NUS RESEARCH
in brief
JANUARY 2021 ISSUE 4

NEW INITIATIVE FOR SMART CITIES
COVID RESEARCH CONTINUED
IN PURSUIT OF HEALTHY AGEING

NRF FELLOWSHIP
CLASS OF 2021
Over the past 12 months, every facet of society has been tested. With vaccines and continued social responsibility, the world will inevitably emerge from the pandemic. However, to emerge stronger and smarter, societies must recognise the vulnerabilities unveiled by COVID-19, particularly in the systems that we rely on for healthcare as well as economic and social growth. These vulnerabilities may be people centric, or represent technology gaps, but in each case, require urgent solutions to safeguard them from future disruptions.

NUS’ research community stepped up during Singapore’s ‘Circuit Breaker’ period, lending both resources and expertise, to contain a growing threat to the country, and ensure everyone was prepared to adopt new practices that would ultimately enable the economy to reopen.

As research activities resumed mid 2020, we began to ask how the NUS research community could best collaborate and commit their collective knowledge, expertise and research capabilities towards finding solutions that would not only make a direct impact on the global fight against COVID-19, but provide the community with solutions to the many needs that resulted from the pandemic.

In doing so, we established a new multidisciplinary grant scheme called the Reimagine Research Initiative. This scheme would provide seed funding to researchers looking to seize the opportunity for research in emerging areas, post-COVID-19. We are happy to see the first batch of recipients tackling issues that range from data science to social policy formulation, and look forward to the new ideas that will be brought forward through this initiative.

In spite of the challenges over the past 12 months, the University has also continued to forge new research partnerships, and build upon existing national-level programmes that connect and synergise industries across Singapore. One such programme that received a boost in 2020 is the Quantum Engineering Programme, which aims to translate quantum science in to industry-led solutions. With the second phase of funding, quantum science researchers from around Singapore can aim to build quantum safe networks, and seek quantum computers that accelerate problem-solving in supply chain management and finance.

Also receiving a second phase of funding is AI Singapore, a national-level programme hosted at NUS, and integrated into the Smart Nation Research Cluster at the innovation 4.0 building. With additional funding from the Government of Singapore, the platform will continue to support Singapore’s industry transformation efforts, with the AI makerpace pillar added to support a wide range of AI innovation activities - from experimentation, to prototype development and industry adoption.

With a deeper appreciation for problem driven research and a focus on collaborative, interdisciplinary approaches, the NUS research community is well placed to rejuvenate their research in 2021.

Professor Chen Tsuhan
Deputy President (Research and Technology)
Six NUS researchers have been awarded the prestigious National Research Foundation Fellowship, Class of 2021. The fellowship is awarded annually and provides early career researchers with a five-year research grant of up to SGD 3 million, to conduct independent, ground-breaking research, in Singapore.
CONTINUED FOCUS ON COVID-19

Automated blood oxygen monitoring system to boost COVID-19 fight

As part of the ongoing efforts to combat COVID-19, Temasek Foundation brought together NUS, National University Hospital (NUH) and Singapore General Hospital (SGH) to develop an open-sourced system that wirelessly collects measurements of oxygen levels taken from Bluetooth-enabled pulse oximeters, and presents the data neatly on a dashboard. This compilation is quicker and more efficient compared to the current method of manually writing down the readings, which then requires additional manpower to consolidate the data electronically.

Pulse oximeters measure the level of oxygen saturation in the blood. Collecting data on oxygen levels is crucial because people with COVID-19 may suffer from “silent hypoxia”, a dangerous condition in which they do not outwardly appear to be short of breath, but are confirmed to be so through a pulse oximeter test.

Currently, workers living in the dormitories are required to measure and record their oximeter readings twice a day, as part of the precautionary measures that are in place at the dormitories. With the NUS system, the time-consuming task of manually collecting and sending pulse oximeter measurements from thousands of individuals could be automated.

The development of this new system was led by Assistant Professor John Ho from the NUS Institute of Health Innovation and Technology, together with Associate Professor Arthur Tay from NUS Electrical and Computer Engineering and Dr Yen Shih-Cheng from NUS Engineering’s Innovation and Design Programme. This project was also supported by the National Research Foundation.

Breathonix Pte Ltd, a spin-off company from NUS founded by Dr Jia Zhunan (left) and Mr Du Fang (middle), has developed an easy-to-use breath test to detect COVID-19 within a minute. This game-changing technology, which is believed to be the first in Asia, achieved more than 90 per cent accuracy in a Singapore-based pilot clinical trial that involved 180 patients.

This work was supported by the NUS Graduate Research Innovation Programme (GRIP), a scheme that encourages the University’s talented graduate students and research staff to establish and run high potential start-ups based on deep technologies.

Rapid identification of individuals who are COVID-19 positive is crucial for contact tracing and helps to reduce virus transmission. The current gold standard for COVID-19 screening involves a swab test, which may be uncomfortable, and diagnosis using polymerase chain reaction (PCR) tests can take a few hours.

The revolutionary breath analysis technology developed by Breathonix offers a fast and convenient solution to identify COVID-19 infection. It works by detecting Volatile Organic Compounds (VOCs) present in a person’s exhaled breath.

Dr Jia explained, “VOCs are consistently produced by various biochemical reactions in human cells. Different diseases cause specific changes to the compounds, resulting in detectable changes in a person’s breath profile. As such, VOCs can be measured as markers for diseases like COVID-19.”

The test is simple to administer. A person only needs to blow into a disposable mouthpiece connected to a high-precision breath sampler. The exhaled breath is collected and fed into a cutting-edge mass spectrometer for measurement. A machine learning software analyses the VOC profile and generates the result in less than a minute.

“Breathonix’s disposable mouthpiece includes a one-way valve and a saliva trap, preventing inhalation and any saliva from entering the machine. This makes cross-contamination unlikely,” said Mr Du, Chief Operating Officer of Breathonix.

If assessed to be suitable, this breath analysis platform could potentially be deployed in airports to facilitate the recovery of the tourism sector, as well as in places with high human traffic, such as dormitories.
**New $9m research programme for smart city solutions**

NUS and ST Engineering are collaborating on a $9 million, multi-year advanced digital technologies research programme to further their common goals of building a people-centric, smart future for Singapore and beyond.

Research efforts of this new programme will focus on technologies related to Smart City as well as Smart Maintenance, Repairs and Overhaul (MRO), covering five areas: resource optimisation and scheduling; prescriptive analytics; decision and sense-making; reasoning, engine and machine learning; as well as digital twin. These research areas support ST Engineering’s focus on developing differentiated and people-centric, smart city solutions that meet the present and future needs of cities around the world. The interdisciplinarity research areas are also aligned with NUS’ endeavours as a driving force behind smart city innovations, leveraging its deep expertise that spans multiple domains and faculties.

Helmed by Associate Professor Aaron Chia from NUS Industrial Systems Engineering and Management as its Director, and Jinian Xu, Head of the Data Analytics Strategic Technology Centre at ST Engineering, as its Co-Director, the programme will first focus on two key research projects to lay the foundations for digital transformation and Industry 4.0.

**Enterprise Digital Platform (EDP)**

As the backbone of smart city solutions, the EDP is a flexible, modular and scalable artificial intelligence (AI) platform that will support all the AI methodological areas, enabling the synthesis of disparate data sources and other internal or external systems, to orchestrate cross-vertical data and insights from customers and partners. All AI models derived from research projects under this programme will be integrated onto a common AI engine stacked within the EDP, paving the way for future-ready platforms that catalyse technology transformation and create new information-based revenue streams.

**Urban Traffic Flow Management**

In this project, researchers will develop algorithms that alleviate traffic congestion by using a holistic urban traffic flow smoothing approach based on traffic data analytics and AI technologies. Examples include traffic state estimation and prediction, in addition to effective active traffic control and management strategies identification and implementation. This will have future applications as autonomous vehicle technologies, 5G infrastructure and machine-to-machine (M2M) technologies start to mature and proliferate.

Professor Chen Tsuhan, NUS Deputy President (Research & Technology), said, “As Singapore advances its position as a Smart Nation, having the right enterprise architecture to support these goals will determine if true digital transformation can be achieved. Over the years, NUS and ST Engineering have enjoyed a close and productive relationship. This new collaboration will combine NUS’ expertise in the science of cities with ST Engineering’s industry knowledge to co-create people-centric Smart City solutions that will form the foundational systems to bring about not just impactful, but radical, change to the lives of people in Singapore and the world.”

Mr Harris Chan, Chief Digital Officer and Chief Technology Officer at ST Engineering, said, “This collaboration with NUS will allow us to drive deeper into the application of AI in new domains to catalyse the pipeline of next-generation technologies and solutions that address the evolving urban challenges that cities will continue to face. ST Engineering and NUS bring unique strengths to this partnership and we are confident that this programme will provide our research and engineering talents with opportunities to enrich their knowledge and deepen their expertise through real-world applications, paving the way for the development of impactful innovations that create more vibrant and sustainable cities of the future.”

**New Asian Institute of Digital Finance to spearhead FinTech education and research**

The Monetary Authority of Singapore (MAS), the National Research Foundation (NRF) and the National University of Singapore (NUS) will jointly set up a research institute that will develop deep capabilities to support the needs of digital financial services in Asia. The Asian Institute of Digital Finance (AIDF) will provide thought leadership and strengthen synergies between education, research and entrepreneurship in the thriving area of digital finance. It is expected to begin operating by the end of this year.

**Education**

Hosted at NUS, AIDF will offer a Master’s programme and award scholarships to outstanding students to pursue research at the doctoral level, as well as train post-doctoral fellows in Digital Finance and FinTech. Through its education programme, the AIDF will build the FinTech leadership pipeline for Singapore and the wider region.

AIDF will be led by Professor Duan Jin-Chuan, the Jardine Cycle & Carriage Professor of Finance at the NUS Business School. A steering group, comprising Professor Ho Teck Hua, Senior Deputy President and Provost of NUS, Mr. Sopnendu Mohanty, Chief FinTech Officer at MAS, and thought leaders from the financial and technology industries, will provide guidance on curriculum design and align AIDF’s research direction with strategic priorities in Singapore and the region. The steering group will also evaluate the impact of AIDF’s research and identity opportunities for collaboration and partnerships in Asia and beyond.

**Research**

AIDF will pursue foundational and inter-disciplinary research projects covering fundamental digital infrastructure, performance optimisation of business processes, and advanced application development research on cyber, fraud and anti-money laundering challenges. The institute will also develop financial services to meet sustainability and resiliency needs. Potential areas of focus include:

a. Digital Assets and Ledger Technology
b. Artificial Intelligence and Machine Learning
c. Digital Finance Platforms
d. Green Finance Technology
e. Next-Gen Financial Services on 5G Networks

**Entrepreneurship**

The regional research institute will also establish a unique “Fincubator” programme that will promote the entrepreneurship and provide the support to drive transformation of ideas and projects by promising students and entrepreneurs into market-ready products and services. Potential areas of focus include:

a. Applied research for commercialisation
b. Incubation of financial solutions to solve unmet digital financial service needs of Asia
c. Industry collaboration to provide comprehensive mentorship to build market-ready solutions
d. Strengthened linkages with investor community to spur research commercialisation

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**New initiatives and partnerships**

The AIDF Faculty will bring together deep expertise in the financial and technology industries, will provide thought leadership and strengthen synergies between education, research and entrepreneurship in the thriving area of digital finance. It is expected to begin operating by the end of this year.

**The AIDF faculty**

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- Professor Ho Teck Hua, Senior Deputy President and Provost of NUS
- Mr. Sopnendu Mohanty, Chief FinTech Officer at MAS
- Thought leaders from the financial and technology industries

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- Fundamental digital infrastructure
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Singapore, like much of the world, faces a rapidly aging population. Globally, increasing life expectancy paired with decreasing birth rates will see the number of elderly exceed the number of children aged below 10, by 2030. This demographic shift will present significant social, economic and health challenges, including decreased workforce, increased pressure on healthcare and social services, and increased economic burdens from the growing costs of elderly healthcare and public services.

Preparing for such an outlook requires societies to seek advancements in research, innovation, and entrepreneurship, particularly in the field of healthy longevity, which encompasses sustained physical, mental, social health and well-being while aging.

With this in mind, one NUS awardee, Dr Goh Jor Ming, will explore the impact of exercise, and in particular, its frequency, intensity, and duration, on healthspan. Dr Goh believes that exercise ought to be personalised. This project aims to encourage people to remain active and engage in regular exercise through routines that are personalised to their physiological characteristics.

10 projects from NUS were awarded up to US$50,000 each to initiate research into bold, innovative ideas that could extend the human health span and promote healthy ageing.

Another awardee, Dr Irwin Cheah, will study the association between ergothioneine levels and the onset of age-related disorders, to establish a baseline for healthy levels of ergothioneine in the blood. Dr Kee, together with Dr Feng Lei from NUS Psychological Medicine and Professor Barry Halliwell from NUS Biochemistry, have recently discovered a correlation between decreasing levels of ergothioneine with age and the onset of certain neurodegenerative disorders. They believe that the decline in blood ergothioneine levels may be a contributing factor towards age-related conditions commonly found in the elderly, and will seek to determine the effect of supplemental ergothioneine on preventing or slowing down the onset of these conditions to extend healthy longevity.

The Healthy Longevity Global Grand Challenge founded by the US National Academy of Medicine (NAM) is a worldwide initiative to accelerate innovation that improves physical, mental, and social well-being for people as they age.

The Challenge comprises an evidence-based report and a competition which accelerates breakthroughs in health longevity through a series of monetary awards and prizes. In the first round of the competition, the Catalyst Phase, 10 projects from NUS were awarded up to US$50,000 each, to initiate research into bold, innovative ideas that could extend the human healthspan through disease prevention, mobility, functionality, social connectedness and longevity.

10 NUS Awardees

Through their respective projects, the researchers will seek to understand how gene expression patterns and biomarkers, as well as nutrient, protein, molecular and cellular functions, are associated with aging. The NUS awardees are:

Dr Irwin Cheah, NUS Department of Biochemistry
Associate Professor Marie-Veronique Clement, NUS Department of Biochemistry
Associate Professor Thameem Dheen, NUS Department of Anatomy
Professor Roger Foo, NUS Department of Medicine
Associate Professor Alfredo Franco-Obregon, iHealthtech
Associate Professor Sanjay Khanna, NUS Department of Physiology
Assistant Professor Ajay Sriram Matharu, Yale-NUS
Dr Goh Jor Ming, NUS Department of Physiology
Assistant Professor Jai S Polepalli, NUS Department of Anatomy
Dr Natalipol Taisena, NUS Department of Biochemistry

From mid-2021, Catalyst Award winners will be able to share their work with policymakers, researchers, potential investors, and fellow innovators from around the world at the annual public Innovator Summit.

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Seven researchers from NUS have been elected Fellows of the Singapore National Academy of Science (SNAS), an organisation that has the dual remit of promoting the advancement of science and technology in Singapore, as well as representing the scientific opinions of its members.

The prominent researchers elected are (Top Row L-R): Professor Antonio Helios Castro Neto, Professor Barry Halliwell, Professor Lim Chwee Teck, (Middle Row L-R): Professor Liu Bin, Professor Ng Huck Hui, Professor Sow Chorng Haur and (Bottom Row) Professor Yu Hao.
Researchers from NUS have been placed among the world’s most highly cited. This is according to the newly unveiled list of Highly Cited Researchers™ 2020 by Clarivate.

The hotly anticipated annual list identifies researchers who demonstrate significant influence in their chosen field by publishing several highly cited papers during the last decade. Their names are drawn from the publications that rank in the top 1 per cent by citations for field and publication year in the Web of Science™ citation index.

A total of 25 NUS researchers have been named in this year’s list. These NUS researchers were recognised by their peers as outstanding in the fields of Chemistry, Clinical Medicine, Computer Science, Economics and Business, Engineering, Materials Science, Physics, Neuroscience and Behaviour and more.

This year, more than 6,000 researchers in 21 fields were selected based on the number of highly cited papers they produced over 11 years from January 2009 to December 2019.

The methodology that determines the “who’s who” of researchers draws on data and analysis performed by bibliometric experts at the Institute for Scientific Information™ at Clarivate. It uses a unique compilation of science performance metrics and trend data based on scholarly paper publication counts and citation data.

IN THE NEWS

NUS Researchers among the world’s most influential scientific minds

The NUS Centre for Trusted Internet and Community (CTIC) has developed LetsCheck, an online platform that lets users check fake claims about the coronavirus against reputable scientific sources.

Associate Professor Duong Hai-Minh and his team from NUS Mechanical Engineering developed a technique that converts pineapple leaf fibres into ultra-light, biodegradable aerogels.

Assistant Professor John Ho from NUS iHealthtech and team developed a smart suit that can be wirelessly powered by a smartphone.

Associate Professor Yan Ning, Assistant Professor Zhou Kang and team from NUS Chemical and Biomolecular Engineering has developed an integrated upcycling process to produce high-value amino acids from waste materials.

Assistant Professor Anand Joyasekharam and Associate Professor Edward Chow from CSI, developed an AI-driven digital medicine platform called Quadratic Phenotypic Optimisation Platform (QPOP) to help doctors make better clinical decisions.

More high impact discoveries and innovations at NUS Research News.
NEW GLOBAL ALLIANCE FOR UNIFIED PROGRAMMING STANDARDS FOR SMART PORTS

The Centre of Excellence in Modelling and Simulation for Next Generation Ports (C4NGP) under NUS Engineering is collaborating with 12 international partners to form an alliance, with the aim of creating a set of programming guidelines to accelerate digitalisation and unify the operations of global maritime and port industries.

The new global alliance brings together researchers, solution developers, governments, port operators, information technology (IT) systems developers and other players in the port and maritime industries to collaborate, create and adopt a set of computer and software application descriptive language standards, known as PortML (Port Mark-up Language). When completed, PortML will be the first-ever universal descriptive language standards for the port and maritime community.

Using PortML, port modelling, designs, configurations and information could be developed in formats that are compatible across all stakeholders in the industry. For example, the adoption of a common descriptive language can better support and augment the development of innovative digital twin capabilities and solutions. This can bring about labour efficiencies, optimised operational costs, and port efficiencies.

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