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# Future Tech, Leading Your Life

26 featured highlights
from 71 technologies
in 2020 Future Tech Award

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# About

To create a single window to easily showcase Taiwan's technological prowess to the world, the Ministry of Science and Technology invited the Academia Sinica, Ministry of Education, Ministry of Health and Welfare to jointly host "2020 Taiwan Innotech Expo - Future Tech" and display cutting-edge Taiwanese technologies and innovative industrial applications.

This exhibition focuses on Precision Health, Electronics & Optoelectronics, Evolutionary Materials, and AI & AloT Application, including research technologies with the potential of industrial developments in three to ten years. We have selected 26 highlight technologies for you. This event will be hosted from September 24th (Thu) to September 26th (Sat) 2020 at Taipei World Trade Center Exhibition Hall 1. We are looking forward to shaping Taiwan into a hub for research and development achievements and a pivotal contributor to the global economy of the future.

# Continuous Monitoring of the Cloud and Rain from Geostationary Satellite

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### **Technical introduction**

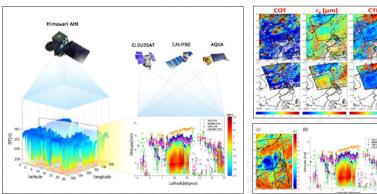
This technology is developed and controlled by the National Central University, Central Weather Bureau and Academic Sinica. The processing system is housed at NCU and technical support is served in Taiwan to the global. The data is acquired and preprocessed by CWB, and followed by the invention of the cloud properties retrieval algorithm package by NCU. The final retrieval algorithm package is evaluated and enhanced by the local observation from Academic Sinica. Therefore, the processing system can be assured for its performance and reliability. This state-of-the-art technology has been recognized and approved by AGU JGR-Atmospheres, the leading journal in Q1 level of the related research community by the anonymous peer reviewing in June 2020.

# Scientific breakthrough

This retrieval package has the breakthrough technology that applied on the satellite observation in geostationary orbit. The retrieval package can infer the cloud microphysical and optical properties from the multi-channel reflectance and brightness temperatures from visible to inferred bands. This is first time in Taiwan that could retrieve and estimate the clouds from satellite observation, along with the data quality control and assurance from local-adaptive enhancement and improvement in the processing system. The result had been evaluated abd verified in multiple resources including both active and passive sensors onboard multiple polar-orbiting satellites, radiosonde, and ground-based active lidar. Therefore, the scientific data are assured for its performance and reliability.

# Industrial applicability

The monitoring of the high-impact weather is an important service for industry for the government. Therefore, the 24-7-365 surveillance of the atmospheric condition from geostationary satellite becomes the most useful technique to archive this goal, in particular under the scenario of global change and increased vulnerability due to extreme weather. Among the factors that related to high-impact weather, cloud plays an important role that link to heavy rainfall, low cloud ceiling, atmospheric convection initiation and etc. These cause the strong influence in airport, harbor management. As a result, our technology help weather agency and related authorities for the advanced application and service.



# **Artificial Intelligence for Customs Fraud Detection**

# National Cheng Kung University | reliefli@gmail.com

# **Technical introduction**

With the astronomically growing trade flows, customs administrations need effective and explainable methods to detect suspicious transactions. This project presents a novel artificial intelligence-based model named DATE that ranks trade flows in the order of fraud risk and to maximize customs revenue. We confirm the superiority of DATE over state-of-the-art AI models, with a remarkable precision of 92.7% on illegal cases and a recall of 49.3% on revenue after inspecting only 1% of all trade flows. Predictions of DATE are also interpretable from the attention mechanism. We are deploying DATE in Nigeria and Malawi Customs Services, in collaboration with the World Customs Organization (WCO). DATE has been published in ACM KDD 2020, which is an AI top conference.

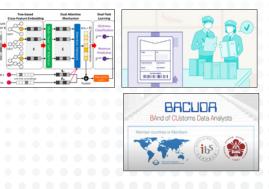
# Scientific breakthrough

The breakthrough and novelty of our customs fraud detection AI DATE includes: (1) a tree-based component to learn cross features, (2) a dual attention mechanism to learn the correlation among cross features, importers, and transactions, (3) a dual-task learning objective to jointly optimize illicit detection and maximize the revenue prediction, and (4) being capable of model interpretability for explaining why a trade flow is detected as illicit. The evaluation conducted on Nigeria Customs' real data exhibits: (1) our DATE model shows a remarkable precision of 92.7% on illegal cases and a recall of 49.3% on revenue after inspecting only 1% of all trade flows. These are

significantly better than state-of-the-art AI benchmarks (i.e., XGBoost and TEM)

# Industrial applicability

Our AI technique are deploying in customs systems of Nigeria and Malawi. We are promoting it to all WCO member countries. The main target of our AI is all countries' customs services in the world. We expect to bring three-fold economic impacts: (1) accurately detecting customs frauds to ensure legal economic behaviors of import and export trades, (2) bringing additional tax revenue and reducing the loss from tariff evasion for government agencies, and (3) being applicable to banking industries for detecting illegal financial trades and preventing money laundering due to the open source of our AI model. Moreover, our AI model is quite useful in the current COVID-19 period because the intelligent customs fraud detector can prevent inspectors from be exposed to the risky circumstance.



# **3D Object Referring and Grasp Detection Networks**

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### **Technical introduction**

It is expected that human will work with robots in the coming years. However, it is still unknown how both can collaborate together. Meanwhile, it is still very timeconsuming to deploy intelligent robots in production lines. For this work, we investigate deep comprehension for 3D (point cloud) and text (voice) signals to enable novel human-robotic object referring for robotic arms.

For the tasks, we emphasize on three core technologies including (1) efficient and effective 3D grasping via novel Grasp Detection Network (GDN), an end-to-end neural networks, (2) text-based object referring over 3D point clouds and the brand-new dataset (OCID-ref, to be public), (3) solving deficiency in training data via cross-domain few shot learning. We achieve state-of-the-art among the key benchmarks.

# Scientific breakthrough

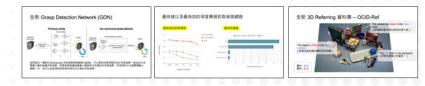
Advancing critical gasp detection for robotic arms, the proposed GDN has the best accuracy in grasping success rate, is the most robust for sparse point clouds, and yields the least computation (30 folds against the prior methods). We argue textbased object referring for human and robots and devise novel multimodal neural networks taking both text (voice) descriptions and 3D point clouds. Pioneering the work, we contribute the first public dataset, 3D Object Cluttered Indoor Dataset with Referring Expression (OCID-Ref).

We are in the leading team in benchmarks such as ScanNet 2019 for 3D scene segmentation hosted by Stanford Univ., and Cross-Domain Few-Shot Learning (CD-FSL) Challenge 2020, hosted by IBM. We shared our 3D researches as a top conference tutorial in ACM Multimedia 2019.

# Industrial applicability

The proposed Grasp Detection Networks (GDN) can huge reduce the deployment cost (time and human) for industry production lines. The proposed language-based 3D object referring entails soon-to-happen human-robot interactions. Meanwhile, the frameworks are all in end-to-end deep learning manners augmented with few-shot learning. It will facilitate the smooth deployment of advanced deep learning solutions in the fields (e.g., industry, healthcare, home, etc.), where the training data are mostly limited.

Dedicated to 3D vision for numerous applications such as autonomous driving, face recognition, AR/VR, and robot perception, we have been working closely with industry partners such as NVIDIA, Microsoft Research, IBM Watson, Qualcomm, MediaTek, FIH, HTC, Quanta, Synology, CyberLink, etc.



# **BPRSJ338: Therapeutic Applications for COVID-19**

# National Health Research Institutes | slee@nhri.edu.tw

# **Technical introduction**

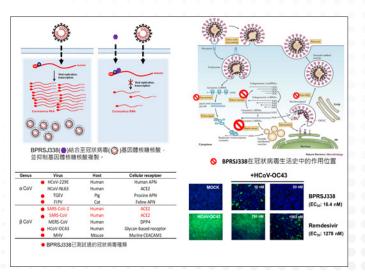
BPRSJ338 exhibits high potency of anti-SARS-CoV-2 activity and is in development for fighting COVID-19. BPRSJ338 also potently inhibits against broad-spectrum coronaviruses including SARS-CoV-2, SARS-CoV, HCoV-229E, HCoV-OC43, TGEV, FIPV, MHV. Therefore it is also applicable to fight against severe evolving coronaviruses in the future.

# Scientific breakthrough

BPRSJ338 is an inhibitor effectively against broad-spectrum coronaviruses. It exhibits high potency of anti-SARS-CoV-2 activity and is in development for fighting COVID-19. BPRSJ338 targets the RNP complex containing viral RNA and nucleoprotein to block replication of coronaviruses including human coronavirus SARS-CoV, SARS-CoV-2, HCoV-229E, HCoV-OC43 as well as FIPV, TGEV and MHV. Related US and Taiwan patents have been granted.

# Industrial applicability

Up to date, there is no effective vaccine or drug treatment for coronaviruses yet. BPRSJ338 exhibits high potency of anti-SARS-CoV-2 activity and is in development for fighting COVID-19. BPRSJ338 also potently inhibits against broad-spectrum coronaviruses including SARS-CoV-2, SARS-CoV, HCoV-229E, HCoV-OC43, TGEV, FIPV, MHV. Therefore it is also applicable to fight against severe evolving coronaviruses in the future.



# DBPR807: a CXCR4-Targeted Antagonist

# National Health Research Institutes National Tsing Hua University | ksshia@nhri.edu.tw

# **Technical introduction**

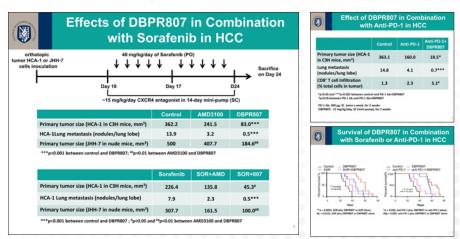
DBPR807 can significantly suppress tumor growth, prevent distant metastasis, reduce angiogenesis, normalize tumor microenvironment and promote cytotoxic T-cell infiltration. In various HCC models, DBPR807 itself can prolong overall survival as effectively as marketed anti-angiogenic agent sorafenib and immune checkpoint inhibitor anti-PD-1 Ab. What's more, its combination therapy with either sorafenib or anti-PD-1 Ab can extend life expectancy even more significantly than aforementioned monotherapy.

# Scientific breakthrough

Combination therapy of DBPR807 with sorafenib or anti-PD-1 Ab has been shown to have better efficacy in HCC disease animal models implanted with HCA-1 or JHH-7 liver cancer cells than the single treatment of sorafenib or anti-PD-1 Ab. This novel combination protocol can simultaneously inhibit angiogenesis, enhance immune response and prevent cancer metastasis, leading to a new horizon of cancer treatment.

# Industrial applicability

DBPR807 can significantly suppress tumor growth, prevent distant metastasis, reduce angiogenesis and normalize tumor microenvironment as well as promote cytotoxic T-cell infiltration. Although DBPR807 treatment alone can prolong survival as effectively as sorafenib and anti-PD-1 Ab, however, its combination therapy with either of them can extend overall survival more significantly than monotherapy. As such, this newly developed combination therapy may confer HCC cancer patients with a new theraputic strategy and may also have a great impact on other advanced cancers of high metastatic incidences.



# A Kinase Inhibitor that Induces Degradation of MYC Oncoprotein

National Health Research Institutes | ychi@nhri.edu.tw

# **Technical introduction**

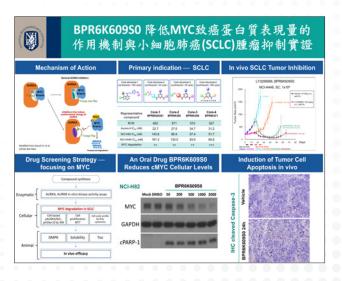
This technology is a development drug lead aiming to meet the medical needs of patients with small cell lung cancer. Through disturbing MYC-Aurora A interaction and inducing degradation of MYC oncoprotein, this bioavailable kinase inhibitor could serve as a potential treatment entity for SCLC.

# Scientific breakthrough

MYC oncoprotein is a transcription factor that induces tumorigenesis. MYC has been viewed as a undruggable drug target in the past 40 years. The novel small molecule developed in this technology breaks through the past viewpoints. It had demonstrated degradation of the MYC oncoprotein, as well as tumor regression in xenograft mouse models.

# Industrial applicability

To date chemotherapy is still a standard treatment strategy for small cell lung cancer (SCLC), and no targeted therapy is available. Novel small molecules that promote degradation of MYC oncoproteins would be of great advancement in cancer treatment. The high percentage of tumors diagnosed with MYC amplification in patients provides clear market differentiation and this technology is therefore warranted.



# Sub-nanometer gold sticker and methods for protecting against endotoxininduced sepsis: Applied for the treatment of malignant wounds

National Health Research Institutes | 971223@nhri.edu.tw

# **Technical introduction**

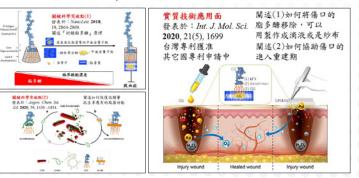
The bioactive core and corona synergism of sub-nanometer gold enables slowed inflammation and increased tissue regeneration in wound hypoxia. The developed dual-function wound dressing based on a gold nanocluster with a plane structure and an adhesive layer presented two features: (1) the gold nanocluster can attenuate the inflammatory response by adjusting the strength of the active site (i.e., lipid A) of lipopolysaccharide in immunological responses, leading to the transition of a wound bed from the inflammation phase to the proliferation phase. (2) The gold nanocluster can continuously provide oxygen for angiogenesis and collagen deposition that can allow for the reconstruction of granulation tissue for wound repair.

### Scientific breakthrough

The supramolecular trap fabricated from a subnanometer nanosheet can seal off the active site (lipid A) of lipopolysaccharide to directly interrupt the strong attraction it exerts, which can in turn minimize endotoxemia and maximize the activity of colistin to achieve greater anti-bacterial efficacy. Thus, the potential crisis of colistin abuse and resistance can potentially be avoided. This invention of gold sub-nanoclusters based on a molecular structure design can effectively compact the intramolecular long hydrocarbon chain-chain distance of lipid A, thereby reducing the inflammation caused by the binding between endotoxin and TLR 4. The concept is applied in malignant wound healing.

# Industrial applicability

The bioactive core and corona synergism of gold nanocluster was developed to simultaneously address these complicated issues by combining the abilities to eliminate endotoxins and provide oxygen for wound sites. Since the inflammatory stage is an essential stage of wound healing, the provision of endotoxin clearance by the outer organic corona of the gold-based wound dressing could slow inflammation that subsequently promotes two other important stages of wound bed healing, namely proliferation and remodeling. The novel wound dressing can promote the development of granulation tissue, including via angiogenesis and collagen deposition. Thus, the simply fabricated dual-function nanocomposite not only offers reduced batch-to-batch variation but also increased options for homecare treatments.



# The establishment of National Biobank Consortium of Taiwan (NBCT)

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# **Technical introduction**

At present, Taiwan already have 33 biobanks approved by the Ministry of Health and Welfare. This project is to establish a National biobank consortium of Taiwan (NBCT) through the fund support from the government. Currently NBCT already successfully invited 25 biobanks to join and the total research participants is more than 150 thousands with all kinds of biosamples available for applications. This Biobank Consortium will also pay intention to the value-added services to further increase the importance of this biobank network, further expanding the database in this biobank consortium. Our goal is to build a huge and comprehensive biomedical big data network research, in line with the needs of biotechnology pharmaceutical, artificial intelligence, auxiliary medical and other industries.

# Scientific breakthrough

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# The comprehensive multi-tier long-term care delivery information platform

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# **Technical introduction**

This project aims to incorporate the state-of-the-art Information and Communication Technologies (ICT), the Internet of Things (IoT), Big Data techniques in linking every aspect of community-based integrated long-term care (LTC), improving the efficiency of care services and administrative process, and to realize the idea of Aging in Place emphasized in the Long-term Care Policy 2.0 in Taiwan.

### Industrial applicability

- Establish local person-centered health database to fulfill personcentered health care services in multi-tier intervention care models by the Long-term Care Policy 2.0 in Taiwan.

- Linkage of multi-tier ABC services to optimize care delivery.

- Facili

# Scientific breakthrough

NHRI has built the comprehensive care-delivery information platform by ICT-introduced long-term care (LTC) service delivering management and resource sharing that integrates LTC services and health care provided by local community-based multi-tier ABC LTC services. This platform will gradually establish local personcentered health database with data standardization for LTC Big Data techniques application in developments of LTC clinical practice guidelines, decision support system and AI in long-term care industry.





# Heterocyclic compounds and use thereof

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# **Technical introduction**

In this technology, a series of potent MOR/NOP agonists has been developed, which demonstrated potent antinociception in tail flick and cancer pain mouse models with fewer side-effects in respiratory suppression, heart rate decreasing, and constipation models than morphine.

# Scientific breakthrough

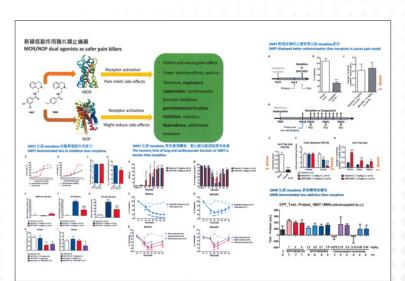
1. A first-in-calss pain-killer with low adverse-effects.

2. A MOR/NOP dual and biased-agonist, which possesses a new mode-of-action.

3. A series of patentable small molecules with novel structural scaffold.

# Industrial applicability

A fast painkiller -The onset time of this drug is within ten minutes after subcutaneous injection. Low addiction -The NOP activation of this drug reduces addiction. Slight affecting in the digestive system - This drug did not cause constipation. High level of safety -This drug caused low and short-term effects on lung and heart function.



# cision Health

# Rapid Detection of AIOT Platform for Food Safety and Epidemic Prevention

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### **Technical introduction**

The innovative technology which is based on the unique biomimetic material, including immunomagnetic nanoparticles, aqueous extraction solvent, and a portable IoT detection device promotes the detection speed, accuracy, and precision of the target molecule. Featuring with the excellent ability of non-specific binding, this technology decreased the probability of false-negative/false-positive successfully. The detection device combines the IoT technology and AI module for statistics and calculation on the cloud for building up "Rapid Detection of AIOT Platform for Food Safety and Epidemic Prevention."

### Scientific breakthrough

"Rapid Detection of AIOT Platform for Food Safety and Epidemic Prevention" possessed with several innovative breakthroughs. The biomimetic modified materials with high ability of non-specific binding which can react under aqueous solution not only break the limitation of previous problems, but also increase safety, practicality, and environmental benefits in detection. Simultaneously, through applications of the cloud and AI module, the portable AIOT detection device provides the service for tracking and personal detection distribution maps for each case to strengthen the security for food safety and epidemic prevention.

### Industrial applicability

The biomimetic modified material and aqueous extraction solvent which can finish the surface modification and extraction under aqueous solution are applied by the "Rapid Detection of AIOT Platform for Food Safety and Epidemic Prevention." The platform breaks through the limitation of materials, restrain the problem of non-specific-binding, and combined with a portable AIOT device that can quickly match with detection molecules such as antibodies and nucleic acid for facilitating the development of biosensor platforms; it owns a wide range of derivative applications for industries like detection and medical material.



# Dual application of Pt/Au nano-alloy electrode in neutral enzyme-free glucose detection and biofuel cell

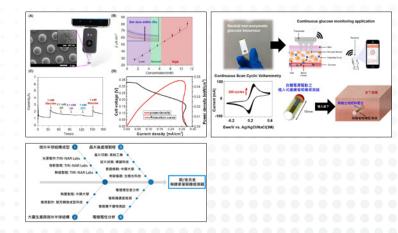
National Chung Hsing University | gjwang@dragon.nchu.edu.tw

# **Technical introduction**

Integrated Taiwan's superior industries such as semiconductor manufacturing processes, precision micro-molding, hot embossing, and chip packaging to develop Pt/Au nano-alloy electrodes with applications in neutral non-enzymatic glucose biosensors and neutral non-enzymatic glucose biofuel cell. This novel Pt/Au nano-alloy electrode possesses advantages of technology foresight, good detection performance, and high feasibility of mass production. Plastics Industry Development Center as a collaborator to link up-stream and downstream manufacturers in Taiwan for trial production of electrodes and sensors. In the future, we will further develop an autogenous power supply implantable continuous glucose sensor by integrating the glucose detection and the glucose biofuel cell.

# Industrial applicability

Integration of long-term glucose continuous tracking technology and automatic drug delivery system is the development direction of blood glucose monitoring technology. The novel neutral non-enzymatic glucose biosensor can replace the existing glucose detection strip, and can be used as the probe accessories of continuous glucose monitoring in the future. If a neutral enzyme-free glucose biofuel power supply system and an automatic drug delivery system are combined, an automated blood glucose monitoring system driven by an autogenous power supply can be further developed. It can enhance the international competitiveness of Taiwan's blood glucose monitoring industry.



# Scientific breakthrough

An enzyme-free glucose detection electrode that can operate in a neutral environment is a key technology for continuous glucose sensing. A neutral enzyme-free glucose biofuel cell is an ideal self-driving power source for implantable devices. The developed Pt/Au nano-alloy electrodes have good applications in neutral non-enzymatic glucose biosensors and neutral non-enzymatic glucose biofuel cell. In the future, these two devices can be integrated together to form an autogenous power supply implantable continuous glucose sensor.

# **Novel Therapy for Critical Limb Ischemia**

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### **Technical introduction**

We used the concepts of tissue regeneration, embedding drugs in biomaterial carriers, and a rigorous regeneration deficient animal model with severe hind limb ischemia to develop an effective novel therapy Grace-001. The new drug can promote neovascularization, tissue regeneration, blood flow maintenance, and restoration of blood vessels, nerves, and muscles as well as their functions. This new drug Grace-001 can effectively retain the patient's non-necrotic tissue and it can prevent limb with severe ischemia from amputation. This new drug saves patient's limb, life, economic, and the heavy burden of national health care.

### Scientific breakthrough

This case is the world's first new concept of novel regenerative medicine. I took the advantage of FDA-approved small molecular drugs and biomaterials, each of which has indicated therapeutic activities, to develop a new specialty drug product Grace-001. Besides, we have established an assessment platform of regeneration-deficient hindlimbischemia murine model. We have broken through the bottleneck of the existing technologies and have evaluated the efficacy of drugs rigorously. We therefore could avoid the problem of high failure rate of more than 86% from animal to human trials during the developmental process of new drugs. In other word, a high success rate will be achieved due to a rigorous screening process of the new drug.

### Industrial applicability

The new drug product"Grace-001" fulfills the unmet clinical needs for the critical limb ischemia. As it comprises a series of FDAapproved ingredients, its approval can be achieved under the 505(b)(2) regulatory pathway. In this case, the costs, risk and time for marketing will be greatly reduced, whereas the successful rate and competitive advantages will be increased. Because of that, it saves experimental funds, improves success rate, enhance product competitiveness, and facilitate the development and promotion of industry and commerce. We expect to have great success in development and marketing of the new drug product against critical limb ischemia.

### 建立缺乏重生能力的小摄動物模式 再生醫學新藥兼顧治療與組織再生 再生醫學 組織修復 及劑型設計,發揮載體控釋 素干擾,以嚴謹驗證藥物治) 効果,以治療患部,目降他 使组织终悔的能力 副作用 百牛! 生醫材



# Germplasm Bank of Medicinal Coral Producing New Targeted Anti-cancer Agent and their Aquaculture Technology Platform

National Dong Hwa University | jinx6609@nmmba.gov.tw

# **Technical introduction**

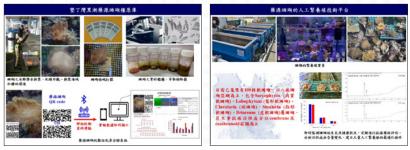
The present invention discloses the germplasm bank of medicinal coral producing new targeted anti-cancer agent and their aquaculture technology platform. The medicinal corals are collected in Kenting, located at the southern tip of Taiwan. In response to the unmet medical needs of new anti-cancer drugs, our research results will provide more diverse types of new drug targets and lead compounds in the "new drug development-new drug discovery and exploration period"

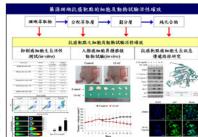
# Scientific breakthrough

The new anti-cancer drug targets in our technology platform are from the Sea: Germplasm Bank of Medicinal Coral in Kenting. The sources of our new drug targets are completely different from the terrestrial plants, and the chemical structures of them also escape the skeletons of the botanical ingredients and their synthetic derivatives. Our research can provide more diverse types of new marine drug targets in Anti-cancer New Drug Development.

# Industrial applicability

Our technology platform can provide the leading compounds of marine anti-cancer new drugs and their production process from the medicinal corals. In the operation models of patent licensing transactions, our present inventions are often good at integrating into the Taiwanese enterprises and multinational companies.





# Precision Health

# Bio-inspired sweat collection for health monitoring during physical activity

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# **Technical introduction**

A wearable sweat sensing device is developed for health monitoring during exercises to prevent illness caused by fluid losses. By biomimetic design and choosing material with high permeability, the sweat collector possesses high sweat collection efficiency, rapid transport and low response time. Inside the channel, salt concentration and sweat rate is deduced by electric property analysis. Finally, the data could be visualized on the phone app by Bluetooth wireless transmission. Thus, it could help user to acquire more information about physical condition and serves as a reference to adjust exertion intensity or intake some supplements.

# Scientific breakthrough

Concerning sweat collection, it is limited by low amount and demand in real-time monitoring. Inspired by the fractal network widely seen in nature, we design a collector possessing high collection efficiency (90%), low flow resistance, low dead time (2 mins compared to 10 mins in literatures), and flow velocity which is twice of that in conventional paper microfluidics. Thus, the time resolution for ion sensing is enhanced. Also, by the change of capacitance in paper absorbent, the function of sweat rate measurement is added.

# Industrial applicability

The core technique of device is sweat collector, which is made of special fabric designed for sports. It could be a cooperation subject with textile industry, which is well developed in Taiwan. By applying fabric with better properties in draining sweat, water transport ability, and single process knitting, the sweat sensing device could be directly incorporated with sports apparels. Addition works contain implantation of miniaturized sensor and chips for measurement and data transmission. The apparels are expected to have higher value added consequently.



# A Non-Invasive AI Imaging Technique for Quick Risk Assessment of Stroke and Cardiovascular Diseases

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# **Technical introduction**

This product is a novel risk assessment tool for carotid artery stenosis and stroke. This is a revolutionary healthcare technology using motion analysis and quantification to extract information from pulses for risk assessments. The entire process is completed by taking a short video clip aimed at the neck with only one simple click on any mobile devices or our apparatus, anywhere, anytime. In less than five minutes, the user receives an evaluation report indicating low to high stroke risk.

Our product accuracy stands higher than 90% when compared to the clinical outcome. The future indications of this product can be extended to arrhythmia, venous fistula obstruction, etc. This product has the great potential to achieve our dream of "personalized mobile hospital" in the future world.

# Scientific breakthrough

This product is a novel non-invasive and non-contact quick risk assessment tool for carotid artery stenosis and stroke. This is a revolutionary healthcare technology using motion analysis and quantification to extract information from individual pulses for risk assessments. The entire process is completed by taking a short video clip aimed at the neck with only one simple click on any mobile device, laptop, or our apparatus, anywhere, anytime. Our product automatically uploads the video files to our cloud server via internet for calculations. In less than five minutes, the user receives an evaluation report indicating low to high risk for stroke risk assessments. The current accuracy of our product stands higher than 90% when compared to the Carotid Duplex Sonography clinical outcome.

### Industrial applicability

In the future, this product could serve as the first screening line prior to Carotid Duplex Sonography at hospitals or personal assessment at home. It is quick, accurate, inexpensive and can be done anywhere, anytime.

We plan to cooperate with major chain pharmacies, clinics, and healthcare centers, putting this product at key locations for providing service to local communities. We plan to launch this product to medical institutions, enterprise, insurance companies, etc., and tailor our product to their specific needs.

The future indications of this product can be extended to arrhythmia, venous fistula obstruction, Parkinson disease, etc. This product has the great potential to set the first major cornerstone to achieve the dream of "personalized mobile hospital" in the future world.



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# Precision blood test for early detection of breast cancer

# Taipei Medical University | Iinruokai@tmu.edu.tw

### **Technical introduction**

EPICAN is a novel technique that uses liquid biopsy for epigenetic analysis. Using methylation-specific PCR method to analyze specific gene methylation of cell-free DNA in plasma for early detection of breast cancer. The advantages of this technology are 1. High accuracy 2. Low false positive rate 3. Low-invasive 4. less limitation 5. Available for routine and continuous detection 6. Monitoring cancer changes 7. Aided diagnosis 8. Automated process 9. Easy-to-operate 10. Rapid analysis. It is expected that EPICAN technique can provide a new option for early detection in breast screening, and it can combine the results of mammography or ultrasound examinations to aid clinician diagnosis and help decrease patients receiving unnecessary puncture/ section invasive examinations.

# Scientific breakthrough

EPICAN technique is the world's first application of liquid biopsies for epigenetic analysis in the early detection of breast cancer. The detection sensitivity is up to 93.0%, specificity 93.0%, AUC is 0.930, and the accuracy is 93.0%, which can detect early-stage breast cancer, which is better than the current breast mammography and breast ultrasound examination. Formal patent application in Taiwan. It is expected that this technology will improve clinical breast screening, diagnosis, and breast cancer treatment monitoring.

# Industrial applicability

According to the market evaluation of the MarketWatch.com website, the global breast cancer screening market is US\$1.68 billion in 2019, and the CAGR is 8.4 %/5 years. It is expected to reach US\$3 billion in 2026. The previous study reveals that is about 1.6 million women undergo breast biopsy each year. Based on the number of annual breast biopsies, the market of EPICAN detection technique is expected to reach US\$160 million. EPICAN detection technique will be commercialized in the form of a detection service and detection kit. We expect to assist the authorized medical laboratories and precision medical molecular testing laboratories in providing detection services. On the other hand, we will authorize the GMP reagent manufacturer to produce and the agents to sell the detection kits.

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# Global Ionospheric Tsunami Monitoring and Early Warning System-Space Buoy

# National Central University | tigerjyliu@gmail.com

# **Technical introduction**

The total electron content derived by existing ground-based GNSS (Global Navigation Satellite System) receivers is used to construct a network of space buoys for real time monitoring traveling ionospheric disturbances triggered by tsunami waves. This space buoy network shall act as a tsunami early warning system confirming the tsunami origin and propagation.

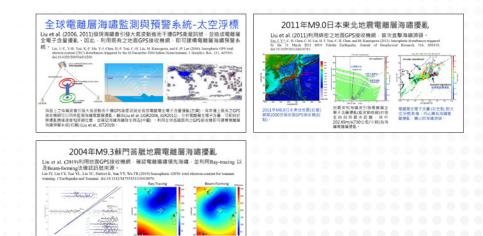
# Industrial applicability

为確波引發增越留全地子含量便氮(黑双動由線)的發 生時刻向震火距離。地面GPS接收機記錄为確地質 層硬亂之到時和位置(黑三角)。为情地能質便亂度

Networks of existing ground-based GNSS (Global Navigation Satellite System; GPS, GLONASS, Galileo, BeiDou) receivers of IGS (International GNSS Server) can be used to construct a regional or global ionospheric tsunami monitoring and early warning system.

# Scientific breakthrough

The total electron content (TEC) derived by existing ground-based GNSS receivers for the first time can be employed to detect traveling ionospheric disturbances induced by tsunami waves. A dense ground-based GNSS receiving network allows us pioneering to observe the tsunami origin and confirm the tsunami occurrence. Networks of existing ground-based receivers of IGS (International GNSS Server) can be used to construct a global ionospheric tsunami early warning system.



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# An 1.6Tb/s Silicon Photonics Chip

# **National Kaohsiung University of Science and Technology** tt@nkust.edu.tw

# **Technical introduction**

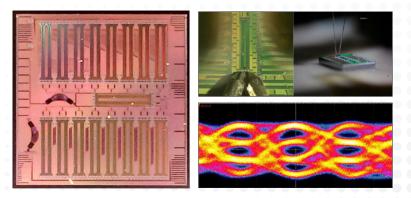
This 1.6Tb/s silicon photonic chip adopts the semiconductor technology to integrated optical couplers, splitters, modulators, and 4x16 AWG optical multiplexer into a 5mm x 5mm area. Thanks to the support of Ministry of Science and Technology (MOST) and Taiwan Semiconductor Research Institute (TSRI), this novel 1.6Tb/ssilicon photonics chip is designed at the end of 2018 and send to IMEC to produce. After getting the chip at the beginning of 2020, those separate devices of optical edge coupler, optical splitter, optical modulator, and 4x16 AWG optical multiplexer have been measured and verified. The overall chip performance has also been checked by injecting lasers and the light signal has been coupled by singlemode fiber to demonstrate the feasibility of this novel silicon photonics chip.

# Scientific breakthrough

Many famous cloud service provider, such as Facebook, Amazon, Apple, Google, and Microsoft invest a lot of resource to build hyperscale data center. The servers inside these hyperscale data centers might over 100,000, and the high speed interconnection and low power consumption is major concerns. Therefore an optical transceiver with higher transmission speed is very critical. According to our proposal at 2018, a 1.6Tb/s silicon photonic chip has been built and demonstrated. This is an essential breakthrough of the data transmission bottleneck inside data center. To our best knowledge, this silicon photonic chip has the most power data transmission capability of 1.6Tb/s in such a small chip area of 5mm x 5mm.

# Industrial applicability

This silicon photonics chip enable a huge data transmission capability of 1.6Tb/s and can be applied inside the data center. Through the development of this chip, we have built a proprietary structure and a full set of component data base to construct the chip. This is a very important technology in the future applications of cloud and 5G networks. In the meantime, these IP and component data base based on silicon photonics technology can be applied and to develop new chips in the field of optical sensing, biological signal detection, vehicle control to create new business possibility and chance



# SS-MRAM: A superlattice based STT-MRAM with extra-high performance

# National Taiwan University | hsuehwj@ntu.edu.tw

# **Technical introduction**

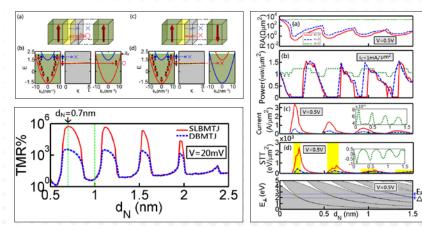
SS-MRAM is a superlattice based magnetoresistive RAM, in which the barrier is made of superlattice to replace crystal MgO (001). The superlattice is a high spin polarization artificial metamaterial, which is composed of stable insulator and metal materials. Compared with the current STT-MRAM, SS-MRAM has the advantages of low reading and writing power consumption, fast reading and writing speed, small component size, compatible with traditional manufacturing process, and high reliability. Moreover, SS-MRAM has more advantage and less weakness comparing to SRAM, DRAM and Flash. Thus, SS-MRAM will be a dream next-generation memory with ultrahigh performance.

# Scientific breakthrough

We propose an SS-MRAM that uses superlattice materials as the barrier to replace current crystal MgO(001). The superlattices is artificial supermaterial, which is composed of stable insulator and metal materials. Higher electron spin polarization efficiency can be provided by the superlattice than current MgO used in MRAM. Compared with STT-MRAM, SS-MRAM has the advantages of low power consumption for reading and writing, fast reading and writing speed, small component size, compatibility with current manufacturing processes, easy manufacturing, and high reliability. Moreover, SS-MRAM has more advantage and less weakness comparing to SRAM, DRAM and Flash.

# Industrial applicability

SS-MRAM can be formed as embedded and stand-alone memory. SS-MRAM can be applied in the fields of internet of things, microcontrollers, machine learning and artificial intelligence, energy, medical, automotive, aerospace, smart factories, automation, and industrial machine control. Due to high performance and less weakness, SS-MRAM can be used to replace traditional Toggle MRAM and STT-MRAM. Moreover, SS-MRAM has advantage of traditional memory SRAM, DRAM, and Flash. Thus SS-MRAM can be applied to different fields to replace traditional memory SRAM, DRAM, and Flash. Thus SS-MRAM, and Flash. SS-MRAM can share the market of all of memory about annual 100 billion US dollars.



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# Wireless Power Transfer System for Electric Vehicles

# National Taiwan University of Science and Technology | hjchiu@mail.ntust.edu.tw

# **Technical introduction**

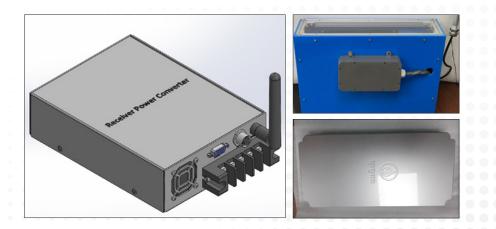
This technology mainly uses magnetic resonance wireless energy transmission technology to effectively improve the non-contact charging efficiency.

# Scientific breakthrough

More and more portable electronics devices adopt wireless power transfer technology that allow them to be recharged without the trouble of plugging in. Wireless chargers for EVs are also being developed. High power WPT technology can be used on electric vehicles, drones, unmanned ship and AGV to solve the inconvenience and safety issues of the conventional high power charging system.

# Industrial applicability

The conventional plug in charging may pose a potential risk of electric shock to users if connectors are plugged or unplugged in a high humidity or rainy environment. Other issue that may affect their reliability includes insulation wear and oxidation/corrosion of metal contacts. The use of wireless charging techniques can eliminate these concerns. The technology can be used on electric vehicles, drones, unmanned ship and AGV to solve the inconvenience and safety issues of the conventional high power charging system.



# Self-healable, Self-powered, Stretchable, and Transparent Electronic Skin (human-device interfaces) and Nanogenerator

National Chung Hsing University | Iai423@gmail.com

# **Technical introduction**

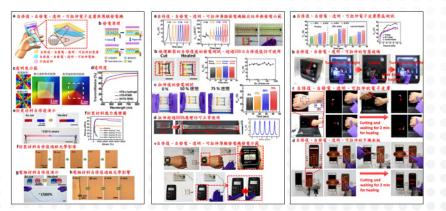
Image that your cell phone can be self-powered and able to self-healing after damage or robots in Sci-fi movie have self-powered and self-healable skins. Here, we present the first energy-harvesting triboelectric artificial skin that is entirely, intrinsically, and autonomously self-healable and simultaneously highly transparent and extraordinarily stretchable and able to drive via selfgenerating electricity. Not only can this energy-harvesting triboelectric skin serve as an untethered power source for personal electronics, but it can also be used as elegant electronic skin that combine all desired attributes including self-healing, self-powered, highly transparent, and superstretchable.

# Scientific breakthrough

The first energy-harvesting human-device interface that is entirely, intrinsically, and autonomously self-healable, self-powered and simultaneously highly transparent and extraordinarily stretchable is developed. The healing time (2 min for repairing its function; 30m for 100% healing efficiency at 900% strain; 8 hr for repairing its appearance), transparency (88.6%), and stretchability (>1000%) are all higher than those of previously reported self-healing sensors and power devices. Competing previous self-healing electronic skins suffer from the need of continuously pre-provided voltage to drive them operation. Our device enables new classes of active electronic skin and human-machine interfaces that are self-powered, self-healing, super-stretchable, and highly transparent.

# Industrial applicability

The first energy-harvesting artificial skin that is entirely, intrinsically, and autonomously self-healable, self-powered, and simultaneously highly transparent and extraordinarily stretchable not only can serves as an untethered power source for personal/remote electronics but also be used as elegant human-device interface that combine all desired attributes. The unprecedented energy-harvesting sensing device that is entirely and inherently ambient self-healable, highly transparent, and intrinsically stretchable, and possesses energy-harvesting and actively-sensing ability is timely and able to usher vast emerging fields including personal energy devices, energy for IOT, stretchable electronics, robotic/prosthetic skins, selfhealing panel, next-generation human-device interfaces.



# High-value recycling waste materials to produce lightweight aggregate

# National Chung Hsing University | hojichen@nchu.edu.tw

### **Technical introduction**

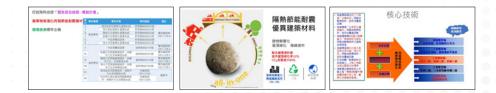
Responding the government's policy of "circular economy". The project is to manufacture high value and energy saving construction material (lightweight aggregate) by using Taiwan environmental and industrial waste, such as paper sludge, textile sludge, organic waste solvent from semiconductor industry, and reservoir sludge, etc. Based on fully recyclable concept to create real benefits for domestic ecological environment.

# Scientific breakthrough

This team pioneered the use of waste, such as paper sludge, textile sludge, urban sewage sludge, organic waste solvent from semiconductor industry, and reservoir sludge, etc. to manufacture high value and energy saving lightweight aggregate. The team also understand the relevant front-end manufacturing equipment and process technology, and have applied for a number of patented technologies to complete the related patent layout of waste sludge lightweight aggregates. Achieves plenty of research results about manufacturing lightweight aggregate with industrial wastes has published at international journal. The team is sure to be the leading group of lightweight aggregate in Taiwan.

# Industrial applicability

The target market of this technology can be divided into waste treatment and lightweight aggregate products. Waste materials such as industrial sludge and organic waste solvent from semiconductor industry, which have high treatment processing income. Lightweight aggregate products such as ready-mixed concrete, pre-cast components, cement products, agricultural planting, and filter material, which are for sale. In terms of the scale of the domestic market, the total annual output of the items mentioned above exceeds 100 billion. The business model of the project provides enormous market value, in which the waste treatment is the blue ocean market of Taiwan waiting to be developed.



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# Composite High-Entropy Oxide of Piezocatalyst in Organic Dye Degradation /

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# **Technical introduction**

Multi-cation-high-entropy-oxide can be used for piezocatalyst materials, which exhibited a superior efficiency in dark environment without application of external light source. Because the high-entropy-oxide possess the characteristic for owning multi-cation, here we design a brand new recipe to add several transition metallic elements to reduce the band-gap and huge cation into, leading to polarization of the localized structure, which equipped with optic-electric and ferroelectric function for superior performance on degradation of the organic dye and hydrogen evolution.

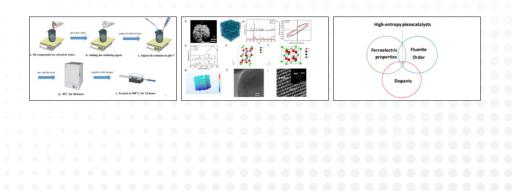
# Scientific breakthrough

Multi-cation-high-entropy-oxide is apart from the single cation ion oxide, like titanium dioxide and zinc oxide, possessing more cation and lead to create more phase coexistence, therefore, from the perspective of the functional properties in high entropy oxide, owning more possibility to create the multifunctional catalyst, which owns the following characteristic: opto-eletronic, piezo-electric, pyro-electric and ferroelectric. Thus, this state of art catalyst can satisfy each needed in real environment. Besides, through modifying the concentration and the number of cation element in oxide, we can create the numerous different single phase or multi-phase in single catalyst, which lead to possessing the multiplicity in functional properties and flexibility for tuning performance.

# Industrial applicability

Multi-cation-high-entropy-oxide is synthesized by simple wet-chemical synthesis, owning the capability to the mass production for the factory. Besides, the sol-gel system utilized here is very flexible, can extend to not only nitrate system, but the acetate and sulface system is also can be used to produce, which is suitable for the factory to make the selection to achieve the economical needed.

Moreover, the multi-cation oxide can possess numerous talents from the activity from multi-cation, which is ascribed to optoeletronics, piezoelectric, pyroelectric and ferroelectric properties. Thus, this catalyst can be multi-functional one for each needed for the clean energy (pollutant degradation, hydrogen evolution), leading to the highly flexibility in commercial application



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# **Technical introduction**

This technology uses in-situ optical photointerrupt sensor or in-situ acoustic ultrasonic transducer to measure the growth of fouling layer thickness during membrane water treatment. Being the world's first to combine real-time filter speed attenuation data and physical mode of clogging, the clogging of film can be instantly analyzed in a smart way which in turn effectively extends its lifetime. The analysis of its real-time changes can optimize appropriate cleaning parameters and operating conditions for subsequent operations thus reducing various important costs.

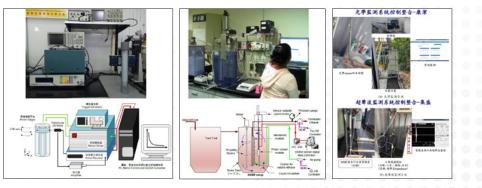
# Scientific breakthrough

An integrated technique for online fouling monitoring with processoriented capacities of:

- 1. in situ measurement of fouling layer thickness
- 2. dynamic analysis of fouling layer structure
- 3. monitoring and predicting membrane fouling potential The analysis of its real-time changes can optimize appropriate cleaning parameters and operating conditions for subsequent operations thus reducing various important costs.

# Industrial applicability

By replacing traditional wastewater treatment process with membrane separation technology, high separation efficiency and good quality of discharged water can be achieved. However, the biggest challenge faced in the developing this technology is the fouling of membrane. When membrane fouling occurs, the filtration rate will significantly reduce which in turn increasing the operation costs. With real-time monitoring technology, the probability of membrane clogging as well as number of cleanings and energy consumption can be greatly reduced. This will also result in lowering system cost and production cost thereafter improving water recovery ratio and quality of reclaimed water.



# All-optical volumetric physiology for brain connectomics: high-speed volumetric / imaging, precise optical stimulation and spiking neural circuit models

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# **Technical introduction**

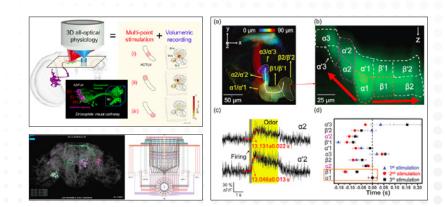
We developed a high-speed volumetric imaging system that provides millisecond temporal resolution to observe 3D neuronal firing dynamics in a living brain, and combined the high-speed volumetric imaging system with a home-built optical neuronal stimulation system, to achieve volumetric all-optical physiology observation, that allows us to resolve the 3D neural connection and coding of a neural circuit. We also constructed a detailed computational model of the neural circuits based on the recorded neural activity. We demonstrated our technology in the late visual system of the fruit flies (Drosophila melanogaster) and will apply the technology in larger species such as mouse. Our technology will greatly improve our knowledge of the brain operation principles.

# Industrial applicability

Our fast and volumetric all-optical physiology platform can be applied not only to neuroscience for various species, but also to other fast dynamical systems. For example, the platform can improve the effectiveness of cell screening in microfluid devices by accurately observing and activating individual cells. The platform also has potential applications in pathological diagnosis of tumor samples. Our algorithms for constructing and tuning neural circuit models based on observed neural signals may be used in brain-machine interfaces and may assist in the development of the next-generation Al algorithms.

# Scientific breakthrough

Our 3D all-optical physiology (AOP) platform incorporates single-photon point stimulation and two-photon high-speed volumetric recordings (Optics Letters 2019, "Editor's pick"). We have demonstrated its effectiveness in studying the anterior visual pathway of fruit flies (iScience 2019). In comparison, contemporary high-speed AOP platforms are limited to single-depth or discrete multi-plane recordings that are not suitable for studying functional connections. Our high-resolution computational model is constructed based on the combination of static connectome and AOP data, and is much more realistic than the existing models. Our work aids establishing in-vivo 3D functional connectomes and computational models of the brains, thus provides insight into the mechanisms of brain functions.



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