqueness and Competitive Advantages:

1. Miniaturized system (about 20×16×5 cm^3)
2. Wide photodetection wavelength range (900—2800 nm)
3. High spectral resolution (5 nm)
4. High detectivity at room temperature (1010 Jones)
5. Fast response speed (less than 10 ms)

特點及優勢：

1. 系統小巧 (約20×16×5 立方厘米)
2. 探測波段寬 (900—2800 納米)
3. 高光譜分辨率 (5 納米)
4. 室溫下高探測靈敏度 (1010 瓊斯)
5. 反應快 (10 毫秒以下)

Collaboration with Department of Mechanical and Automation Engineering of CUHK, Hon Kok Technology Co. and Weimu Intelligent System Ltd.

合作夥伴為香港中文大學機械與自動化工程學系、漢國科技公司及微木智能系統有限公司

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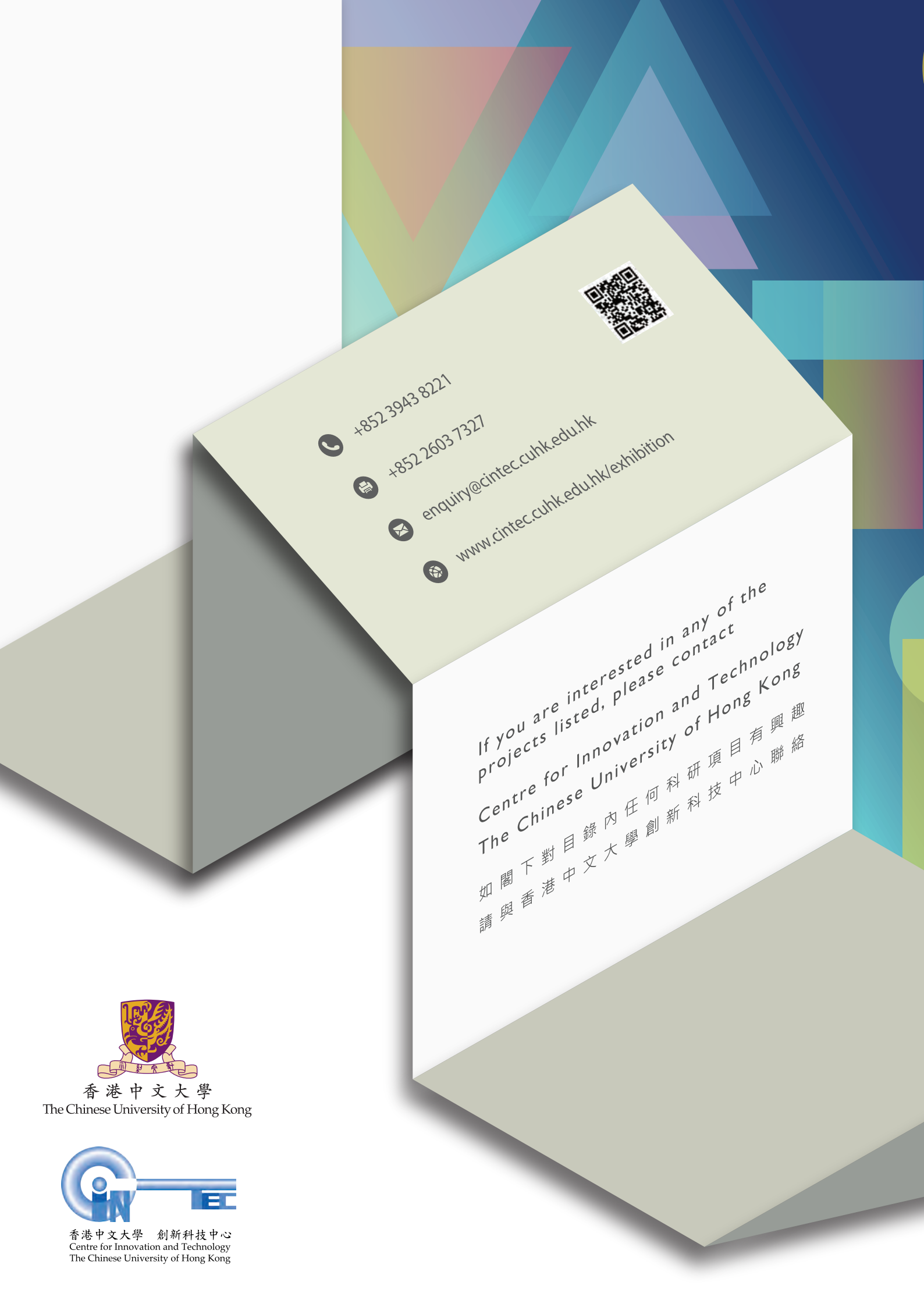
趙鈮教授

Department of Electronic Engineering
電子工程學系



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