3D Vision-Driven Robots
三維視覺驅動機器人

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Abstract

Existing robots work without any visual feedback or with slow visual feedback so that they cannot work safely and adaptively in a natural dynamic environment with a lot of uncertainties. This project aims at developing and commercializing technologies and products of 3D vision-driven robots that realize effective and real-time eye-brain-motor coordination for more adaptive, faster, and safer interactions with humans, other robots and objects in natural working environments. The cutting-edge technologies to be developed include real-time 3D imaging sensors and perception algorithms, and universal software and hardware platforms supporting high-frequency eye-brain-motor coordination of robots. We will closely collaborate with the industrial partners to commercialize the 3D vision-driven robots in smart logistics, smart cities, smart construction and smart manufacturing.

現有機器人無法在缺少視覺反饋或視覺反饋緩慢的情況下工作。因此，在充滿不確定性的自然動態環境中，機器人難以安全、快速、且高適配性地進行作業。本項目旨在開發三維視覺驅動機器人的核心技術和產品，實現有效及實時的眼-腦-運動協調控制，以便讓機器人在實際工作環境中與人類、其他機器人及物件進行更高適配性、更快速且更安全的相互交互。計劃開發的尖端技術包括實時三維成像感測器與感知算法，以及支持高頻眼-腦-運動協調的通用控制平台。項目團隊將與業界夥伴緊密合作，推動三維視覺驅動機器人在智慧物流、智慧城市、智慧建築以及智能製造等領域實現商業化。

Accessible Surgical Robotic System
普及化手術機械人系統

Prof. Kwok Wai Samuel AU
歐國威教授

Abstract

Our research project, "Accessible Surgical Robotic System", led by Prof Samuel Kwok-Wai AU from Department of Mechanical and Automation Engineering, aims to develop a safe, affordable, and effective surgical robotic platform, that offers accessible robotic surgery, enabling more patients worldwide to cost-effectively benefit from the highest standards of care.

The project focuses on developing a first-generation multi-port laparoscopic surgical robot designed to be used in robotic surgery within the urology, gynecology, and general surgery specialties and provides surgeons with a precise and intuitive manipulation as to improve surgical quality and efficacy. The system is also designed with the usage habits of surgeons in mind, making it convenient and easy to use.

Our research project also includes commercialization effort in clinical trials, regulatory compliance, and marketing activities in Hong Kong and Mainland China. By integrating these cutting-edge technologies, the initiative not only offers significant benefits to patients but also improves the accessibility of robotic surgery worldwide in the future.

「普及化手術機械人系統」是由機械與自動化工程學系的歐國威教授領導的團隊開發的研究項目。此項目透過與醫療機器人創新技術中心及初創公司康諾思騰的合作，開發一個安全、經濟且有效的手術機器人平台，讓全球更多患者能以合理成本享受頂尖的醫療技術。此計畫專注於開發第一代多端口腹腔鏡手術機器人，適用於泌尿科、婦科和普通手術，能為外科醫生提供精確且直觀的操作，從而提升手術質量和效率。此外，項目還包括了臨床試驗、醫療合規和市場推廣活動。這一項目預期將為香港和中國大陸的患者帶來顯著利益，進而提升全球機器人手術的普及和可及性。

Development of Personalized Advanced Therapeutic Products (ATPs) – Engineered Osteochondral Tissue (eOCT) for cartilage regeneration therapy
開發個人化先進治療產品 (ATPs) – 用於軟骨再生治療的工程骨軟骨組織 (eOCT)

Prof. Barbara P. CHAN
陳佩教授

Abstract

Cartilage injuries are very common but existing treatments are not satisfactory. Advanced technologies such as cell and tissue engineering therapies offer great hope in treating cartilage injuries. We have developed a novel autologous mesenchymal stem cell (MSC)-based engineered osteochondral tissue (eOCT) with proper structural organization mimicking that of the native joint tissues. Pre-clinical evaluation in animal models showed exciting outcomes with rapid and sustained regeneration of high quality hyaline cartilage that are comparable with the clinical gold standard autografting, without hurting the patient's own cartilage. Working with orthopaedic surgeons, we also developed minimal invasive arthroscopic implantation of eOCT. A first-in-human (FIH) trial to establish the safety profile of eOCT is also underway. In the current RAISe+ scheme, we aim to (1) develop new eOCT series for osteoarthritis; (2) transfer the validated GMP manufacturing process back to HKSAR; (3) conduct phase II clinical trial on eOCT efficacy; and (4) launch the eOCT medical treatment for individual patients.

軟骨損傷很常見，但現有的治療方法並不令人滿意。細胞和組織工程療法等先進技術為治療軟骨損傷帶來了希望。我們開發了一種新型自體間質幹細胞（MSC）為基礎的工程化骨軟骨組織（eOCT），其具有模仿天然關節組織的適當結構組織。動物模型的臨床前評估顯示出令人興奮的結果，快速、持續地再生高品質透明軟骨，可與臨床金標準自體移植相媲美，且不會傷害患者自身的軟骨。我們也與骨科醫生合作開發了 eOCT 的微創關節鏡植入術。旨在確定 eOCT 安全性的首次人體 (FIH) 試驗也在進行中。在目前的 RAISe+ 計劃中，我們的目標是 (1) 開發新的骨關節炎 eOCT 系列；（2）將經過驗證的 GMP 生產流程轉移回香港特區；（3）進行 eOCT 療效 II 期臨床試驗；（4）針對個別患者開展 eOCT 軟骨損傷治療。

Silicon Photonic Integrated Circuits for Sensing and Optical Interconnects
用於傳感及光互聯的矽光集成晶片

Prof. Hon Ki TSANG, Dr. David CHAN, Dr. Dan YI , Dr. Xuetong ZHOU
曾漢奇教授， 陳永裕博士，易丹博士，周學通博士

Abstract

This project aims to develop the next generation technology of silicon photonic integrated circuits which can advance the performance of systems beyond what can be achieved using purely microelectronic integrated circuits. As one of the first groups in Asia to develop silicon photonics, the team has some of the most advanced silicon photonic designs that can be used to advance the performance of communications equipment, 3D imaging and quantum information systems. Following the successful paradigm of the fabless design business model in the microelectronics industry, our focus will be on the design while we will use existing foundries for the manufacture of the photonic integrated circuits (PIC). Their products will include silicon photonics based 1.6 and 3.2 TbE optical engines for datacenter interconnects and miniaturized hand-held optical coherence tomography (OCT) imaging systems for healthcare equipment and industrial metrology.

香港中文大學的電子工程學系團隊作為在亞洲最早開展矽光子研究的團隊之一，在矽光子領域有超過20年的研究經驗。基於在大學研發的先進矽光子器件和系統，相關技術可用於提升通信設備、三維成像和量子信息系統等的性能。我們將使用過往在微電子行業有不少成功先例的無廠設計商業模式，我們將集中於晶片設計，並使用現有的晶圓廠進行矽光子集成電路（PIC）生產。首先研發和推出的第一批產品將包括用於數據中心互連，基於矽光子技術的 1.6 和 3.2 TbE 光學引擎，以及用於醫療設備和工業測量的微型手持式光學相干斷層掃描成像系統（OCT）。

Network Coding for Next Generation Networks
網絡編碼在新一代網絡的應用

Prof. Wai Ho YEUNG
楊偉豪教授

Abstract

Network coding, a revolutionary technology co-invented by the person-in-charge in the 1990s, is widely acknowledged as a significant breakthrough in information sciences. Differing from conventional routing techniques, network coding combines incoming data packets into new ones for onward transmission to the subsequent node. This results in communication networks (including computer, wireless, satellite, and underwater networks) and data storage systems that are more efficient, resilient, and secure.

To realize the vast potential of network coding, through this project we will promote the adoption of network coding technologies and their practical application in real-world contexts. The project will primarily concentrate on the deployment of BATS in three critical domains: cellular networks, smart cities, and data centres. In addition to undertaking the necessary R&D, we aim to expedite the market introduction of our innovative products by collaborating with industrial partners. This will propel the evolution of communication networks and data storage systems towards enhanced efficiency, reliability, and security.

網絡編碼是項目負責人 在 1990 年代共同發明的革命性技術，被廣泛認為是信息科學的重大突破。 與傳統的路由技術不同，網絡編碼將接收的數據包重新組合成新的數據包， 然後傳輸到下一個節點，令通信網絡（包括計算機、無線、衛星和水底網絡）和數據儲存系統更加高效、可靠和安全。

為了實現網絡編碼的巨大潛力，透過這個項目，我們將促進網絡編碼技術特別是 BATS 在各種系統的實際應用。我們將集中在三個關鍵領域： 移動網絡、智慧城市和數據中心。 除了進行所需的研發外，我們的目標是透過與產業合作，加速我們的創新產品的市場推出。這將推動通信網絡和數據儲存系統在提高效率、可靠性和安全性的方向發展。

Intelligent Wearable Sensing Technologies for Eldercare and Prevention of Cardiovascular Diseases

用於老年人護理和心血管疾病診斷的智能可穿戴傳感技術

Prof. Ni ZHAO
趙鈮教授

Abstract

This project aims to transform our years of leading research achievements in biomedical sensing technologies and health informatics into a series of wearable medical-grade devices that can track cardiovascular disease (CVD) risk factors in an unobtrusive, accurate and continuous fashion, as well as to pair the devices with personalized AI doctor (Dr. PAI) based on generative AI models to enable real-time CVD prediction and diagnosis with a unique human-and-sensor-in-the-loop approach. The platform will be tested, optimized and standardized through large scale clinical trials in both Hong Kong and mainland China, by our interdisciplinary team including cardiologists and eldercare providers. Our innovative approach opens new horizons in personalized healthcare, especially in the realm of eldercare and cardiovascular disease management.

The founding members of the team include Prof. Yuan-Ting Zhang (CUHK), Prof. Ni Zhao (CUHK) and Prof. David Clifton (Oxford).

這個項目的目標是將我們多年來在生物醫學感測技術和健康信息學方面的領先研究成果轉化為一系列可穿戴的醫療級設備，這些設備可以無擾、準確和連續的方式追蹤心血管疾病（CVD）的風險因素，並可通過基於生成式人工智能的模型以獨特的病人與傳感器交互的反饋方式創造個性化虛擬 AI 醫生（Dr. PAI），實現實時的 CVD 預測和診斷。該平台將通過我們包括心臟病學家和老年護理提供方在內的跨學科團隊、在香港和中國內地進行的大規模臨床試驗中進行測試、優化和標準化。我們的創新方法為在老年護理和心血管疾病管理領域的個性化醫療開闢了新的前景。

本項目團隊創始成員包括張元亭教授（香港中文大學）、趙鈮教授（香港中文大學）和 David Clifton 教授（牛津大學）。

Seeding the Future: Integrating Biotechnology, Space Technology and AIoT to Soybean Cultivation for Food Security and Environmental Solutions

播種未來：整合生物科技、空間技術和人工智能物聯網，優化大豆種植以提供糧食安全和環境解決方案

Prof. Hon Ming LAM
林漢明教授

Abstract

FARMily Biotechnology Company Limited, a pioneering agricultural and food enterprise, is excited to introduce its groundbreaking project aimed at revolutionizing soybean cultivation in order to address the challenges of food security and environmental sustainability. The project, titled "Seeding the Future: Integrating Biotechnology, Space Technology, and AIoT to Soybean Cultivation for Food Security and Environmental Solutions," embodies our commitment to deploying cutting-edge technologies and innovative approaches for a more sustainable and secure future.

China faces several pressing challenges, including limited land and freshwater resources, the impact of global climate change, and the increasing demands of an aging population for high-quality nutrition. Soybeans, being a vital source of protein and essential nutrients, play a crucial role in addressing these challenges. However, China's soybean self-sufficiency rate is currently below 20%, leading to concerns of inadequate supply, soaring prices, and logistical constraints.

At FARMily Biotechnology, we perceive these challenges as opportunities to revolutionize the agricultural landscape. Our visionary approach combines biotechnology, space technology, and AIoT to develop innovative solutions for soybean cultivation, ensuring food security and environmental sustainability. We aim to provide solutions for food security, sustainable environments, and high-quality food. Our solutions include: (1) the development of resilient and nutritionally rich climate-smart soybeans to increase yields in marginal agricultural lands; (2) the research and development of biofertilizers with soil microbial formulas and efficient methods that can contribute to energy-saving and emission reduction in crop cultivation; (3) the utilization of field data for precision farming with optimized production; and (4) the creation of high-value functional and nutritious food products.

The project builds upon our team's extensive experience and expertise in soybean and agricultural research. Over the past two decades, we have successfully cultivated and commercialized three soybean varieties across the challenging terrain of the Loess Plateau in Gansu Province. This initiative has resulted in a significant increase in local farmers' income by 97 million RMB and an estimated reduction of over 70,000 metric tons of carbon dioxide emissions. The positive impact of our soybean cultivation in the mountainous region of Longnan, Gansu, in 2023 serves as a testament to the project's potential.

To ensure the long-term transformation and scalability of our achievements, we are actively seeking support and collaboration from various stakeholders. We have already garnered expressions of support from commercial and research partners, including the Aerospace Technology Company for space mutation experiments, agricultural researchers nationwide for field experiments and promotion, and companies providing AIoT support and sales channels for high-nutrition and functional soy-based food products.

Our business model encompasses the development and application of resilient soybean seeds and innovative farming practices to increase yields and reduce costs on marginal lands. Through contract farming, we empower farmers to produce high-quality seeds, backed by our research capabilities and quality assurance. Additionally, we aim to leverage our soybean research to create value-added food products that cater to the growing demand for high-nutrition and functional foods. The field data collected will be transformed into a comprehensive database and production model, offering valuable

insights and solutions for the industry. The revenue generated from these initiatives will be reinvested to support further research and development, in line with national and regional development policies.

FARMily Biotechnology Company Limited, with its unique expertise and commitment to innovation, is poised to lead the transformation of China's agricultural landscape. Our project aims to not only address the challenges of food security and environmental sustainability but also create economic and social benefits for society at large.

播種家創科有限公司，一家開創性的農業和食品企業，很高興介紹我們的突破性項目，旨在革新大豆栽培，以應對食品安全和環境可持續性方面的挑戰。該項目名為「播種未來：整合生物科技、空間技術和人工智能物聯網，優化大豆種植以提供糧食安全和環境解決方案」，體現了我們致力於應用尖端技術和創新方法，為更可持續和安全的未來做出貢獻的使命。

中國面臨著幾個迫切的挑戰，包括有限的土地和淡水資源、全球氣候變化的影響以及老齡人口對高品質營養的需求增加。大豆作為重要的蛋白質和營養素來源，在應對這些挑戰方面起著關鍵作用。然而，中國的大豆自給率目前低於 20%，引發了供應不足、價格飆升和物流限制的擔憂。

在播種家創科，我們將這些挑戰視為改革農業景觀的機遇。我們的願景是建立一個以生物科技為主體、數據為支撐、結合跨學科創新技術的現代農業及食品企業，提供糧食安全、永續環境及優質食品的解決方案。解決方案包括: (1)研發耐逆、高營養氣候智能大豆，在邊緣農地增產; (2)研發能配合作物節能減排的生物肥料土壤菌配方和有效使用的方法; (3)應用田間數據的精準農業以優化生產; (4)發展高價值功能及營養食品。

該項目建立在我們團隊在大豆和農業研究方面的豐富經驗和專業知識之上。在過去的二十年中，我們成功在甘肅省的黃土高原崎嶇地區栽培和商業化了三個大豆品種。該項目使當地農民的收入增加了 9700 萬人民幣，估計減少了超過 7 萬公噸的二氧化碳排放。我們在 2023 年在甘肅隴南山區大豆栽培的積極影響，證明了該項目的潛力。

為確保我們的成就能長期轉型和擴展，我們正在積極尋求各方的支持和合作。我們已經獲得商業和研究合作夥伴的支持，包括能支援航天誘變實驗航空科技公司、全國農業研究人員進行田間實驗和推廣，以及提供 AIoT 支持和銷售渠道的公司，用於高營養和功能性大豆食品產品。

我們的商業模式包括開發和應用具有抗逆性的大豆種子和創新的耕作方式，在邊陲土地上增加產量並降低成本。通過合同種植，我們賦予農民生產高品質種子的能力，並以我們的研究能力和質量保證為後盾。此外，我們還希望利用我們的大豆研究來創造增值的食品產品，以滿足對高營養和功能性食品的不斷增長需求。收集的田野數據將轉化為一個全面的數據庫和生產模型，為該行業提供寶貴的洞察和解決方案。從這些舉措中產生的收入將重新投資支持進一步的研究和發展，與國家和地區的發展政策保持一致。

播種家創科有限公司以其獨特的專業知識和創新精神，致力於引領中國農業景觀的轉型。我們的項目旨在不僅應對食品安全和環境可持續性方面的挑戰，還為整個社會創造經濟和社會效益。