



## 5G AND BEYOND

5G is the next generation wireless network as defined by global standards agencies. The first generation (1G) was a technology emerged in the 1980s where it all began with large cellphones that could make phone call only. Since then, 2G, 3G and 4G are introduced to change the way people live and work and bring a leap in downloading speeds. While companies are racing to develop faster and larger 5G networks, we are one of the region's top academic and research institutions leading in the development of 5G applications.



Electronic Engineering



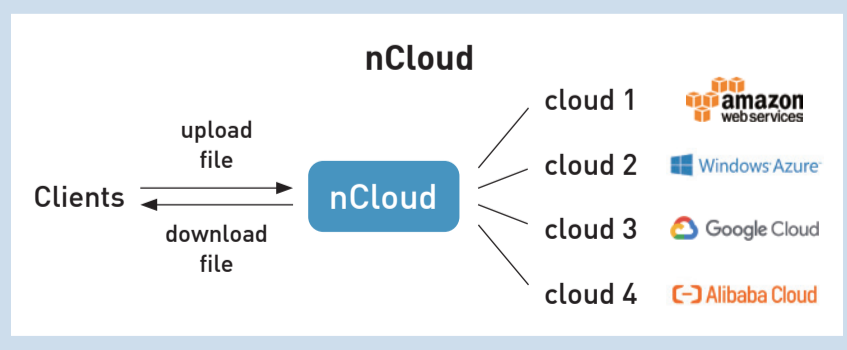
### Reliable and Intelligent Software-defined Multi-Cloud Storage in CSE

The Applied Distributed Systems Lab (ADSLab) (<http://adslab.cse.cuhk.edu.hk>), led by Prof. Patrick Lee in the Department of Computer Science and Engineering, has developed nCloud, a reliable and intelligent multi-cloud storage system that provides fault-tolerance, security, low-cost, scalability, performance, and configurability guarantees. The core design of nCloud builds on the network coding theory to interconnect the storage resources of multiple cloud storage providers.

With network coding, the storage overhead of nCloud is much less than that of traditional replication, and in the meantime, the failure recovery and degraded read performance is also provably optimal with the minimum bandwidth overhead (up to 70% bandwidth savings over state-of-the-art erasure coding).

In addition, by distributing data across multiple clouds, nCloud by design provides the security guarantees as it makes malicious attacks more difficult to compromise multiple storage locations. Furthermore, nCloud supports a programmable and intelligent infrastructure to automate storage management for backups and file system workloads.

The vision of nCloud is to blend the traditional cloud storage and emerging AI technologies, thereby motivating the need of advancing big data management. The nCloud development is funded by the Innovation and Technology Commission and the private industry, with a total awarded amount of HK\$4M. nCloud also has several successful trial and deployed cases.



### Real-time Radio Processing Trial Site for 5G AI Research

Fifth Generation wireless systems (5G) has been developed for the last few years. Compared with 4G wireless communication, there are three distinct improvements of 5G: super-fast download speed (20 times faster), low latency (1 millisecond) and mass connectivity. 5G can easily provide a better everyday entertainment experience: smooth streaming, enhanced gaming response, fast file transfer, stable connection in crowded place, etc. More importantly, 5G contributes to the future technology developments. Virtual Reality (VR), Internet of things (IoT), and Artificial Intelligence (AI) all need fast speed, massive network connection and data transmission. One thing for sure, 5G will revolutionize people's life.

Prof. Ming Yu's research team at the Department of Electronic Engineering focuses on related research fields, including 5G filter/multiplexer technology and base station antenna design.

Recently, with the help of a local company, a 5G Trial Site is set up in CUHK lab at Room 431 of Ho Sin Hang Engineering Building. The 5G base station system is based on ERICSSON modules and operates at 3.3GHz. It uses AI Real-time Radio Processing technique. Besides, due to Ericsson's dynamic spectrum sharing technology, users can experience seamless connectivity between 4G and 5G. As mentioned, 5G communication features low latency. Therefore, it can support demanding applications like remote surgery and massive gaming. We will soon perform remotely controlled robot on this 5G Trial Site.





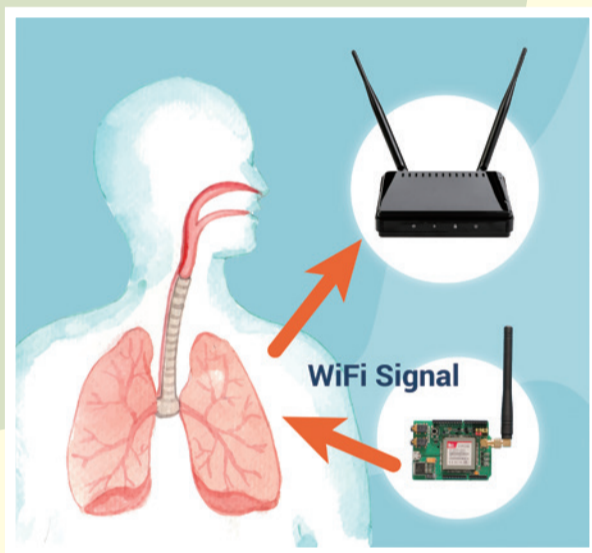
Information Engineering

## Turning In-Home WiFi into IoT Sensors for Healthcare Monitoring of Older Adults

The worldwide population over 65 is expected to grow to one billion in 2030. Every year 33% of elderly people over the age of 65 will fall. The fall could cause injuries and a reduction of the quality of life. Therefore, it is vital to continuously monitor the health conditions of the older adults in their living places. However, the invasive clinical monitoring methods do not lend itself to everyday use in home and community settings. Besides, previous studies have reported that the elderly are reluctant to put on wearable devices on a daily basis.

The Wireless Internet of Things Research Team, which led by Prof. Henry Chen from Department of Information Engineering, is developing a comprehensive wireless sensing system, which turns in-home WiFi into IoT sensors for contactless and continuous monitoring of the older adults. The system can detect the breathing, heart rates, and body movements of the older adults when they are in home. The basic principle of these signal detection is that the breathing/heartbeat-induced chest movement and other body movements will change the WiFi signals reflected.

By detecting these changes, we can detect the underlying signals of interest. Based on these collected data, we can apply cutting-edge machine learning algorithms to infer the sleeping quality, amounts of exercise (e.g., the time length of standing and sitting), falling of the seniors.



# MAE

Mechanical and  
Automation Engineering

## Autonomous Driving Project in MAE

A team from the Department of Mechanical and Automation Engineering are developing an autonomous driving technology for industrial vehicles, which typically carries a heavy load and moves at slower speeds but requires greater accuracy as it operates in semi-closed environments. The technologies they are developing include a precise dynamic control with varying load, real-time sensor monitoring and perception of the environment, and integration of the visual SLAM (simultaneous localization and mapping) technique.

In particular, the vision-based navigation and control technologies have been implemented in several commercial products (commercialized through our start-up: VisionNav Robotics (Shen-zhen) Co., Limited): autonomous pallet forklift trucks, forklift trucks, and tractors. The autonomous lifting forklift can lift pallets carrying a load of up to 2 tonnes to a height of 9.4m in warehouses automatically, setting a world record. They also have retrofitted a diesel tractor into an autonomous driving prototype, and it is capable of operating autonomously in an indoor-outdoor environment while working with variable heavy loads and executing with great accuracy.

The autonomous tractor developed is currently undergoing field tests at the Hong Kong International Airport starting from May 2019, and is being used for airport cargo transportation. The successful implementation of this autonomous vehicle will significantly increase the efficiency of goods and luggage handling and transportation at the airport, and the project is supported by the Hong Kong Innovation and Technology Commission (ITC).



# SEEM

Systems Engineering  
and Engineering Management

## The Design of Stable Coins

A blockchain is a list of data records that are linked and secured via cryptographic tools. The blockchain technology enables the decentralized storage of transactions, for which a consensus can be reached even though the digital ledger is distributed over the network, since the transaction records cannot be retrospectively modified without the consensus of the majority in the network.

The blockchain technology has a wide range of practical applications. It gives rise to the use of cryptocurrencies, whose transactions are verified by the network without the need of a central clearing party. Another application of the blockchain is the smart contract, which can be triggered and enforced automatically based on a blockchain network without human interaction.

One type of cryptocurrencies currently of particular interest is the stable coins, which have a stable value to other financial assets such as the U.S. dollar. Using financial engineering tools, the research initiated by Prof. Chen Yang from Dept. of Systems Engineering and Engineering Management proposes a design that transforms the existing cryptocurrencies into a multi-layered structure offering entitlements to stable coins as well as leveraged investment opportunities. The proposed design does not require locked-in collaterals unlike many existing stable coin designs, and can be implemented as a smart contract on the Ethereum network.





## CUHK Students Won Top Awards at the 6<sup>th</sup> Hong Kong University Student Innovation and Entrepreneurship Competition

The 6<sup>th</sup> Hong Kong University Student Innovation and Entrepreneurship Competition was organized by the Hong Kong New Generation Cultural Association. Winning teams will represent the Hong Kong Special Administrative Region in the biennial "Challenge Cup" National College Students' Extracurricular Academic and Technology Contest, the China College Students' "Internet+" Innovation and Entrepreneurship Competition, and the Beijing-Hong Kong Youth Innovation and Entrepreneurship Cup

### Entrepreneurship First-class Award: LaSense Ultra-sensitive Gas Sensing and Control System

Coal-fired thermal power plants are the main source of electrical power in China, accounting for more than 60% of the total power generation. They are also the main source of air pollutant emissions. A large number of Nitrogen Oxides (NO<sub>x</sub>) are produced in coal combustion, which are toxic gases in various forms. In recent years, with the more strict environmental protection policy, coal-fired power plants have been urged to carry out ultra-low emission renovation work. PhD student Xu Ke and Prof. Ren Wei from the Department of Mechanical and Automation Engineering at CUHK, established a startup named LaSense Technology in November 2019, and have designed and developed a real-time, calibration-free and ultra-sensitive (sub-ppm) gas sensing and control system, which can meet the requirements of the simultaneous measurement of NO<sub>x</sub> and NH<sub>3</sub>, in order to meet the urgent market demand from the energy industry. The system will be used in the denitration process control to improve the denitration capacity and efficiency of the power plant, and to achieve the source prevention of air pollution as well.



### Entrepreneurship Second-class Award: Soft Wearable Exoskeleton for Rehabilitation

Heung Ho Lam, Tang Zhi Qiang and Shi Xiangqian, PhD students from the Department of Biomedical Engineering have won Entrepreneurship Second-class Award with the project "Soft Wearable Exoskeletons for Rehabilitation" in 6<sup>th</sup> Hong Kong University Student Innovation and Entrepreneurship Competition. The team, supervised by Prof. Li Zheng and Prof. Raymond Tong, has started a company *Soft Wearable Robotic Limited* since 2017.

Their company dedicated to the development of latest soft wearable robotics technologies for rehabilitation of people after stroke and the elderly with joint diseases. Their missions are to get disabled people moving again and enable them to reintegrate to the society with better activities of daily living (ADL). In partnership with the Neurorehabilitation and Robotics Laboratory in CUHK, they introduce the pioneering soft wearable robotic exoskeletons to hospitals, rehabilitation centers, and even every stroke individual for recovering normal body function.



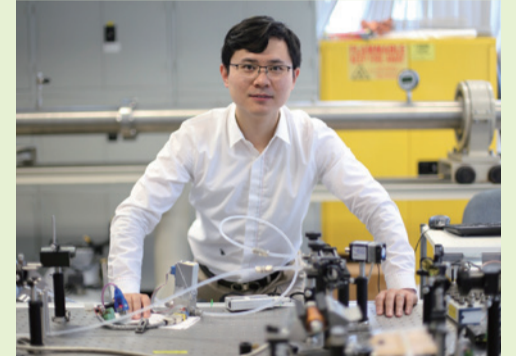
Winning engineering projects are listed below.

Award	Name of Project	Name of Students	Affiliated Department / Programme
<b>Category: Innovation</b>			
Third-class	Optical activation of TrkB signaling	HUANG Peiyuan	Department of Biomedical Engineering
Third-class	Annealing of strontium titanate based thermoelectric materials by graphite mechanistic analysis by spectroscopic and chromatographic techniques	LI Haoran	Department of Mechanical and Automation Engineering
Third-class	Modularized ROV	KWOK Chun Keung	Department of Mechanical and Automation Engineering
Merit	Portable Microscope System for Real-Time Aerosol Measurement	GU Songyun, CHEN Bingxu, LAI Huasheng	Department of Mechanical and Automation Engineering, Department of Surgery
<b>Category: Entrepreneurship</b>			
First-class	LaSense Ultra-sensitive Gas Sensing and Control System	XU Ke, Professor REN Wai	Department of Mechanical and Automation Engineering
Second-class	Soft Wearable Exoskeleton for Rehabilitation	HEUNG Ho Lam, TANG Zhiqiang, SHI Xiangqian, Professor LI Zheng, Professor TONG Kai Yu	Department of Biomedical Engineering

## MAE Research Team Revealed the Role of Water Vapour in Methanol Atmospheric Reaction

A research team led by Prof. Ren Wei from MAE department has adopted high-level quantum chemistry calculations to provide a definitive answer to the role of water vapour in methanol atmospheric reaction. The new findings will enable a more accurate and reliable prediction of air pollution and atmospheric chemistry. The research work has been reported in *Angewandte Chemie-International Edition* and highlighted as the Very Important Paper (VIP). (<https://doi.org/10.1002/anie.202001065>)

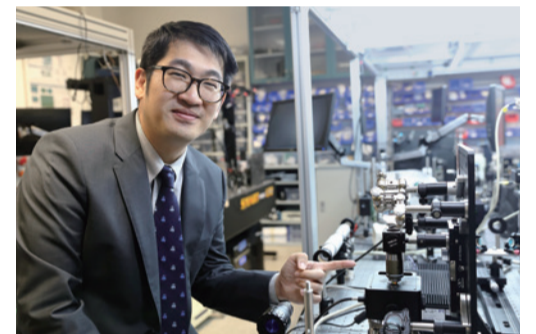
Professor Ren said, "this research unveils a novel method for predicting atmospheric reactions. With the new dimension provided for the study of atmospheric reactions, we hope that in the future there will be a more accurate and faster application on monitoring air pollution in addition to the ultrasensitive trace gas sensors, leading to a higher quality alert system, and even better precautionary measures by the relevant corporations and authorities."



## MAE Professor Received an Innovation Award

Prof. Shih Chi Chen received an innovation award (發明創業獎—人物獎) from the China Association of Inventions, which recognizes his outstanding research, invention, and successful commercialization (Nano-Builder) of new 3D printing technologies.

He received his B.S. degree in Mechanical Engineering from the National Tsing Hua University, Taiwan, in 1999; and his S.M. and Ph.D. degrees in Mechanical Engineering from the Massachusetts Institute of Technology, Cambridge, in 2003 and 2007, respectively. Following his graduate work, he entered a post-doctoral fellowship in the Wellman Center for Photomedicine, Harvard Medical School, where his research focused on biomedical optics and endomicroscopy.

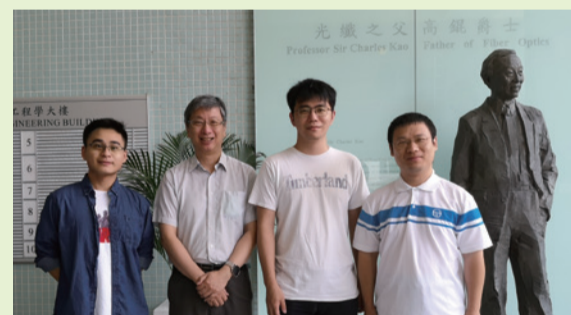


## Breakthrough in Photonic Integration Published in Nature Communications

The ever-increasing growth in data traffic requires more powerful transmission networks. To respond to such demand, a group of researchers led by Prof. Xiankai Sun and Prof. Hon Ki Tsang in the Department of Electronic Engineering, has recently revealed a way to use light to convey large rates of data in advanced optical chips. Their findings and demonstrations shed new light on increasing the data capacity with low insertion loss and crosstalk.

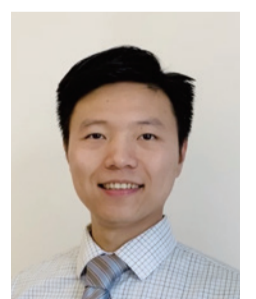
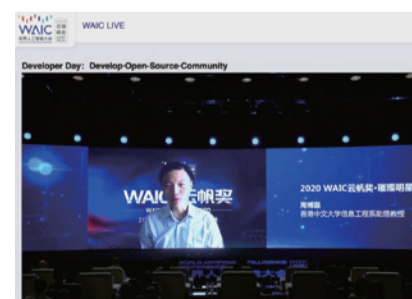
In their paper titled "High-dimensional communication on etchless lithium niobate platform with photonic bound states in the continuum" published in *Nature Communications* on 25 May 2020, they explained how they made use of an old concept, the so-called bound states

in the continuum (BICs), first proposed by John von Neumann and Eugene Wigner in 1929 during the early historical development of quantum theory, to confine light without necessarily having the high-refractive-index channel that is needed for the conventional total-internal-reflection-based waveguiding in optical fibers and photonic integrated circuits.



## Prof. Bolei Zhou Received the WAIC Yunfan Award

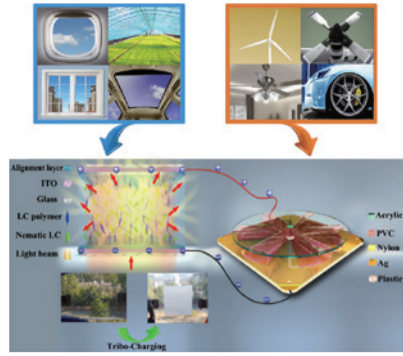
Prof. Bolei Zhou, Department of Information Engineering has been selected as one of the 20 recipients of the first WAIC Yunfan Award (世界人工智能大會雲帆獎). The award is highly selective, and awardees are recognized for their high-impact contribution to the AI community and are under the age of 35.



Prof. Zhou's research is on computer vision and machine learning, particularly visual scene understanding and interpretable AI systems. His representative work includes the large-scale scene benchmarks Places Database and Places-CNN, ADE20K Dataset, as well as neural network interpretation methods Class Activation Mapping (CAM) and Network Dissection.



## MAE Research Team Invented a Normally Transparent Tribo-Induced Smart Window



A self-powered smart window was developed by Prof. Yunlong Zi's group, by combining a freestanding sliding triboelectric nanogenerator (FS-TENG) and a polymer network liquid crystal (PNLC).

The transparency of the developed window can be tuned by the environmental mechanical motions. Such a tribo-induced smart window can benefit a wide variety of fields, such as self-powered sunroofs, wind driven smart farming systems etc.

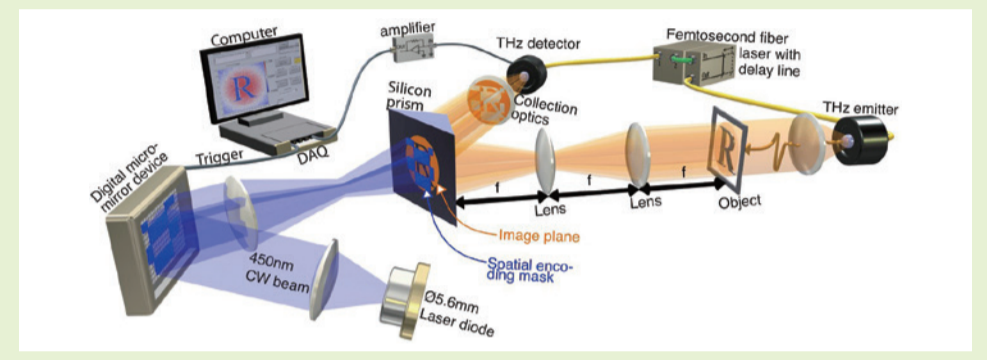
Ref: *ACS Nano* 14 (3), 3630-3639.

## T-ray Camera Speed Boosted a Hundred Times Over

A research team from the Department of Electronic Engineering, CUHK and the University of Warwick has reached a crucial milestone towards developing single-pixel terahertz radiation (T-ray) imaging technology. Their single-pixel T-ray camera reached 100 times faster acquisition than the previous state-of-the-art without adding any significant costs to the entire system or sacrificing the sub-picosecond temporal resolution needed for the most sought-after applications, potentially opening the opportunity for them to be used in non-invasive security and medical screening. The breakthrough has been published in the journal *Nature Communications*.



Prof. Emma Pickwell-Macpherson said: "We use what is called 'a single-pixel camera' to obtain our images. In short, we spatially modulate the THz beam and shine this light onto an object. Then, using a single-element detector, we record the light that is transmitted (or reflected) through the object we want to image. We keep doing this for many different spatial patterns until we can mathematically reconstruct an image of our object."



## Prof. Ming Yu Received 2020 Microwave Application Award of the IEEE Microwave Theory and Techniques Society

Prof. Ming Yu, Department of Electronic Engineering has been selected for the 2020 Microwave Application Award of the IEEE Microwave Theory and Techniques Society (MTT-S) for his contribution to the development of computer aided and robotic tuning for filters and multiplexers. The award recognizes an individual or team of no more than five individuals for an outstanding application of microwave theory and techniques, which has been reduced to practice nominally 10 years before the award.



## INNOVATION AND TECHNOLOGY STUDENT CLUB

With a view to prepare Hong Kong for upcoming challenges and to develop into a knowledge-based economy, the Faculty of Engineering, The Chinese University of Hong Kong (CUHK) has established the "Innovation and Technology Student Club" (ITSC) jointly with Innovation and Technology Commission. Our vision is to nurture young talents to become future technology elites who will contribute to the development of Hong Kong.

ITSC is marking its 10<sup>th</sup> anniversary at CUHK. A number of celebrations have been held for members:

- Research Mentorship: an opportunity to experience how a research was conducted in University environment
- Technology Reporters: members can do interview on advanced technology topics in university
- Summer Camps / Winter Camps: members can reside at university hostel and experience authentic university life. (Advanced themes include 3D printing, AI, VR/AR, Computer games, Apps, Drones control)
- Exchange Camp: an opportunity to reach out technologies outside Hong Kong (including Shenzhen, Guangzhou, Shanghai, Huizhou, Jiangmen, Foshan and etc..).
- STEM workshops : an opportunity to learn solid Science and Engineering hands on technology, for examples, DNA workshop, Bluetooth control robots, AI control robots, 3D printing technique etc..
- Technology Visits: an opportunity to learn how technologies are applied in our daily life, for examples visits to Hong Kong Science Park, Cyberport, Microsoft, ASTRI, Cathay City, TVB, HAECO, HIT, HAESL, CAD, AAT, BYD in SZ, EMSD, CLP Green Resort, MRI technology from Time Medical Ltd., and InnoLab.
- Technology Ambassadors: an opportunity to promote technologies and STEM projects to public by participating in InnoCarnival
- STEM Fun Day / ITSC Ceremony: an event to recognize members' achievements and for members to have fun activities



2010 Meet With Prof. Charles Kao, former CUHK Vice-Chancellor and Nobel Laureate



Winter Camp: 2018 CU Hunt in Winter Camp for members experienced University life



2018 Summer Camp: dialogue with Prof. Tong Siu Sing



2017 Exchange Camp: visit manufacturing of high speed train



Technology Ambassador 2016: InnoCarnival Booth in Hong Kong Science Park



Technology Visit: 2016 visit HAECO in Airport

For the 10<sup>th</sup> anniversary programme, we introduced a new program "STEM tutors training". We are hoping that our activities can gather all students with similar interests in science and engineering together to empower their STEM strengths.

Action now to apply ITSC membership. Give "Like" in facebook to receive ITSC latest news.

ITSC is planning various activities in coming winter. Follow us on our Facebook page and YouTube channel as below: [www.itsc.org.hk](http://www.itsc.org.hk) <https://www.facebook.com/ITSC.HK> and [www.youtube.com/CUHKcintec](http://www.youtube.com/CUHKcintec).

If you are a secondary student, you are welcome to join our activities by online application for ITSC membership through [www.itsc.org.hk/chi/membership.html](http://www.itsc.org.hk/chi/membership.html). By joining our membership program, most activities will be free of charge.

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