Appendix

Data Storage and Retrieval using Peptides and Tandem Mass Spectrometry Sequencing

Having secured over HK$9.7 million funding, Dr YAO Zhongping, Associate Professor of PolyU's Department of Applied Biology and Chemical Technology leads a project titled "Data Storage and Retrieval using Peptides and Tandem Mass Spectrometry Sequencing". Coupling data storage with proteomics techniques for the first time, this is a novel data storage method that are revolutionary in the field of data storage.

In the age of big data, data are generated at an unprecedented speed and stored in digital form using electrical, magnetic or optical devices, which are not durable and require large physical storage spaces. To tackle these problems, new data storage methods that are durable and of high density are urgently needed. In the approach taken by the project team, raw data will be stored in mixtures of peptides, which can be separated and sequenced using liquid chromatography coupled with tandem mass spectrometry (MS/MS). The preliminary results have demonstrated that it is feasible to store data in peptides and retrieve the data using MS/MS sequencing.

An interdisciplinary team, comprising members with expertise in peptide synthesis and sequencing, data storage and retrieval, mass spectrometry, computing and bioinformatics, has been formed to for this project.

Forward-Looking Intravascular Photoacoustic/Ultrasound Imaging Technology for the Assessment and Guidance of Cardiovascular Chronic Total Occlusion Intervention

Dr LAM Kwok-ho, Associate Professor & Associate Head, Department of Electrical Engineering, is leading a project titled "Forward-Looking Intravascular Photoacoustic/Ultrasound Imaging Technology for the Assessment and Guidance of Cardiovascular Chronic Total Occlusion Intervention", which was awarded over HK$4.3 million. In this research, a novel imaging technology is proposed to assess and guide coronary heart disease intervention, particularly for cardiovascular chronic total occlusion (CTO) cases.

CTO is one of the most prevalent heart diseases, which is due to a heavy buildup of cholesterol plaque inside the coronary artery, resulting in the complete blockage of the artery. CTO can cause chest pain, shortness of breath, stroke or even death. One of the low-risk viable options for treatment strategy is to open the blockages using special guide wires and catheters. Nevertheless, the procedure requires a very high level of skill and knowledge.

To reduce the procedure time and further enhance the success rate of surgery, an imaging technology that can assist surgeons to develop optimal treatment strategies before the procedure and provide real-time therapy guidance during the procedure is highly desired. The proposed technology combines the functional imaging offered by the photoacoustic effect and the structural imaging offered by high-resolution ultrasound. Integrated with a forward-looking design, the technology can offer real-time visualization of the vessel and plaque morphology as well as information about plaque characteristics such as its constituents and inflammation within the coronary artery.

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Mapping and Characterization for Optimized Evaluation of Potential Landing Sites on the Moon and Mars to Support Future Missions

Identifying a suitable landing site is vital for any in situ exploration mission to the Moon and Mars. In the research project titled "Mapping and Characterization for Optimized Evaluation of Potential Landing Sites on the Moon and Mars to Support Future Missions", Dr WU Bo, Associate Professor, Department of Land Surveying and Geo-Informatics, is leading a team to develop innovative approaches for mapping and characterizing topographical, geomorphological and geological features, and analyzing these data concurrently to enable optimized evaluation of potential landing sites on the Moon and Mars. The project was awarded over HK$4.5 million funding.

The project aims to meet the following objectives:
(1) Development of innovative high-resolution, high-precision topographical mapping approaches to support detailed analysis of surface hazards for landing site evaluation on the Moon and Mars
(2) Development of more automated, robust geomorphological mapping approaches to characterize typical geomorphological features for landing site evaluation on the Moon and Mars
(3) Development of a multiple-source spectral database of rocks and minerals for spectral interpretation to characterize geological records and mineral compositions for landing site evaluation on the Moon and Mars
(4) Optimization of joint topographical, geomorphological and geological analysis for systematic evaluation of potential landing sites on the Moon and Mars, to support future exploration missions.

Improving Vision and Quality of Life in Patients with Glaucoma Using Non-Invasive Brain Stimulation and Perceptual Learning: A Randomized Clinical Trial

Dr CHEONG Ming Yan Allen, Associate Professor of PolyU's School of Optometry, is leading a project titled "Improving Vision and Quality of Life in Patients with Glaucoma Using Non-Invasive Brain Stimulation and Perceptual Learning: A Randomized Clinical Trial", which was granted over HK$8.8 million funding.

Glaucoma is a neurodegenerative disease, which is caused by degeneration of the cells that connect the eye to the brain, leading to progressive vision loss. Despite intense research efforts to restore vision loss in glaucoma, current treatment strategies only arrest or slow vision loss.

Current vision rehabilitation for peripheral field loss involves compensation strategies such as the use of prisms to move images into central vision or eye movement training to optimize the use of remaining vision. Yet, none of these approaches result in improved vision. Recent scientific advances have discovered that neurons and neural circuits in our brain can be rewired and this process is called neuroplasticity. Emerging evidence has demonstrated that the new intervention approach "Vision restoration" can help improved vision by harnessing brain plasticity using visual perceptual learning (i.e. intensive visual training by repeated presenting stimuli at one or more locations in the visual field) and/or neuro-modulation (i.e. alteration of brain activity through non-invasive brain stimulation).

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The team will conduct large-scale, randomized controlled trials to assess the effectiveness of the new intervention approach. With this breakthrough paradigm, the project aims to improve glaucoma patients' visual functions through modulating brain function.

Edge Learning: The Enabling Technology for Distributed Big Data Analytics in Cloud-Edge Environment

Professor GUO Song, Professor & Associate Head, Department of Computing, is leading a project titled "Edge Learning: The Enabling Technology for Distributed Big Data Analytics in Cloud-Edge Environment", which has secured over HK$5.3 million funding. In the project, the research team has proposed Edge Learning, a paradigm complementary to cloud-based methods for big data analytics in the cloud-edge environment.

With the booming number of edge devices (e.g. phones, tablets, sensors, etc.), an enormous amount of data is generated on a regular basis which constitutes big data. It is of vital significance to learn from such big data for intelligent applications, such as smart buildings. Traditional cloud-based methods have made great achievements in big data learning, especially for applications that allow long response delay and data aggregation from edge to cloud. To further extend the frontiers of distributed learning, Edge Learning is proposed and has been developed for moving the training and inference to the edge environment in order to serve delay-sensitive and privacy-sensitive applications, of which the data cannot be gathered to the cloud.

To tackle the challenges rooted in the inherent characteristics of the cloud-edge environment, in this project the team will make efforts to develop new Edge Learning techniques. These include (1) collaborative learning architecture, (2) learning-oriented communication scheme, (3) fault tolerance and resilience strategy, (4) privacy protection and security guarantee, and (5) trained model deployment and update. A highlight of the proposed work is its strong emphasis on practical implementation. The team will develop an Edge Learning platform that enables learning-based applications to be deployed in an edge environment in an efficient and secure manner, resulting in the quick deployment of AI-enabled services in smart cities, which has tremendous technological and social significance.

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