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"Fullness of life" from a neural perspective: Brain health and mental wellbeing

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香港理工大學高等研究院

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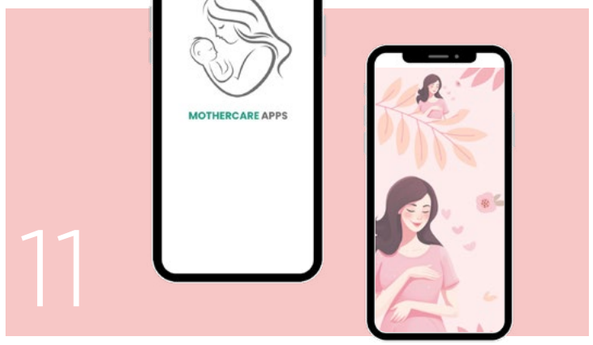

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Chief Editor's Corner

As Issue 15 is published, our first course, "Healthy Life and Smart Living", also commences. PAIR is dedicated to fostering a culture of interdisciplinary innovation through research and scholarship. We are happy to see our interdisciplinary efforts now expanding to education. Our brand-new initiative, the PAIR Advanced Education Programme, provides short courses to the public on interdisciplinary scientific topics that are related to daily living.

Offered in dual mode (online and in person) and designed for learners from all backgrounds, the Programme addresses some of the biggest societal challenges facing the world today and the solutions to these problems. We are already planning for the next course, "Sustainable Cities", and further details will be announced in due time. We invite you to join our courses and share this valuable learning opportunity with your network.

Issue 15 presents a collection of compelling articles and important academy updates. In the Feature Stories section, we interview three leading scholars from distinct disciplines, who offer their perspectives on mental health research, photonics development and clean air actions. Prof. QIU Anqi, Director of the Mental Health Research Centre, explains how mental health diagnosis and intervention can be supported by engineering and data-driven approaches. PAIR Senior Fellow, Prof. YAO Jianping of the University of Ottawa, Canada, addresses the current development in and challenges facing the photonics industry. Prof. David PUI, also a PAIR Senior Fellow, describes how the giant air cleaning towers he designed help contribute to cleaner air in China and India.

This Issue's Research Achievements section takes a closer look at studies at PAIR which bring unique insights into sustainability, cultural heritage and human health. The News & Events section summarises the latest knowledge-exchange activities, including international conferences, lectures and seminars, conducted by PAIR and its constituent units. The Knowledge Transfer section highlights healthy ageing technologies developed by PAIR researchers that integrate medical engineering and artificial intelligence. The People section reports on the recent achievements by our researchers, including recognition as tech leaders or best scientists in their respective fields.

Last but not least, the PAIR Advanced Education Programme is the culmination of a collective effort by PAIR research units. Gaining an understanding and awareness of societal problems is the first step in problem-solving. Please stay tuned for news about our upcoming courses and join us on a scientific learning journey.

Prof. CHEN Qingyan

Director of PolyU Academy for Interdisciplinary Research

Research Achievements

PolyU research unveils hidden microbial threats to ecosystem caused by plastic waste

A research team led by Prof. Nathanael JIN Ling, Member of the Research Institute for Future Food (RiFood) and the Research Institute for Sustainable Urban Development (RISUD), and Assistant Professor in the Department of Civil and Environmental Engineering and the Department of Health Technology and Informatics, has shed light on the often-overlooked microbial threats associated with plastic waste.

Prof. Lin's research team has developed a global database and model to map the trajectory of the harmful microbiomes carried by plastic debris and to forecast the potential ecological risks. The team combined field-collected samples and publicly available raw data to analyse the microbial communities in the plastisphere and its associated natural environments, covering freshwater, seawater and terrestrial ecosystems. The research found that, in all three environmental systems, microbial communities in the plastisphere differ markedly from those in the natural environment, in terms of both the genera of microorganisms present and their coexistence patterns. These communities consist of fragile networks of specialised microorganisms, which are rarely encountered in nature.

Compared with the microbial communities in natural environments, microorganisms in the plastisphere exhibit a pronounced ability to decompose organic compounds, potentially increasing the release of greenhouse gases and accelerating carbon turnover. The findings also highlight disturbances in the nitrogen cycle caused by the plastisphere, especially in the freshwater ecosystem where bacteria that release harmful substances such as nitrite and nitrous oxide thrive.

In addition, a significant rise in pathogens that pose risks to humans, animals and plants has been spotted in the plastisphere. Notably, some of the pathogen species had not been detected in the corresponding natural environment previously, which indicates the potential of the plastisphere to carry pathogens across ecosystems.

These findings underscore the urgent need to address plastic pollution, as plastics not only pose environmental hazards, but also act as vectors for transmitting microbial diseases that can lead to a cascade of ecological and public health consequences. By prioritising interdisciplinary research and policy action, society can better anticipate and curb the hidden dangers posed by plastic-borne microbiomes. This is a critical step towards safeguarding ecosystems and human health in an increasingly plastic-dependent world.

The research results provide a comprehensive overview of the unique and diverse microbial communities of the plastisphere, and the findings have been published in the international interdisciplinary journal *The Innovation* (https://www.sciencedirect.com/science/article/pii/S2666675823001716).

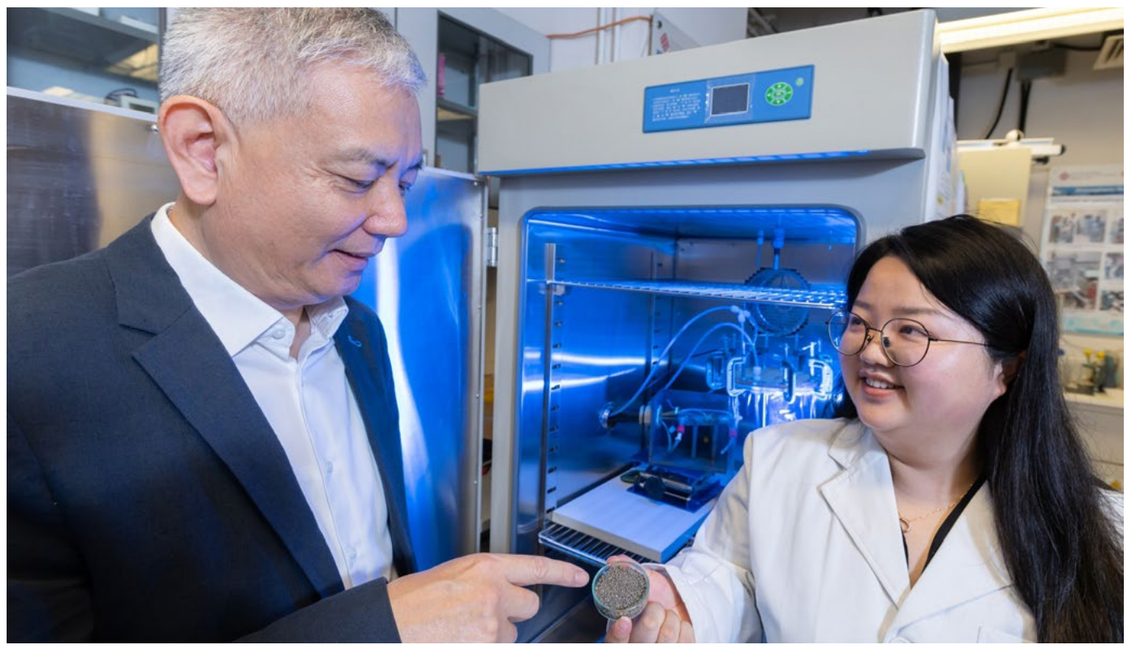
PolyU research reveals that rising soil nitrous acid emissions exacerbate global ozone pollution

A study led by Prof. WANG Tao, Executive Committee member of the Research Institute for Sustainable Urban Development (RISUD) and Chair Professor of Atmospheric Environment in the Department of Civil and Environmental Engineering, along with his research team, has unveiled the pivotal role of soil nitrous acid (HONO) emissions in the increase of the ozone mixing ratio in the air and the negative impact of these emissions on vegetation.

The team analysed global soil HONO emissions data from 1980 to 2016. They found that these emissions increased from 9.4 Tg N in 1980 to 11.5 Tg N in 2016. Using the chemistry-climate model to simulate the impact of soil HONO emissions on atmospheric composition, the researchers discovered an average 2.5% rise annually in the global surface ozone mixing ratio, with localised increases reaching 29%. The team pointed out that soil HONO emissions are influenced by the combined effects of nitrogen fertiliser usage and climate factors such as soil temperature and soil water content, resulting in seasonal and geographical variations.

The research established a comprehensive dataset by integrating multiple variables, incorporating climate factors like soil temperature, soil water content, and fertiliser type and application rates into the parameterisation scheme. For unquantifiable factors such as microbial activities, land use, and soil texture, the team applied diverse parameters based on latitude, longitude, and land use data for the corresponding soil samples.

The findings have been published in *Nature Communications* (https://www.nature.com/articles/s41467-025-57161-6).



RILS study reveals Malacca heritage with cutting-edge geospatial technologies

A project named "Antiquity and Heritage Lost, Found and Revealed: Promotion of 21st Century Geo-spatial Technologies" led by Prof. Wallace LAI Wai-lok, Member of the Research Institute for Land and Space (RILS), Associate Head (Teaching) and Professor of the Department of Land Surveying and Geo-informatics, has been granted HK$3.22 million from the General Support Programme under the Innovation and Technology Fund (ITF-GSP) of the Innovation and Technology Commission of the HKSAR Government.

This two-year project, in collaboration with Hong Kong Baptist University and local amateur war historians, aims to uncover and document the city's concealed historical sites using advanced geospatial technologies. By employing techniques such as geo-referencing, airborne and terrestrial laser scanning, and geophysical technologies, the team is capturing detailed images of buried wartime relics and antiquities, bringing these lost historical artefacts back to light.

To foster community involvement in STEAM (science, technology, engineering, arts, and mathematics) education, the team will organise public programmes such as guided visits to cultural and wartime heritage sites, STEAM-focused seminars, interactive workshops, and immersive exhibitions. The team has collaborated with a wide range of stakeholders including government bodies, universities and industry partners, science magazines, non-governmental organisations and local village communities to enhance public engagement and advance the application of geospatial innovations in uncovering Hong Kong's hidden historical stories.

In May 2025, the team expanded the study scope to Malacca, Malaysia, where they conducted 3D scanning and mapping of historic structures, including the Porta de Santiago and St. Paul's Church. By integrating digitised historical maps with modern scanning technologies, the team identified remnants of long-buried colonial fortifications. Further expeditions to other regions in Malaysia and Indonesia have been planned.

Joint study reveals nearly half of online dietary advice is misleading

A survey conducted by The Hong Kong Polytechnic University (PolyU), in collaboration with the Hong Kong Nutrition Association (HKNA) and the Hong Kong Metropolitan University, has revealed that more than 40% of online nutrition-related advice lacks scientific credibility. Additionally, the research found that close to 40% of respondents had followed at least one fad diet.

Prof. Kenneth LO Ka-hei, Member of the Research Institute for Future Food (RiFood) and the Research Institute for Smart Ageing (RISA), Assistant Professor in the Department of Food Science and Nutrition of PolyU, and Internal Affairs Officer of HKNA, emphasised that the results underscore the increasing focus among Hong Kong residents on healthier eating habits and their willingness to explore various dietary strategies to enhance their well-being.

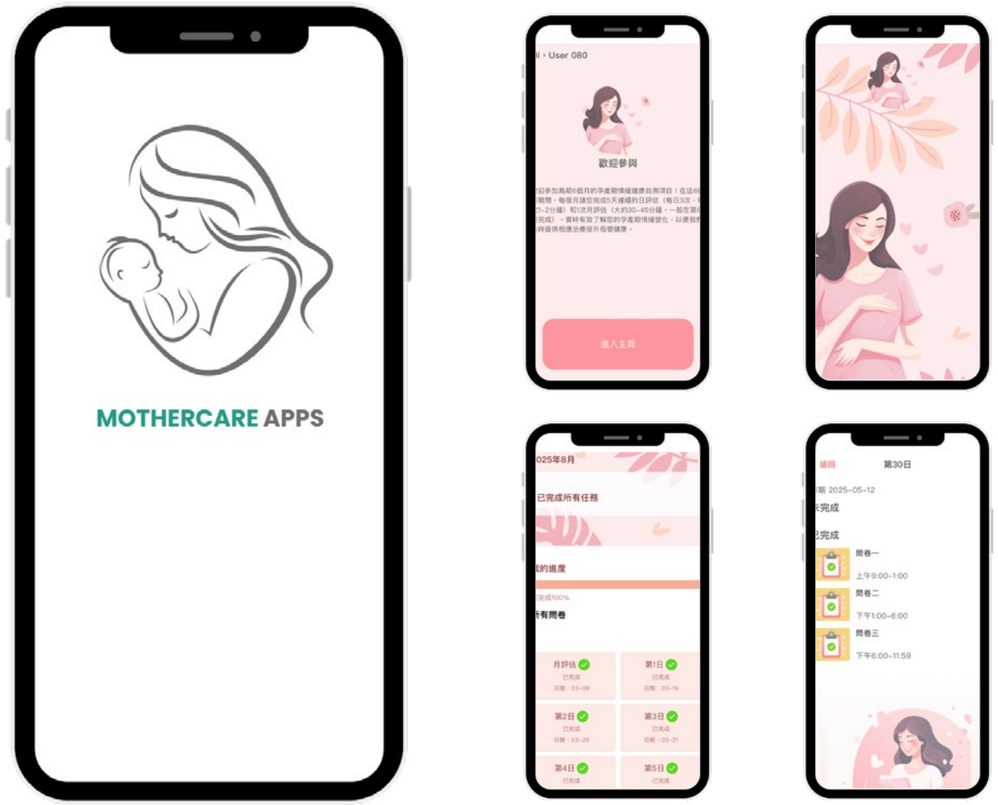
Knowledge Transfer

MHRC develops mobile application “MotherCare” for detecting perinatal depression

Supported by the Health and Medical Research Fund (HMRF) of the Health Bureau of the HKSAR Government, Prof. Jessie LIN, Member of the Mental Health Research Centre (MHRC) and Assistant Professor in the Department of Rehabilitation Sciences, and her team have developed a mobile application called “MotherCare” to facilitate the early detection of perinatal depression through ecological momentary assessment (EMA).

Perinatal depression (PND) is a serious mental health condition that can significantly affect both mothers and their infants. Early detection is essential to preventing adverse outcomes. In Hong Kong, current screening practices rely on manual assessments using the paper-based Edinburgh Postnatal Depression Scale (EPDS), administered at three timepoints from pregnancy to six weeks postpartum. However, these screenings are limited by the infrequent intervals as well as resource constraints, often resulting in underdiagnosis of PND.

To address these challenges, Prof. Lin’s team collected both EMA and EPDS responses from over 120 women throughout the prenatal and postnatal periods to evaluate the feasibility and validity of mobile-based EMA for perinatal depression screening. Their findings indicated that EMA is comparable to the traditional paper-based questionnaire in identifying individuals at risk of PND, highlighting the potential of the new approach as a scalable tool for dynamic, real-time monitoring. This research suggests that mobile-based EMA could serve as an effective supplement or alternative to current screening methods, with significant implications for early identification of and intervention in perinatal mental health issues.



RISA drives technological innovation in healthy ageing

The Research Institute for Smart Ageing (RISA) is dedicated to advancing interdisciplinary research in healthy ageing with the integration of medical engineering and artificial intelligence (AI) healthcare technologies, bringing forth personalised therapeutic and care solutions.

Ir Prof. ZHENG Yongping, Director of RISA, Henry G. Leong Professor in Biomedical Engineering and Chair Professor of Biomedical Engineering, has pioneered 3D ultrasound imaging technology for muscle assessment. This innovation provides detailed visualisation of muscle structures, enables healthcare professionals to analyse patients' gait and movement patterns based on the 3D images, and allows the risk of muscle loss to be assessed through AI-driven motion analysis. Furthermore, it offers visualised strength training guidance to elders, thereby making it possible to prevent, delay and reverse sarcopenia. Prof. Zheng has highlighted the application of the imaging technology in the diagnosis of Parkinson's disease. By pinpointing lesions in specific midbrain regions through image analysis, the technology can improve diagnostic accuracy and facilitate evaluation of the risk for stroke among older adults.

Prof. Angela LEUNG Yee-man, Associate Director of RISA, Associate Head (Research) of the School of Nursing and Director of the World Health Organization Collaborating Centre for Community Health Services, focuses on implementing the "intrinsic capacity" theory and the "Integrated Care for Older People" (ICOPE) model. Her team has developed a rapid screening tool which employs a standardised assessment framework to identify the health needs of older adults, empower them to maintain independence, and facilitate their quality of life. Through interdisciplinary collaboration among experts in nursing, physiotherapy, nutrition and speech therapy, her team has designed dual-task training programmes for individuals with mild cognitive impairment. The programmes incorporate samba-dance cognitive training, a tablet-based remote support system, nutrition plans, physical exercises and cognitive tasks to improve the functioning of senior citizens.

Prof. Elaine KWONG Yee-lan, Associate Director of RISA, Associate Professor in the Department of Chinese and Bilingual Studies and a speech therapist, is developing ultrasound-based assessment tools that are portable and powered by AI algorithms for swallowing assessment. This technology addresses a gap in the traditional method by allowing swallowing assessments to be conducted in community or home settings without the need for X-rays and invasive endoscopy, thereby significantly enhancing diagnostic accuracy and efficiency.

Through continuous interdisciplinary collaboration, RISA is committed to propelling medical innovation through the expansion of its international collaborative network, positioning itself as a leader in global smart ageing research and innovation.

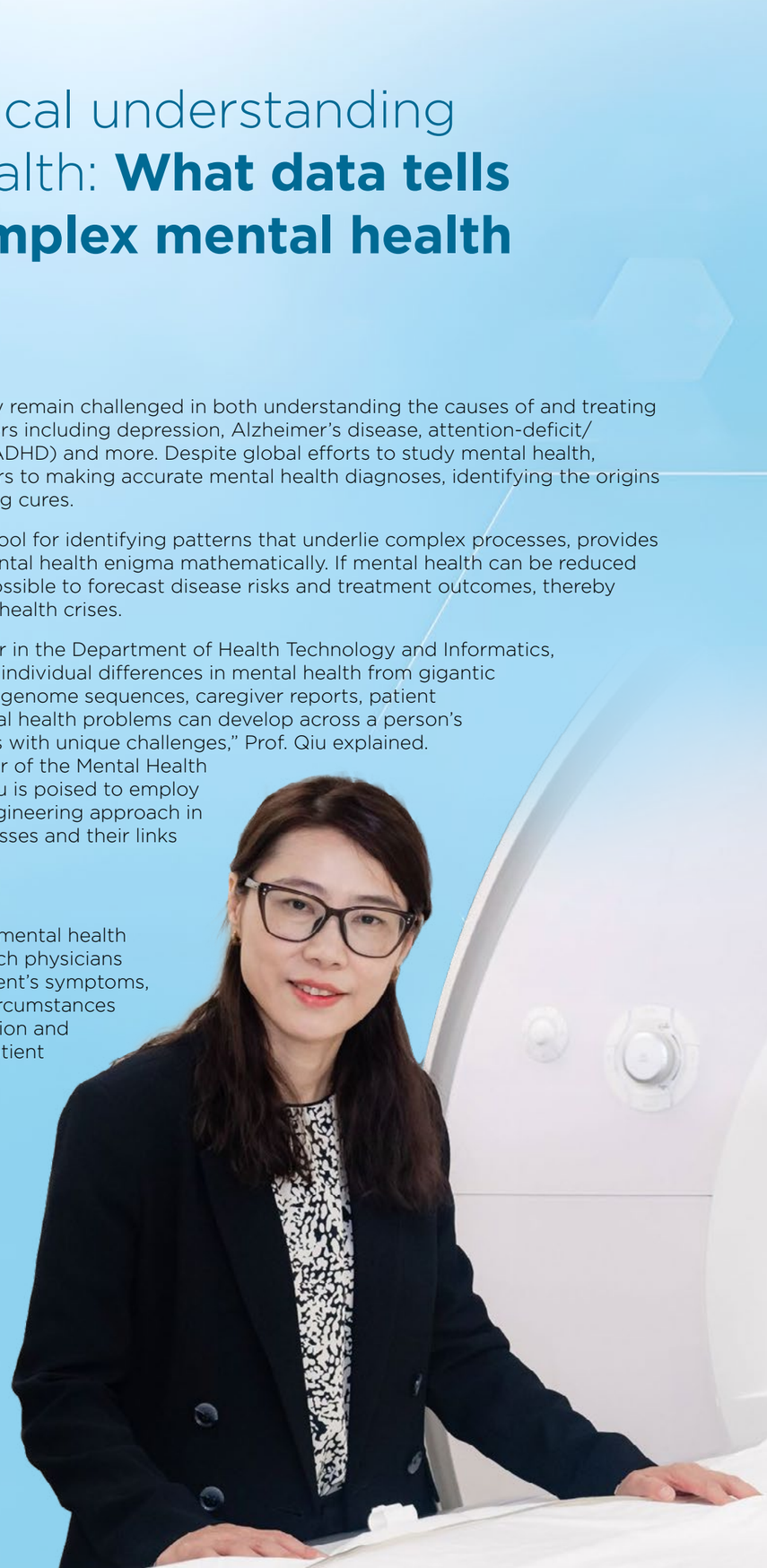
Feature Stories

A mathematical understanding of mental health: **What data tells us about complex mental health conditions**

Health professionals today remain challenged in both understanding the causes of and treating neuropsychiatric disorders including depression, Alzheimer's disease, attention-deficit/hyperactivity disorder (ADHD) and more. Despite global efforts to study mental health, clinicians still face barriers to making accurate mental health diagnoses, identifying the origins of psychiatric problems and finding cures.

Computational modelling, a vital tool for identifying patterns that underlie complex processes, provides a new pathway for solving the mental health enigma mathematically. If mental health can be reduced to a math equation, it becomes possible to forecast disease risks and treatment outcomes, thereby preventing and mitigating mental health crises.

At PolyU, Prof. QIU Anqi, Professor in the Department of Health Technology and Informatics, seeks answers about the origin of individual differences in mental health from gigantic collections of data—brain images, genome sequences, caregiver reports, patient symptoms and many more. "Mental health problems can develop across a person's lifespan, but each life stage comes with unique challenges," Prof. Qiu explained. In her new capacity as the Director of the Mental Health Research Centre (MHRC), Prof. Qiu is poised to employ mathematical methods and an engineering approach in understanding human brain processes and their links with mental health disorders.



The diagnosis jigsaw puzzle

The routine diagnostic process in mental health includes a clinical interview in which physicians gather information about the patient's symptoms, medical history, and current life circumstances through communication, observation and assessment. The subjectivity of patient self-reporting and comorbidity (the presence of multiple medical conditions simultaneously in a patient) are known factors that make clinical diagnosis of mental health a difficult art to master. In young children, such diagnosis is even harder.

"It is hard to determine whether a particular condition is normal for a child since children develop at different paces and in their own ways. The result is diagnostic uncertainty."

"Children grow very fast, and they exhibit more dynamic presentations of clinical features," Prof. Qiu explained. "Currently, the clinical diagnosis for mental problems among young children after the age of 6 is a knotty problem for medical doctors, psychiatrists and pediatricians. They are the professionals who follow the children as they grow. Childhood is a period of rapid development where variations across children also emerge. It is hard to determine whether a condition is normal for a child since children develop at different paces and in their own ways. The result is diagnostic uncertainty."

"This uncertainty is particularly dangerous in making a diagnosis of attention-deficit/hyperactivity disorder (ADHD) or autism spectrum disorder (ASD) among children. During clinical examinations, kids with ADHD may interrupt and say some other things which they want to share. Meanwhile, children with ASD tend to be quiet; some may go completely silent. Not all children are good at expressing themselves, and this may result in misdiagnosis. Furthermore, doctors are uncertain about making a definite diagnosis as they worry about the fear that the diagnosis brings to parents, although the conditions can be changed and treated."

Improving the art of diagnosis with science and technology

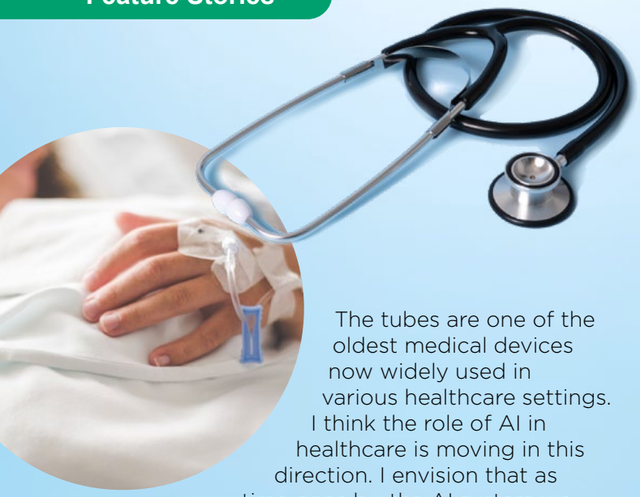
To disentangle the confusing issues in diagnosis, Prof. Qiu's team developed an innovative approach to mental health diagnosis in children: multidimensional brain imaging analysis that integrates deep-learning artificial intelligence (AI) technology and multimodal magnetic resonance imaging (MRI) data. The new method uses diverse types of information, including brain images, genetic information, and caregiver reports, to identify groups that are at high risk for ADHD, depression and anxiety from the fetal stage through adolescence, enhancing predictive accuracy by up to 25%. "What the model does is to combine all factors and calculate a risk score. This is like making an objective diagnosis at the press of a single button," Prof. Qiu said.

The start of an AI take-over?

When asked about the application of the AI-enabled system she developed in primary healthcare and the impact of AI on her research, Prof. Qiu emphasised the important role of physicians and clarified that her innovation is not trying to replace doctors.

"The AI system we developed would gain wide recognition from doctors, making diagnosis more convenient, objective and efficient by reducing the need for patients to undergo multiple diagnostic tests."

"Humans are still smarter than AI in some ways," she said. "In clinical setting, I see that AI can serve as an aid to doctors, helping them to make good clinical decisions based on their experiences and the objective information provided by the system. Ultimately, I hope that the AI system we developed and AI technologies at large can be used as a vital tool for mental health diagnosis. This is like medical tubes used in implants, surgical and dental instruments.



The tubes are one of the oldest medical devices now widely used in various healthcare settings. I think the role of AI in healthcare is moving in this direction. I envision that as time goes by, the AI system we developed would gain wide recognition from doctors, making diagnosis more convenient, objective and efficient by reducing the need for patients to undergo multiple diagnostic tests."

Happy mum, happy baby

Using a deep learning AI approach, Prof. Qiu's team also validated a truth about maternal mental health: mothers' emotions during pregnancy have a direct impact on fetal brain development. By integrating fetal MRI, genome sequencing, child behaviour assessments and maternal health records, the research has revealed that girls born to mothers who reported greater positive mental health during pregnancy exhibited changes in several neural networks, including those linked to memory performance, as well as emotion perception and regulation.

This significant finding reminds us of a popular quote, "happy mum, happy children". The best gift a mother can give to her children is to take care of her own happiness. While the idea of "keeping mum happy" is not new, an important take-away from Prof. Qiu's study is that the impact of maternal mental health on children starts before childbirth.

"Our investigation focuses on the pregnancy stage because it is the very beginning of human lives."

"Our investigation focuses on the pregnancy stage because it is the very beginning of human lives. I personally see the fetal stage as more critical than the postnatal stages because processes within the mother's body, such as emotion, can directly influence children's development," Prof. Qiu said. "Depression and stress during pregnancy can bring about biochemical responses such as hormonal changes and other signals which can be transferred directly to the fetus through the placenta."

Past studies on the link between maternal and children's mental health have been focused on genetic inheritance and parenting behaviour. Prof. Qiu's research provides a new perspective. "Epidemiological studies have shown clearly that children born to mothers affected by depression during pregnancy are at high risk for mental problems. Our research has unveiled the mechanism behind this phenomenon," she explained. This fundamental finding holds profound implications for mental health interventions. To Prof. Qiu, a more direct, fundamental route to addressing mental health problems should focus on "treating the entire family" in addition to "treating the child"—providing family support, fostering a mother-friendly workplace environment and improving social welfare at large.

Keeping your brain young is your responsibility

On the other end of the age spectrum, modern medicine is still nowhere near a cure for Alzheimer's disease, although there are treatments for slowing down its progression and reducing symptoms. Still, research has shown that preventing and delaying the onset of dementia is possible.

In another study by Prof. Qiu, sustained obesity was found to be linked to accelerated brain ageing in middle-aged and older adults. The research suggested that persistent obesity could be used as a potential biomarker for assessing brain ageing. Crucially, the study pointed to the importance of weight management for preserving brain health. We have no excuse for not exercising and staying healthy, to a certain extent.

"Healthy habits can be maintained through exercise, diet and other factors that we manipulate and control by ourselves."

"In my view, mental health intervention approach should focus on 'treatment for children' and 'prevention for elderly adults," Prof. Qiu said. "From the big data we studied, it is clear that lifestyle is more important in determining the brain health of old adults. Healthy habits can be maintained through exercise, diet and other factors that we manipulate and control by ourselves."

When asked for her conclusions regarding lifestyle tips for better health after decades of research, Prof. Qiu pointed to good sleep, nutrition and stress management. "The food we eat affects our blood pressure and sugar levels, and research has already indicated their associations with symptoms of mental health disorders. Chronic stress can cause the hypothalamic–pituitary–adrenal (HPA) axis, a complex hormone network in our body, to become dysregulated, and HPA axis malfunction is widely observed in patients with mental illnesses."

Finding the competitive edge for PolyU's mental health research

In August 2023, Prof. Qiu joined PolyU under the Global STEM Professorship Scheme of the HKSAR Government. Previously, she served as a departmental deputy head, innovation centre director, and college master at National University of Singapore (NUS). After spending over 20 years abroad, she and her family decided it was time to return home to China. Hong Kong and PolyU provide attractive conditions for scaling up her research and driving it forward.

"The unique location of Hong Kong enables researchers to collaborate at international and national levels," Prof. Qiu observed. "I also feel that PolyU offers very strong internal support to researchers, not only in terms of funding, but also guidance on formulating research ideas from senior faculty, as well as external networks and administrative support. The whole university ecosystem is very helpful for pushing researchers forward." In her new role as the Director of the Mental Health Research Centre, Prof. Qiu aspires to inject the engineering approach into the centre's research by leveraging PolyU's engineering strength and world-class research facilities.

"PolyU has numerous devices that support the use of the engineering approach to study mental health, including AI tools for speeding up data monitoring and collection processes, and transcranial magnetic stimulation (TMS) devices for treating mental health symptoms. These will enable me to steer the centre in the engineering direction and towards larger-scale research," she said.

This year, Prof. Qiu has been elected as the Council Chair of the Organization for Human Brain Mapping, an international society dedicated to advancing the understanding of the anatomical and functional organisation of the human brain using neuroimaging. Stepping into a higher leadership role at the organisation which she has served for many years, Prof. Qiu has high ambitions for her new career journey in Hong Kong—to build up Hong Kong's presence and visibility in the field of brain mapping in collaboration with other reputable universities in the discipline.

Beyond traditional electronics engineering: **Microwave photonics for faster speed, wider bandwidth and lower-loss signal handling**

In the current digital era, the flow of information and data—be it wireless communication, computing or sensing—essentially hinges on signals. Scientists are continually finding ways to make signal transmission and processing faster, more efficient, and with lower loss. The surge of artificial intelligence (AI) has driven unprecedented demand for specially designed microchips, as these devices play a key role in achieving super-speed signal transmission and processing.

Microwave photonics (MWP), an interdisciplinary field that has gained significant traction in the past three decades, is opening new avenues in super signal technology. In the field of MWP, a novel kind of microchip known as the "photonic integrated circuit" (PIC) has enabled drastic improvement in communication and sensing capacities. Like the electronic integrated circuits (EICs) embedded in smart phones, computers and electronic devices, PICs integrate multiple components onto a single chip. However, the fundamental principles on which the two chips operate are significantly different. PICs use photons (light) and photonic components to generate, transmit, control and process microwaves. These capabilities position PICs as an alternative to EICs, which rely on electrical signals (electrons) and electronic components.

With the significant progress made in chip integration, the next major question facing photonics scientists and companies is the implementation of PICs in a wide array of MWP systems.

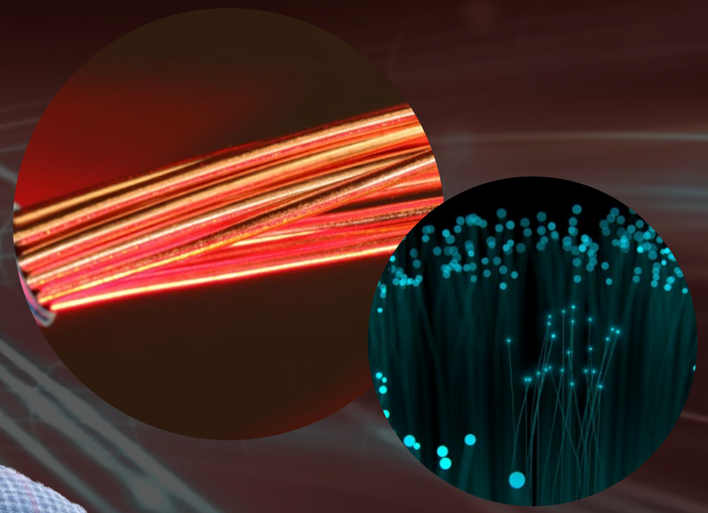
In this Issue, we chat with PAIR Senior Fellow Prof. YAO Jianping, one of the early pioneers in MWP research, about the development trends and challenges in the field, the attractive functions provided by MWP technologies, and the implications they hold for AI development. Prof. Yao is a Distinguished University Professor and the University Research Chair in Microwave Photonics at the University of Ottawa, Canada.

Microwave photonics: Where microwave engineering and photonic technology meet

"Microwave photonics (MWP), an interdisciplinary field that has gained significant traction in the past three decades, is opening new avenues in super signal technology"

Microwave photonics (MWP) combines microwave engineering and photonics engineering to bring forth unique properties that cannot be achieved in traditional electrical engineering. What are some of the major competitive advantages provided by MWP?

Wide bandwidth and low loss are crucial for fast and uninterrupted data transfer, which in turn is extremely important for digital electronics, broadband wireless communication and radar. In microwave engineering, bandwidth is a critical factor in the speed of signal transmission and processing. MWP employs photonics technologies to enable a much wider bandwidth for microwave signal transmission and processing. Other powerful advantages of MWP are small weight and low loss. For example, a 10 km copper cable is so heavy that it needs to be transported by trucks, and its signal loss is a few hundred per kilometer. Optical cable, by contrast, is very thin and light, to the extent that it can be carried by humans, and its loss is only 0.2 dB per kilometer. With optical fibre, long-haul underwater communication across continents has become possible.



Given the very attractive functional properties that MWP offers, are these technologies very expensive? How are they being applied in real-world settings?

Photonic devices were not so integrated in the past. Thirty years ago, before the concept of photonic integration, circuits were composed of separate optical devices like lasers, modulators and photodetectors. These "discrete components" were very expensive. For example, a high-speed modulator, a kind of optical component for converting electrical signals into optical signals, may cost a few thousand dollars or more. At that time, scientists needed to design and develop different architectures to implement different specific functions, like microwave signal generation or filtering, but their applications were limited due to the high cost. In addition, systems based on discrete components are heavy and have poor stability.

With the fast progress of photonic integration technology, MWP systems can now be implemented based on photonic integrated circuits (PICs). PICs contain multiple individual components assembled within a chip, thus significantly reducing the cost and improving the stability. Currently, the major task is to implement the MWP systems using PICs.

Transforming random, noisy signals into clearer ones: When signals become tunable and frequency-consistent

MWP emerged in the 1990s, and the Microwave Photonics Research Laboratory (MWPLab) you established in 2002 is among the early research organisations in the field. Your group was the first to demonstrate novel devices, including the Fully Reconfigurable Photonic Integrated Signal Processor and the Parity-Time Symmetry Optoelectronic Oscillator, and has developed other devices such as the Integrated Parity-Time Symmetric Wavelength-Tunable Single-Mode Microring Laser and the Photonic Integrated Field-Programmable Disk Array Signal Processor. These innovations are built on the concepts of "tunability" and "parity-time symmetry". In what ways are these capabilities important for optimised signal processing?

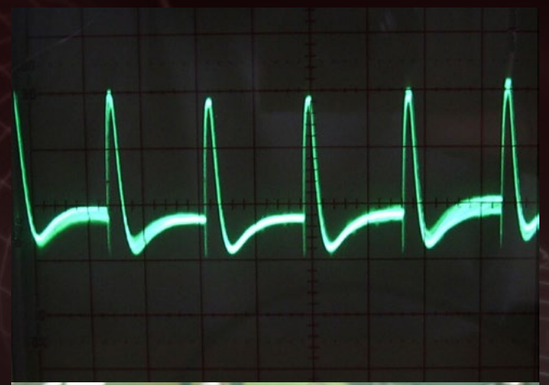
Just like the wave spectrum, a signal contains multiple frequencies. A major role of signal processors is to filter out certain frequencies to produce a signal containing a preferred and desired frequency range. When we make these devices or processors "tunable", it becomes possible to handle different types of signals and remove interferences or noise that compromise signal quality.

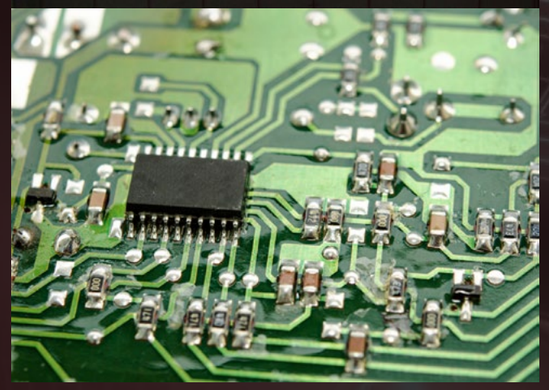
"For applications like wireless communications and radar, microwave signals with low phase noise are essential to overall system performance."

Conventional electronic oscillators produce relatively high phase noise because they have a smaller quality factor (Q factor). A smaller Q factor suggests that a system has higher

energy loss, resulting in a generated signal with higher phase noise. For applications like wireless communications and radar, microwave signals with low phase noise are essential to overall system performance.

"Parity-time symmetry" is an important technical concept for optoelectronic oscillators, which are a kind of MWP device for generating microwave signals at a high and single frequency. Through "parity-time symmetry", a single oscillation frequency can be selected without using an ultra-narrow band filter, thus greatly simplifying the implementation.





Accelerating and leveraging supercomputing: Bilateral interactions between AI and microwave photonics

AI technologies heighten the need for hardware that supports real-time processing and large-scale data analysis. PICs stand as a powerful solution for AI-related tasks since they enable ultra-fast processing speed and low power consumption. It is clear that MWP can support AI development. Conversely, how does AI benefit the development of MWP?

Microwave photonic systems can accelerate the computational speed of neural networks—a foundational architecture powering modern AI systems. For example, the computational speed based on MWP can be three orders of magnitude faster than electronics, and thus MWP could complement traditional digital processors, such as graphic processing units (GPUs), in specialised AI tasks. On the other hand, MWP systems can also benefit from AI. For example, microwave photonic signal transmission can be optimised with AI. Signal processing requires the use of filters. With AI algorithms, filter design can be optimised to make the identification of signal deviations and subsequent processing more rapid and efficient.

Going beyond computing and communication: Microwave photonics for sensing technology applications

MWP systems find diverse practical applications. In addition to telecommunication and computing, what other fields or sectors can benefit from MWP innovations?

In the past, MWP developments were mainly for radar and wireless communication. In modern times, when MWP innovations are applied in the context of sensing and networking, the technology can find useful applications in diverse fields. Distributed sensing is one powerful example. It is a sensor network system which includes multiple sensors that are spatially scattered to obtain measurements from various locations and transmit data to a central processing unit through connected thin, flexible optical fibre.

This distributed sensor system can be particularly useful for health monitoring, especially today when cities are striving to build smart-ageing environments. For instance, the system can be installed in care homes for monitoring the health of senior residents. A central computer collects health data such as body temperature and heart rate from the sensors worn by elders living in different rooms, and it will notify healthcare workers if the system detects anyone who is feeling unwell.

This MWP-enabled sensing technology can also be used for infrastructure monitoring, such as assessing the structural health of bridges and buildings. It can also be employed in advanced manufacturing: sensors installed along a production line alert manufacturers if there are any machine malfunctions or quality problems.

A closer look at the global photonics race

Photonics is a burgeoning industry. Countries around the world are competing to develop silicon photonics to meet the growing demand for high-speed data transmission and advanced sensing, and to drive new application areas such as smart healthcare and quantum computing. China is now leading the photonics market, followed by Europe and the United States. In your view, what are some factors that account for a country's competitiveness in the photonics race?

I think the efforts of the people working in the field are a major reason for the country's photonics development. This is evidenced by the sizable number of Chinese photonics entrepreneurs who are recognised by Forbes; the groundbreaking work on optical fibre by Nobel Prize-winning scientist Charles K. KAO, who was ethnically Chinese; and the cutting-edge research conducted by Chinese researchers in the photonics field.

Education, government support, and industry are also important. According to my experience as a university professor, graduate students from China are very strong in fundamental mathematics and physics, and both disciplines provide a solid foundation for understanding and applying concepts in photonics. The government is very supportive of entrepreneurship through policies and incentives, which have helped the establishment of photonics start-ups.

Facing the talent shortage in photonics and interdisciplinary research

Lasers and photonics are very specialised fields. The industry struggles to find suitable talents because photonics is a relatively young field that has not attracted much interest from students as compared to other subjects. The Hong Kong government is now proactively developing the city's photonics industry, noting the need to step up efforts to attract and retain talented workers. At PolyU, PAIR is reviewing the Academy's strategies aimed at attracting young talents for interdisciplinary research. In your view, what can be done by local authorities and universities to address the talent shortage?

"Hong Kong universities can set up schemes such as fellowships and subsidies to attract students from overseas institutions to join them and conduct interdisciplinary research."

If the government can attract some international companies to set up branches and offices in the city, the new job opportunities will become a significant draw for talents. Hong Kong universities can set up schemes such as fellowships and subsidies to attract students from overseas institutions to join them and conduct interdisciplinary research. However, an evaluation mechanism is needed to ensure that they are working on research ideas that are different from their PhD disciplines.

Synergising cross-sectoral efforts to secure cleaner, safer air for all

The air we breathe has a significant impact on our health. Air pollutants such as fine particulates, ozone, volatile organic compounds and toxic gases are notorious for their links to a wide range of health issues—not only respiratory illnesses, but also cardiovascular and neurological diseases. Air is essential for our lives, but human activities in modern societies often result in the release of fumes and harmful gases into the atmosphere. Although clean air has become an increasingly important asset, not everyone has access to it.

In indoor settings such as homes and offices, air purifiers are particularly helpful in improving the air quality and reducing the concentrations of air contaminants. But what if gigantic versions of these purifiers were erected in cities to achieve cleaner air outdoors?

Standing out among the houses and other buildings in China's third-most populous city, Xi'an, is a 20-storey air purifier. This skyscraper-sized air cleaning system, dubbed the world's largest air purifier, was unveiled in 2016 to fight the persistent air pollution plaguing the city. The chimney-like tower draws in polluted air at the bottom; filters out particulate matter like $PM_{2.5}$; and releases clean air at the top. To date, a total of four towers of similar kind have been built in Xi'an and Yancheng, China, and Delhi, India. Among the experts who have made these giant air purifiers possible is Prof. David Y. H. PUI, PAIR Senior Fellow. He designed the towers with his marvelous hands. His collaborators in Minnesota include Prof. Emeritus Thomas KUEHN, Charles LO, and former student/post-doc Dr Qingfeng CAO and Prof. Shawn CHEN of Virginia Commonwealth University. The local Principal Investigators are Prof. Junji CAO in Xi'an, Prof. Jing SUN in Yansheng, and Profs. M. SAHU and Y.S. MAYYA in Delhi.

In this Issue, PAIR is privileged to interview Prof. Pui, Regents Professor at the University of Minnesota, USA, about the tower development and the keys to achieving clean air, based on his decades-long experience in aerosol and air filtration research. Prof. Pui is Director of the Center for Filtration Research and the Particle Technology Laboratory at the university.

The smog battle: Giant air purifiers that protect our blue skies

Following the debut of the Solar-Assisted Large-Scale Cleaning System (SALSCS) in Xi'an, Prof. Pui and his team have continued to enhance the system's design and performance. Over the years, the group has developed three generations of air cleaning towers, including the first one in Xi'an, a second-generation tower in Yancheng, and two units of a third-generation system in Delhi, India. In general, these systems are composed of three main structures, a large solar collector, a chimney, and a filtration system for removing pollutants. From one generation to the next, new technologies have been incorporated into the systems to enhance their cleaning capacities.

"The first generation makes use of solar heating to drive polluted air into the system, where a filter array is set up to remove the polluted air. The clean air then exits through the tower to the surrounding area," Prof. Pui explained. "In the second generation, installed in Yancheng Science Park, the filter array is replaced with a water spray array to scrub out the polluted air. This second generation can also be used to take out carbon dioxide by dissolving NaOH in the water. The sprayed NaOH droplets can take out the CO_2. Two units of the third generation, installed in Delhi, India, make use of fans to drive clean air from the tower to the surrounding environment."

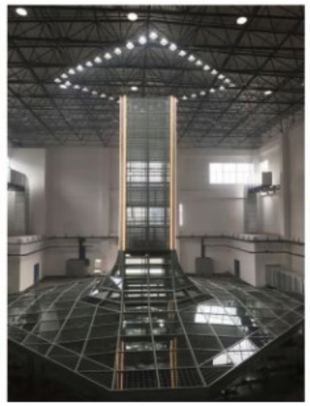
From drawing to building, from design to construction

A large tower in the backyard can change the look of a neighbourhood, especially in low-rise communities. Furthermore, just like household air purifiers, the large-scale systems can produce some noise during operation. Building giant facilities in public spaces often creates dissent and resistance from the local community. However, in the case of SALSCS, there does not seem to be much concern about noise or other potential impacts of the tower. By contrast, people would rather spend more money to live in the surrounding area.

"When the Xi'an tower was constructed and put into operation, an economics professor from Shanghai Jiaotong University led a team to survey the residents living near the clean air tower. They found that the residents were willing to pay 4% more in real estate value to live close to the tower," Prof. Pui explained.

When asked which factors determined the towers' location, Prof. Pui expounded on the importance of government support. "The first tower cost $2 million US dollars to build. This is a large amount that many companies cannot afford, so the implementation really depends on support from the government," he said. "We were very fortunate to have the support of the Xi'an government in building the first tower, the Yancheng Science Park for the second one, and the Delhi government and the central government of India for the two third-generation systems."

First generation SALSCS, Xi'an



Second generation SALSCS, Yancheng

Third generation system, Delhi, India

"For small cities like Hong Kong, where severe land and housing shortages have been thorny issues for years, building such large purifiers can be even more difficult."

The SALSCS brings new hope to cities battling urban air pollution. However, for small cities like Hong Kong where severe land and housing shortages have been thorny issues for years, building such large purifiers can be even more difficult. Perhaps more time is needed to address the city's long-standing problems before a similar tower can be built.

"Unlike cities in mainland China which have many parks situated between building clusters, Hong Kong tends to have buildings and houses squeezed into congested areas. There are few parks among the building clusters in Hong Kong, and the parks are relatively small. Given the traffic congestion in Hong Kong, it would be good to have towers built in areas where people living nearby are inhaling a lot of the combustion particles from cars. Small particles released from cars, especially those in the ultrafine particle size range, are particularly harmful. They have greater effects on human health due to their large surface areas. During my sabbatical leave at The University of Hong Kong (HKU) in 2014, I worked with Prof. Sun KWOK at HKU and Prof. Chak CHAN at City University of Hong Kong (CityU) to file a patent on a 'Freeway Air Cleaning System' to clean polluted air along freeways and roadways. We have not been successful in getting government funding to develop it."

Tripartite efforts in untangling the knotty air problem

Climate change and air pollution are deeply intertwined. Greenhouse gases cause a warmer climate, increase the production of ozone that can manifest into haze, and exacerbate wildfire risks, resulting in a vicious cycle. The cleaning system designed by Prof. Pui represents a powerful new solution for climate action.

Turning engineering drawings into built structures requires collaborative efforts by governments, architects and construction companies. Throughout the interview, Prof. Pui humbly reiterated the importance of cross-sectoral efforts. "My team served as consultant in the projects. We designed the tower and provided the drawing to governments and construction companies who put it into practice," he said.

"Academia, government and industry are three gears driving the wheel of progress in addressing climate change and $PM_{2.5}$ problems."

"We need to have government support first, and then feasibility studies by experts, before industry can participate. Still, the companies need to be reimbursed. Where does this money come from? I think it depends on the government after all."

Academia, government and industry are three gears driving the wheel of progress in addressing climate change and $PM_{2.5}$ problems. To Prof. Pui, the three sectors have distinct roles at different stages in the process. "Academia can most effectively address the sources (coal burning and vehicle emissions) and their effects (visibility and health). To protect public and environmental health, the government can set progressively stricter regulations for $PM_{2.5}$ and vehicle emissions standards. Industry can respond by developing novel control technologies for baghouse filters and diesel/gasoline particulate filters. Furthermore, academia can help the government to set the regulations and help industry to develop novel technologies," he explained.

Lessons from the pandemic for air filtration research

The field of air filtration has gained greater public interest due to increasing awareness of airborne diseases in recent years. Although the COVID-19 virus continues to circulate, the situation may not be as intimidating as it was several years ago.

When the virus first emerged to cause widespread pandemic, the market saw a surge in demand for approved respirators. In response, Prof. Pui's team evaluated all available respirators and face masks, finding that Electret (charged-fibre) filters have significantly higher filtration efficiencies than mechanical filters. Amid the global panic buying, particularly when there was a scarcity of facial masks alongside an influx of counterfeit, sub-standard and non-equivalent N95-like respirators, Prof. Pui's team developed various cleaning methods for re-using the respirators and masks. The group also developed a "Particle Decay Model" for evaluating indoor air cleanliness. "I was told that the University of Minnesota has a lower infection rate than other Big Ten universities because facility engineers can use our model to evaluate classroom cleanliness," he remarked.

Should scientists become entrepreneurs?

"Dedication to the advancement of knowledge and society is the fundamental scientific virtue that drives a scientist's endeavours"

Over the years, Prof. Pui has developed over 40 patented technologies, and some have developed into commercial instruments that have propelled businesses to grow into leading manufacturers.

In the 2000s, he co-founded a start-up that applies the electrospray technologies that he and his former student Da-Ren CHEN (now Chair Professor of Virginia Commonwealth University) developed in biopharmaceutical products. After the initial set-up, Prof. Pui has not been heavily involved with the company. The convergence of science and entrepreneurship is a growing trend, with increasing numbers of scientists transitioning into entrepreneurial roles to commercialise their research. When asked whether he aspires to pursue parallel paths in academia and entrepreneurship, Prof. Pui's response reflected the fundamental virtue that drives a scientist's endeavours: dedication to the advancement of knowledge and society. "I put a wall between the company and academic research. If there is even a perception that you are doing something to benefit your company, this is not good. I hope the start-up will be successful and will save many lives along the way. Similarly, my development of the SALSCS will also save many lives."

People

DoMHRC honoured among Top 50 Asia Women Tech Leaders of 2025 for advancing mental health and brain research

Prof. QIU Anqi, Director of the Mental Health Research Centre (MHRC), Professor in the Department of Health Technology and Informatics and Global STEM Scholar, has been recognised as one of the "Top 50 Asia Women Tech Leaders 2025". This recognition testifies to Prof. Qiu's outstanding contributions to the fields of neuroimaging and biomedical engineering, particularly in advancing research on mental health and brain development.

Beyond Prof. Qiu's professional achievements, this award also recognises her remarkable leadership. As a dedicated mentor, she continues to inspire and empower women in STEM. Her influence and commitment to fostering the next generation of female technology leaders are commendable.

The 2025 Asia Women Tech Leaders Award ceremony was recently held in Singapore. Its selection of 50 technology leaders in Asia aims to honour women who drive technological innovation, lead research, and manage complex tech projects with expertise and operational excellence.

Twelve MHRC members named among 2025 World's Best Scientists by Research.com

Leading academic research portal Research.com has named 12 members of the Mental Health Research Center (MHRC) among the world's best scientists in their respective disciplines, including Computer Science, Medicine, Neuroscience, Psychology, and Social Sciences and Humanities. This international recognition highlights MHRC members' exceptional contributions to their fields and the significant impact their research has on society.

*In alphabetical order by discipline and surname of scholar

World Ranking	National Ranking	MHRC Member	Discipline
1504	185 (China)	**Prof. QIN Jing**	Computer Science
716	79 (United Kingdom)	**Prof. Keith HAWTON**	Medicine
7181	121 (China)	**Prof. Georg KRANZ**	Neuroscience
3954	52 (China)	**Prof. QIU Anqi**	Neuroscience
2758	35 (China)	**Prof. Benjamin YEE**	Neuroscience
10011	99 (China)	**Dr Alma AU**	Psychology
9782	5062 (United States)	**Prof. CAI Huajian**	Psychology
8737	82 (China)	**Prof. Sylvia CHEN**	Psychology
137	82 (United States)	**Prof. Patrick CORRIGAN**	Psychology
2740	23 (China)	**Prof. David SHUM**	Psychology
3840	35 (China)	**Prof. Winnie MAK**	Psychology
49	1 (China)	**Prof. Paul YIP**	Social Sciences and Humanities

Two PAIR members receive PolyU Young Innovative Researcher Award 2025

Congratulations to the following two rising stars at PAIR for winning the PolyU Young Innovative Researcher Award (YIRA) 2025!

YIRA aims to honour PolyU researchers under the age of 35 who have demonstrated originality, contributed to technological advancement, and propelled transformational innovation into solutions to global challenges through their work. Each awardee will receive research funding of HK$500,000 and a personal cash prize of HK$20,000 to encourage their continued pursuit of innovative and impactful research.

Awardee	Post Title and Department	Affiliated PAIR Research Unit	Research Focus
Prof. LIN Wanyu	Assistant Professor in Department of Data Science and Artificial Intelligence and Department of Computing	Member of Research Institute for Artificial Intelligence of Things	An Interpretable Deep Learning-Based Computational Framework for Crystal Materials Design
Dr TAO Yong	Research Assistant Professor in Department of Civil and Environmental Engineering	Member of Research Centre for Resources Engineering towards Carbon Neutrality	Advancing CO_2 Mineralization and Waste Concrete Valorization for a Sustainable Future

Prof. LI Heng ranked nation's top scientist in Engineering and Technology by Research.com

Prof. LI Heng, Associate Director of the Research Institute for Artificial Intelligence of Things (RIAIoT) and Chair Professor of Construction Informatics, has been ranked first in China and 21st globally in Engineering and Technology, in the 2025 Best Scientists Rankings by Research.com.

The rankings are determined by the D-index (Discipline H-index), which evaluates a scientist's scholarly impact through discipline-specific publications and citation metrics. This international recognition underscores Prof. Li's exceptional contributions to the fields of engineering and technology, as well as the profound societal impact of his research.

Prof. Li has conducted numerous funded research projects related to the innovative application and transfer of construction information technologies. His research interests include digital construction, smart construction, ergonomics and robotics. With an extensive research career spanning more than two decades, Prof. Li has steered the development of a diverse range of products, encompassing computer-aided drawing systems, construction planning and management systems, and sophisticated intelligent safety systems. In recent years, his research efforts have been directed intensively towards the realms of cloud computing, artificial intelligence, and applications in the Internet of Things (IoT).

News & Events

PAIR co-hosts the inaugural Master Lecture on the value of medical innovations against pandemics

The Hong Kong Polytechnic University (PolyU)'s Department of Health Technology and Informatics (HTI), together with the PolyU Academy for Interdisciplinary Research (PAIR) and PolyU Academy for Artificial Intelligence (PAAI), co-hosted the inaugural PolyU Master Lecture on 28 May 2025. Prof. ZHANG Wenhong, Director of the National Medical Centre for Infectious Diseases and Head of the Institute of Infection and Health at Fudan University, gave the keynote speech, "The Race between Evolving Infectious Diseases and Human Technology". He shared insights on how medical innovation and technology can rapidly anticipate and counteract the challenges posed by the unpredictable progress of infectious diseases before the next pandemic emerges. The event attracted approximately 450 participants, including PolyU faculty members, students, alumni, healthcare professionals and members of the public.

Prof. Zhang Wenhong is a world-renowned expert on infectious disease control, specialising in the clinical diagnosis, treatment and prevention of such diseases. A prominent figure in the field of infectious diseases in Mainland China, Prof. Zhang has been honoured as a role model in the battle with COVID-19 and as a Young and Middle-Aged Expert with Outstanding Contributions of the National Health Commission in recognition of his professional excellence in the Nation's fight against the pandemic. He has been appointed as an Honorary Professor of the PolyU Department of Health Technology and Informatics and serves as an Expert Advisory Committee member for the University's proposed third medical school.

During the lecture, Prof. Zhang shared insights on the origins and evolution of infectious diseases, the importance and challenges of vaccination during pandemics, and how medical innovations

can predict and counter pandemic outbreaks. Prof. Zhang explained that infectious diseases evolve in unpredictable patterns, constantly reshaping themselves in ways that challenge the medical community's ability to anticipate the next dangerous variant. While medical researchers methodically develop vaccines and treatments by means of careful scientific processes, disease-causing organisms rapidly adapt through random mutations that can bypass the most sophisticated defences.

Prof. Zhang also pointed out that while vaccination can effectively reduce the severity and mortality rate of infections, the silent transmission chains within communities and the emergence of new variants can weaken the protection provided by vaccines. Developing new vaccines will enable the global community to respond more effectively and help prevent future outbreaks and epidemics. Key strategies in addressing the next pandemic include achieving herd immunity, scaling up vaccine production, improving treatment plans, and developing tools and methods for the detection of, response to and containment of future infectious threats.

The subsequent Q&A session was moderated by Prof. YANG Hongxia, Executive Director of PAAI, and Prof. Gilman SIU, Professor in the HTI. Prof. Zhang engaged in in-depth exchanges with participants, inspiring all who were present.

PolyU Master 理大名師講堂 Lecture

PAIR members participate in Asia Summit on Global Health, showcasing healthtech innovations

PAIR members participated in the Asia Summit on Global Health (ASGH) held at the Hong Kong Convention and Exhibition Centre, 26–27 May 2025. This prestigious event brought together global leaders, policymakers, researchers and industry professionals to discuss the latest trends and opportunities in the health sector.

Prof. ZHANG Weixiong, Associate Director of PAIR, Chair Professor of Systems Biology and Artificial Intelligence in the Department of Health Technology and Informatics and Global STEM Scholar, participated in a thematic session titled “Data-driven Healthcare Transforming the Patient Journey”. Alongside industry peers, Prof. Zhang explored innovative applications of and prospects for using big data and AI technologies to optimise patient healthcare processes. He emphasised the importance of healthcare data for healthcare research and the need for long-term collaboration among all stakeholders to collectively advance healthcare research and innovation.

In addition, several start-ups founded by PAIR members participated in the Summit, showcasing their innovative products. Eieling Technology Limited, co-founded by Ir Prof. ZHENG Yongping, Director of the Research Institute for Smart Ageing (RISA), exhibited its “Liverscan”, a palm-sized, wireless, radiation-free device for non-invasive liver fibrosis assessment and staging. Wellness Phytoscience Limited, co-founded by Prof. WONG Man-sau, Director of the Research Centre for Chinese Medicine Innovation (RCMI), and RCMI Members including Dr POON Chui-Wa Christina and Dr ZHOU Liping Zhou, presented its cutting-edge developments in botanical supplements and functional foods, emphasising evidence-based approaches to wellness and preventive healthcare. AIM International Pharmaceutical Limited, founded by Prof. LEE Ming-yuen, RCMI Management Committee Member, showcased its novel drug discovery platforms and recent progress in developing new therapeutic agents derived from traditional Chinese medicine.

Nanotech expert Prof. G. Q. Max LU explores revolutionary advances in green hydrogen

Prof. G. Q. Max LU, President and Vice-Chancellor of the University of Surrey in the United Kingdom, delivered the 39th PAIR Distinguished Lecture titled “Functional Nanomaterials for Green Hydrogen Production and Storage” on 20 May 2025 on the PolyU campus. The lecture drew over 60 attendees in person and captivated an online audience of more than 15,900 from different countries and regions who watched the live broadcast on social media platforms.

Prof. Lu began his presentation with a brief outline of the role of functional nanomaterials in addressing global challenges and advancing green hydrogen technologies. He highlighted the critical importance of electrodes, membranes, catalysts and photocatalysts in enhancing the efficiency and scalability of electrolysis and photocatalysis systems, as well as the significance of solid-state storage materials in overcoming challenges related to hydrogen storage and distribution, noting that some low-pressure solutions are already in use.

Still, Prof. Lu emphasised that further technological innovations are needed to reduce costs and enhance performance. He explained that green hydrogen is a valuable energy carrier; it not only contributes to decarbonisation in the power sector, but can also serve as zero-emission fuel for sea, land and air freight, which is crucial for the achievement of a net-zero future by 2050. In conclusion, Prof. Lu called on the academic community to accelerate the commercialisation of new materials for the construction of cost-effective hydrogen infrastructure, and urged researchers to bridge the gap between technology R&D and practical applications.

Trailblazing PAIR Seminar by Prof. YAO Jianping on the advancement of microwave photonic systems

Prof. YAO Jianping from the University of Ottawa, Canada, delivered the PAIR Seminar titled “Photonic Integrated Circuits for Next-Generation Microwave Photonic Systems” on 11 June 2025 on the PolyU campus. The seminar drew over 70 attendees in person and engaged an online audience of more than 15,300 from various countries and regions who joined the live broadcast on social media platforms.

Prof. Yao began his presentation with an overview of microwave photonics (MWP), emphasising that the technology uses light as a carrier and employs photonic and optoelectronic devices for the generation, transmission, control and processing of microwave signals. He compared the properties of four major material systems including indium phosphide (InP), silicon nitride (Si_3N_4), lithium niobate on insulator (LNOI) and silicon on insulator (SOI), highlighting that SOI, Si_3N_4, and LNOI play an important role in the implementation of photonic integrated circuits (PICs).

Next, Prof. Yao explored current applications of photonic integrated MWP systems. These include true time-delay networks for wideband beamforming; optoelectronic oscillators for low-phase-noise, high-frequency microwave generation; and programmable signal processors for versatile photonic signal processing, high-sensitivity optical sensors and integrated MWP radar.

In his closing remarks, Prof. Yao emphasised that the PICs’ small size, wide bandwidth and low loss, enhanced functionality and increased scalability enable the microchips to bring powerful solutions for MWP systems, paving the way for next-generation systems in radar, wireless communications (5G/6G) and AI computing, and delivering greater speed, bandwidth and dynamic range. He also stressed that heterogenous integration is a key challenge in the field—but one that presents opportunities for future development.

Exploring the frontiers of mechanics: Prof. GAO Huajian of Tsinghua University on mechano-X innovations

Prof. GAO Huajian, Xinghua Distinguished University Professor and Director of the Mechano-X Institute of Tsinghua University, China, delivered the 40th PAIR Distinguished Lecture titled "Mechano-X: Interdisciplinary Research and Innovation at the Frontiers of Mechanics" on 13 June 2025 on the PolyU campus.

Prof. Gao began his presentation with a brief description of the important role of mechanics in the development of structural and functional materials, enlightening the audience on the recent advances in nanostructured materials, biomedical materials, mechanical metamaterials, soft actuators, flexible electronics, tunable mechanochromics, regenerative mechanomedicine and more.

Furthermore, he illustrated the ways in which fundamental principles of mechanics enable the proactive modulation and programming of properties in both engineering and biological systems. Through case studies, Prof. Gao highlighted breakthroughs in mechano-energy, mechano-interfaces, and mechano-materials, demonstrating their transformative potential.

In closing, Prof. Gao emphasised that mechanics remains a discipline with boundless possibilities in the era of interdisciplinary research and innovation. He underscored the promise of mechanics-based modelling and design, which could expand into areas such as nanostructured, low-dimensional, biological, biomimetic, soft, gradient, and metamaterials. Such approaches, he noted, could deeply intersect with the fields of advanced manufacturing, healthcare technology, sustainable energy, and biomedical tissue and organ engineering, opening new opportunities for the development of related solutions.

Prof. David PUI unpacks nanoparticle technology applications at PAIR Seminar

Prof. David Y. H. PUI from the University of Minnesota, USA, delivered the PAIR Seminar titled "Nanoparticle Technologies in Microelectronics, Air Quality, Health Effects, and Filtration" on 13 June 2025 on the PolyU campus.

Prof. Pui began his presentation by outlining the recent advancements in nanoparticle technologies, covering instrumentation developments, ISO standards and industry partnerships. He then delved into the applications of nanoparticle technologies in four interdisciplinary areas:

1. Microelectronics: contamination control in extreme UV lithography (EUVL) systems;
2. Air Quality: $PM_{2.5}$ mitigation, respirators, and indoor and urban pollution controls;
3. Health Effects: nanomedicine, bioaerosol sensors and UV-C decontamination; and
4. Filtration: prediction of filter media performance and wildfire impacts on electret filter efficiency, and large-scale direct capture of atmospheric CO_2 to combat climate change.

In his closing remarks, Prof. Pui emphasised that nanoparticles are involved in multiple disciplines, bringing both benefits and potential harm to the environment, human health and semiconductor manufacturing. He underscored the importance of collaborative fundamental and applied research between academia and industry to foster a sustainable future, urging stronger partnerships among governments, industries and researchers to create a healthier and more prosperous society in the long run.

Towards the future of long-duration energy storage: Prof. ZHAO Tianshou of SUSTech on novel flow cells

Prof. ZHAO Tianshou, Director of the Energy Institute for Carbon Neutrality, Chair Professor of Mechanical and Energy Engineering, Southern University of Science and Technology (SUSTech), China, delivered the 41st PAIR Distinguished Lecture titled "Flow Cells for Long-Duration Energy Storage" on 4 July 2025 on the PolyU campus.

In his lecture, Prof. Zhao stressed that grid-scale energy storage must meet three core requirements: safety and reliability, cost-effectiveness, and not being limited by site and resource constraints. He introduced the concept of "e-fuel", a clean, renewable, electrically rechargeable liquid fuel. E-fuel represents an excellent alternative to conventional fuel cells. Its storage has no site or time limitations, and it exhibits high efficiency and power density, scalability, safety, and the potential for economic viability.

Uncertainty posed by AI: Geospatial science pioneer Prof. Michael GOODCHILD dissects past, present and future

On 1 August 2025, Prof. Michael GOODCHILD, Distinguished Professor Emeritus at the University of California, Santa Barbara, USA gave the 42nd PAIR Distinguished Lecture on the topic of "Geospatial Futures".

The lecture reviewed the key developments and legacy practices in the evolution of GIS and revealed the forthcoming directions and future prospects in the field. According to Prof. Goodchild, the uncertainty problem in GIS is likely to intensify as geospatial applications in AI become more universal. He emphasised a new direction for GIS: the achievement of more powerful and cheaper computation for finer-resolution data, better models, machine learning and 3D photorealism. He also drew attention to the ethics of GIS, remarking that while software developers are maximising the use of general-purpose GIS packages, the public should exercise responsibility in using the software appropriately and repurposing it.

PolyU journal Nexus hosts forum on promoting interdisciplinary research and innovation for smart sustainable development

PolyU and Cell Press co-hosted the Nexus Forum 2025 from 8 to 10 May. Themed “Collaborative Innovation for Smart Sustainable Development”, the Forum served as a vital platform for promoting exchange and collaboration in interdisciplinary research and innovation, facilitating the advancement of smart technology and sustainable development. The event attracted over 170 participants, including academic experts and authors, as well as consulate and industry representatives. More than 300 PolyU faculty members and students also attended.

The Forum featured three inspiring keynote speeches centred on three core themes: innovative techniques for sustainable cities, industrial and interdisciplinary solutions for sustainability, and carbon neutrality and energy system transformation. The speeches sparked thought-provoking discussion on the latest technologies and industry developments in these areas, highlighting the ways in which collaborative innovation and research can help shape a sustainable future for all.

At the panel discussion titled “Technology Innovation for Decarbonisation of the Power Sector”, scholars from PolyU, the local community, mainland China, and overseas universities, as well as representatives from two local power companies, introduced and explored the research projects supported by the Strategic Topics Grant under the Hong Kong Research Grants Council.

In addition, multiple oral and poster sessions were organised to allow participants to share their views and exchange research findings on various topics, thereby facilitating knowledge exchange and transfer. The editing workshop, co-organised by the PolyU Graduate School, drew over 180 PolyU postgraduate and undergraduate students. Editors-in-chief and editors from seven academic journals, including *Nexus* and *Nature Energy*, introduced young researchers to the skills and tools necessary for writing scientific papers. The workshop aimed to enhance the readability and impact of their manuscripts, and to demonstrate the skills of integrating advanced technologies into research.

RISA co-hosts Healthy Ageing Conference 2025

The Research Institute of Smart Ageing (RISA), in collaboration with the School of Nursing, hosted the Healthy Ageing Conference 2025 from 29 to 30 May. With the theme of “Progressing the Healthy Ageing Agenda: Translating and Implementing Healthy Ageing Programmes and Initiatives in Our Communities”, the Conference aimed to promote healthy ageing efforts in the Western Pacific region and beyond.

The Conference brought together over 200 experts from 15 countries and regions. It addressed a variety of topics related to healthy ageing, including health policies for the elderly, technological innovations, and the latest developments in community care. Key areas of focus were geriatric medicine, mental health and smart ageing technologies, highlighting the latest research findings and practical examples of ageing studies from the Western Pacific region.

Since 2007, the School of Nursing has been designated by the World Health Organization (WHO) as a WHO Collaborating Centre for Community Health Services. In 2023, the School was redesignated by WHO, with a focus on key indicators related to ageing and health. It is dedicated to promoting and implementing the WHO’s Integrated Care for Older People (ICOPE) guidelines, while also providing a platform for interdisciplinary collaboration to foster initiatives in healthy ageing.

RCTFF and RI-IWEAR co-host The Fiber Society’s 2025 Spring Conference

The 2025 Spring Conference of The Fiber Society was successfully held on the PolyU campus, 21–23 May 2025. The Conference was jointly hosted by several PolyU units including the School of Fashion and Textiles, Research Centre of Textiles for Future Fashion (RCTFF), Research Institute for Intelligent Wearable Systems (RI-IWEAR), Joint Research Centre for Fiber Innovations and Renewable Materials, and PolyU–Xingguo Technology and Innovation Research Institute. Prof. SHOU Dahua, Associate Director of RCTFF and member of RI-IWEAR, served as the Chair of the Organising Committee. Under the theme of “Future Fibers for Wellbeing, Intelligence, and Sustainability”, the event brought together more than 300 scholars, experts and industry representatives from approximately 20 countries and regions, and featured a total of 200 high-quality academic presentations focusing on the latest advancements in fiber science.

World Fuel Cell Conference 2025 successfully held

The World Fuel Cell Conference 2025, organised jointly by the Otto Poon Charitable Foundation Research Institute for Smart Energy (RISE) of The Hong Kong Polytechnic University (PolyU), City University of Hong Kong, the University of Waterloo, Canada, and the International Association for Green Energy, was successfully held on the PolyU campus, 9–12 July 2025.

Chaired by Prof. NI Meng, Associate Dean (Research) of the Faculty of Construction and Environment and Management Committee Member of RISE, the conference brought together more than 300 speakers and participants from 15 different countries and regions for valuable exchanges on topics including hydrogen production, hydrogen storage, fuel cells, and innovative systems.

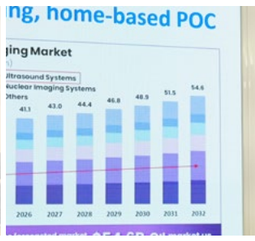
In the closing ceremony, three different awards, the Best Poster Award, Best Presentation Award and Three Minute Thesis (3MT) Competition Award, were presented to over 50 winners. The conference committee also announced that its next meeting will be held in Japan and further details will be provided in due course.

RISA organises 2025 Symposium on Ultrasound AI

To foster the development of ultrasound AI and healthcare fields, the Research Institute for Smart Ageing (RISA) and the Department of Biomedical Engineering organised the 2025 Symposium on Ultrasound AI on 15 July 2025. Over 250 participants attended the symposium, where 17 distinguished speakers, including leading experts and scholars from both academia and industry, shared their valuable insights and latest research findings on how AI can empower ultrasound imaging and revolutionise clinical practice.

At the Symposium, Prof. YANG Hongxia, Executive Director of the PolyU Academy for Artificial Intelligence, Associate Dean (Global Engagement) of the Faculty of Computer and Mathematical Sciences and Professor of the Department of Computing, illustrated the potential of Co-GenAI and its application in the medical field. In the invited talk sessions, speakers presented their cutting-edge research on integrating artificial intelligence (AI) and ultrasound imaging for health assessment and disease diagnosis, covering tongue movement, swallowing function, scoliosis, neurodegenerative disease, cancer, etc.

The Symposium also included poster presentations, facilitating knowledge exchange and collaboration in the field of ultrasound AI. Participants also visited the Jockey Club Smart Ageing Hub (JCSAH), where Prof. ZHENG Yongping, Director of RISA and JCSAH, Henry G. Leong Professor in Biomedical Engineering and Chair Professor of Biomedical Engineering, showcased innovative gerontechnology products integrated with ultrasound AI.



Three PAIR research units support PolyU Alumni Sports & Wellness Day

The PolyU Alumni Sports and Wellness Day on 26 July 2025 brought together over 3,300 alumni, their friends and family members, university staff, students, and other participants for an exciting line-up of sports and health technologies, expert-led workshops, new sports, thrilling matches, and other activities.

Sports and health technologies were a key highlight of the event. Three PAIR research units including the Research Institute for Sports Science and Technology (RISports), the Research Institute for Smart Ageing (RISA) and the Research Centre for SHARP Vision (RCSV) supported the event, showcasing their impactful research to visitors. Innovations on display included advanced functional sportswear as well as technologies for AR eye coordination, gait analysis, 3D foot scanning, AI eye disease screening and scoliosis assessment.

RiFood and Soy-Sky FarmTech collaborate to establish joint laboratory for innovative soy research and functional food development

PolyU and Soy-Sky FarmTech Company Limited (Soy-Sky FarmTech) have announced the establishment of the PolyU–Soy-Sky FarmTech Joint Laboratory for Innovative Soy Research and Functional Food Development (the Laboratory). A donation ceremony for the Joint Laboratory was held on 10 July on the PolyU campus.

The Laboratory marks a collaboration between the Research Institute for Future Food (RiFood) and Soy-Sky FarmTech to advance research on soy-based functional foods and promote the translation of sustainable agricultural technologies. Through interdisciplinary collaboration, the Laboratory will conduct innovative research on soybeans and food development, support the industry in developing novel soy-based functional foods and related sustainability, and foster a “Healthy Eating and Sustainable Living” culture.

Global Smart Cities Summit cum 4th International Conference on Urban Informatics

The Global Smart Cities Summit cum the 4th International Conference on Urban Informatics (GSCS & ICUI 2025), jointly organised by The International Society for Urban Informatics (ISUI) and the Otto Poon Charitable Foundation Smart Cities Research Institute (SCRI) of PolyU, was successfully held on the PolyU campus, 5–8 August 2025.

Under the theme of "AI for Future Cities", the three-day conference brought together over 240 speakers from around the world to share cutting-edge insights and innovations in urban informatics and smart city development, attracting over 600 scholars and industry professionals. It featured keynote speeches by internationally renowned scientists, forums with government and industry leaders, and innovation and technology exhibitions, providing an excellent platform to foster collaborations among government, industry, academia, and research sectors in the field of smart cities.

During the event, SCRI and ISUI also jointly announced the ISUI Smart City Index 2025, developed by a team led by Prof. John Wenzhong SHI, Director of SCRI, Chair Professor of Geographical Information Science and Remote Sensing, and President of ISUI. The Index utilises a human-centric evaluation framework, comprising six dimensions—citizen, environment, social landscape, economy, infrastructure and governance, across 97 indicators. It adopts an inclusive approach applicable to cities across all development stages—from advanced, to developing and emerging economies, and utilises only publicly available data, giving a broader perspective that enables more relevant and effective policy formulation worldwide.

The Index assessed 73 cities worldwide, with the top 10 ranked cities being Stockholm, Washington, D.C., Barcelona, London, Tokyo, Zurich, New York, Hong Kong, Copenhagen, and Oslo. Hong Kong ranked eighth globally and second in Asia, outperforming major regional competitors such as Singapore, as well as key cities in Europe and North America. Notably, Hong Kong excelled in the dimensions of environment, economy, and governance.

PolyU research projects win funding support from RAISe+ Scheme

Four PolyU research projects have been named among the second batch of recipients under the HKSAR Government's Research, Academic, and Industry Sectors One-plus (RAISe+) Scheme. The Scheme provides funding, on a matching basis, to research teams from universities funded by the University Grants Committee which demonstrate strong potential to evolve into successful startups.

Three projects are led by PAIR scholars.

Project	Project Leader	Roles at PAIR
High-Speed 3D Stacked AI Vision Sensors	**Prof. CHAI Yang** Associate Dean of Faculty of Science; Chair Professor of Semiconductor Physics in Department of Applied Physics; Director of Joint Research Centre for Microelectronics	Management Committee Member of RI-IWEAR; Member of RIAIoT, PRI and RISE
Novel Nutraceuticals for Neurodegenerative Diseases	**Prof. Simon LEE Ming-yuen** Cally Kwong Mei Wan Professor in Biomedical Sciences and Chinese Medicine Innovation; Chair Professor of Biomedical Sciences in Department of Food Science and Nutrition; Director of PolyU-BGI Joint Research Centre for Genomics and Synthetic Biology in Global Ocean Resources	Management Committee Member of RCMI; Member of RiFood and RISA
Tunable Laser Chip Based on Metasurface Structure and its Application	**Prof. YU Changyuan** Director of PolyU-Jinjiang Technology and Innovation Research Institute; Professor in Department of Electrical and Electronic Engineering	Management Committee Member of PRI; Member of RI-IWEAR, RISports, RISUD and RCDSE

PAIR rolls out Advanced Education Programme

We are thrilled to announce that the Academy has rolled out the PAIR Advanced Education Programme, which aims to provide students with up-to-date and broad knowledge of many of the biggest societal challenges facing the world today, and the latest developments and advances in various disciplines that can help provide solutions to these real-world problems. It is designed to be suitable for learners from diverse backgrounds and sectors and does not require any prior specialised knowledge.FW: 2108 PWIFB Annual Report 2024-25 from Labour Department (pls revise v.3)

This Programme, offered in dual mode and taught by members of PAIR constituent research units, dives deep into the landscape of a select number of pressing issues, the existing technological efforts and challenges in addressing them, and the way forward. It addresses three priority themes which PAIR has identified as significant for conducting research: advanced technologies and manufacturing, good health and well-being, and smart and sustainable cities.

Commencing in Fall 2025, the first course focusing on "Healthy Life and Smart Living" (PAIR 6001) covers six disciplines related to the theme, including food nutrition, sports, smart ageing, mental health, sharp vision and Chinese medicine. The next course on "Smart and Sustainable Cities" is scheduled for Spring 2026.

Don't miss the chance to learn from our distinguished scholars and practitioners! Please stay tuned to our course details and enrolment information!

Programme website: https://www.polyu.edu.hk/pair/education/