2020 FUTEX 未來科技館

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 "Future Tech" .

This exhibition focuses on "6 core tactics" including Precision Health, Electronics & Optoelectronics, Evolutionary Materials, and AI & AIoT Applications which showcase over hundred creative technologies. In addition to the physical presentation on the booths, there is also One on One Matching system to accelerate industry-academia catalyst.

AI & AIoT Applications

Precision Health Ecosystem

Future Tech, Leading Your Life

Electronic & Optoelectronics

Evolutionary Materials

Excellence Research Center

National Applied Research Laboratories

National Synchrotron Radiation Research Center

National Science and Technology Center for Disaster Reduction

2020
FUTEX 未來科技館

FUTURE TECH,
LEADING YOUR LIFE

AI & AIoT Applications

Multifunctional liquid crystal smart cloud sensors

Tamkang University | Prof. Chih-Hsin Chen; Prof. Shun-Wei Liu; Prof. Yang-Han Lee; Jung-Jung Chang; Jhih-Wei Huang; Yi-Lun Chen

Technical Introduction

The optical images on the liquid crystal microarray chip in sample solutions are captured and interpreted by an App of smartphone, which are further uploaded to the cloud for analysis and recording. This sensor is lightweight, low-cost, simple to operate, and the target-of-interest can be multiple and custom-made.

Scientific Breakthrough

This sensing technology integrates "organic light-emitting diodes", "liquid crystal chemical sensors" and "mobile communication system" for the first time. The scientific breakthrough of technology focuses on the design and synthesis of molecular probes, establishing the manufacturing process for sensor chip, definition of the OLED device parameters for this system, and integration of the data collecting and transmission system.

Industrial Applicability

This multifunctional liquid crystal smart cloud sensor is a new application of organic electronic devices. Its industrial applications include: material synthesis, environmental and biomedical detection, chip and panel manufacturing, mobile communication transmission, and cloud big data analysis. The technical insight of this sensor fits the goal of the blueprint of future technology of Taiwan that plans to promote the biotechnology medical industry, develop new generation chips, and apply 5G communication to makes Taiwan a smart country.

AI & AIoT Applications

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Sensing device | Before sensing | After sensing

Multifunctional liquid crystal smart cloud sensors

Result pH <7

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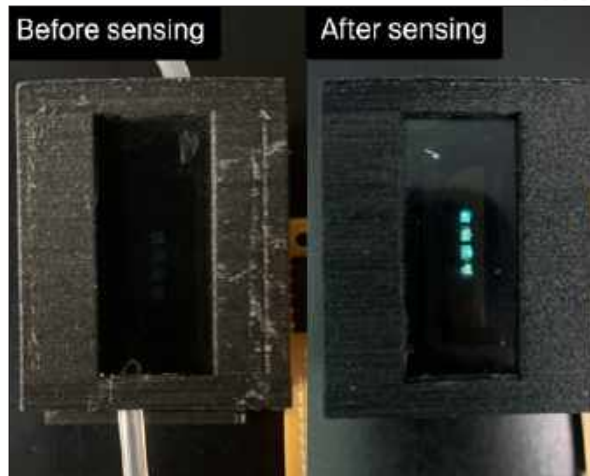
Continuous Monitoring of the Cloud and Rain from Geostationary Satellite

Natiocwbnal Central University, Central Weather Bureau, Academia Sinica | Chian-Yi Liu, Yu-Cheng Chang, Luh-Hsiang Chi, Charles C.-K. Chou

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, and featured as cover image.

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 multichannel 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 and 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.

AI & AIoT Applications

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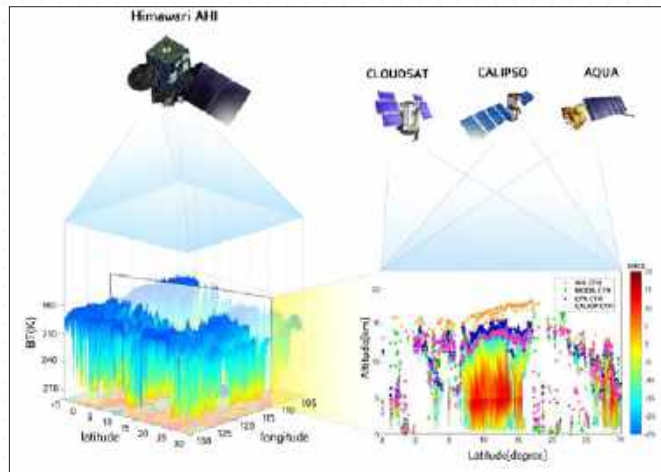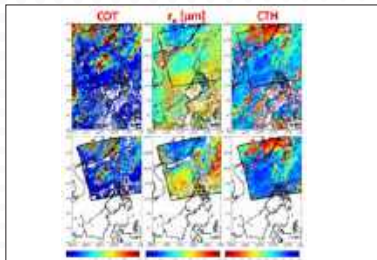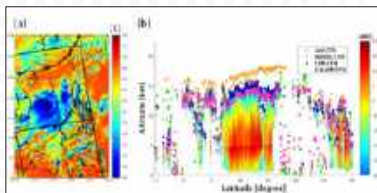
Air/ground cooperation for optimal rice harvesting model

National Chung Hsing University, Taiwan Agricultural Research Institute |

Ming-Der Yang; Ming-Hsin Lai

Technical Introduction

The Air/Ground cooperation for optimal rice harvesting model is established to provide a visual harvesting decision service on a cloud platform. Drones and mobile devices are employed to estimate grain moisture and forecast the variation of harvest moisture content (HMC) in the coming days by huge amounts of imagery data, deep learning algorithms, and weather forecasts. This model can benefit in several aspects, such as setting an accurate and comprehensive optimal harvest schedule, reducing the cost of operation in agricultural apparatus and barn ovens, ensuring the rice quality, and maximizing farmers' benefits. The potential value of the model practice could be more than a billion in Taiwan.

Scientific Breakthrough

Through massive images of UAVs and smartphones, AI technologies, such as Deep Neural Networks, Multilayer perceptron, and Random Forest, are applied to establish a water content evaluation model so to reveal HMC by a large-area non-destructive approach. Combining the air (drone) and ground (mobile devices) information, the HMC assessment model can be implemented on a cloud platform. By integrating weather forecast, the multi-day HMC can be predicted as an assistant reference for decision-making in remote intelligent cultivation.

Industrial Applicability

With rice paddies of 170,000 hectares in Taiwan, the profit by just reducing 3% HMC can be made up to 1.7 billion. The proposed optimal harvesting model cooperates with a cloud platform of air (UAVs) and ground (smartphones) image analysis technologies. This proposed model can provide multi-day grain moisture content of the individual rice field, which can be displayed through friendly visualization to assist to arrange the optimized harvesting schedule, greatly increase rice quality and both farmers' and purchasers' profits, and eventually significantly reduce the carbon footprint.

AI & AIoT Applications

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A Badminton Training and Activities Recognition System

National Chiao Tung University / National Taiwan University of Science and Technology |
Chih-Wei Yi, Yu-Chee Tseng / Yuan-Hsiang Lin

Technical Introduction

The system consists of a racket sensor, a smartphone App, and the IoT shuttlecock serving machines. Data of the 3-axis inertial sensor will be sent to the smartphone via Bluetooth for analysis. The App can recognize 7 stroke activities, including clear, cut, drive, lob, rush, net play, and smash using machine learning algorithms, while the speed, force, and stroke times are recorded at the same time. The App also enables the user to set parameters of the serving machines for assigning shot placements and serving schedules.

Scientific Breakthrough

The IoT-based shuttlecock serving machine is a breakthrough innovation. Controlling multiple shuttlecock serving machines at the same time diversifies the shuttlecock serving paths, increases the coverage of the court, and solves the problem of too low launching frequency of using single shuttlecock serving machine. Therefore, the system is suitable for top players' training. In addition, the combination of the sensor and the IoT serving machines allows interactive training in an innovative way. This new architecture would have a wide range of applications in scientific and diverse badminton training.

Industrial Applicability

With the innovative design, the system are suitable for badminton players at different levels and can assist the coaches in training the players. This training system features connecting multiple shuttlecock serving machines, which diversifies serving paths and shortens shooting intervals to simulate the process of real playing. In addition, the users can get customized feedback and interaction according to their own habits. The system can be placed in sport centers for training or used for personal practice.

AI & AIoT Applications

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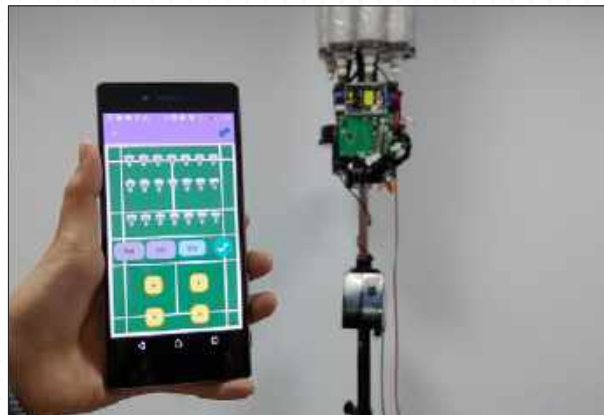
Applying Machine Learning to User Mobility Type Identification for 5th Generation Mobile Networks

National Chiao Tung University | Jyh-Cheng Chen

Technical Introduction

Due to the fast development of 5G networks, it is critical to identify users service types to allocate resources intelligently. Our technology focuses on users' mobility type identification, and only needs to extract features from users' cellular information.

Scientific Breakthrough

Mobility type identification using smartphone sensors has some limitations: 1. Environment: GPS may be blocked by obstacles, and magnetometer, barometer or light sensor can be affected by environments. Our solution: Our technology applies cellular data instead of using those sensors. 2. Energy consumption: Computing resources limit the long-term sensing by smart devices. Our solution: Our technology only needs cellular information with event-based sampling to reduce energy consumption. 3. Privacy issue: Smart device sensors may leak users' location and physical activity information. Our solution: We only collect cellular information and it has coarser granularity of location information. Our technology can achieve 95% accuracy and reduce 16% energy consumption compared to traditional methods.

Industrial Applicability

1. Network providers: Our technology is designed for 5G networks to identify users' mobility types, so that network providers can deploy specific mechanisms for users on high-speed transportation, or offload network traffic from car-to-outside-BS to car-to-inside-BS. 2. People: Our technology can be deployed as a mobile app on smartphones for smart navigation, carbon footprint, elderly tracking, or calories calculator. 3. Vehicles: This technology can be used for usage-based pricing and driving behavior analysis, allowing service providers and insurance companies to innovate. 4. Cities: This technology can be used to understand the mobility and traffic patterns in cities for applications such as congestion control, traffic planning, or travel time prediction.

AI & AIoT Applications

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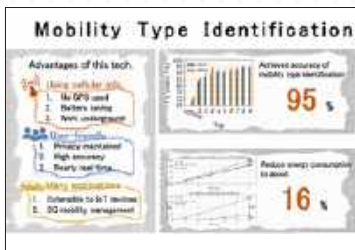
Artificial Intelligence for Customs Fraud Detection

National Cheng Kung University | Cheng-Te Li, Yu-Che Tsai

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 that DATE leads to 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 models (i.e., XGBoost and TEM).

Industrial Applicability

Our AI technique is 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.
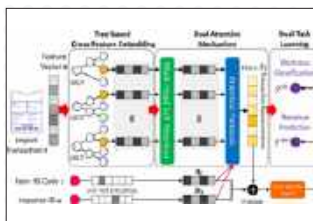
AI & AIoT Applications

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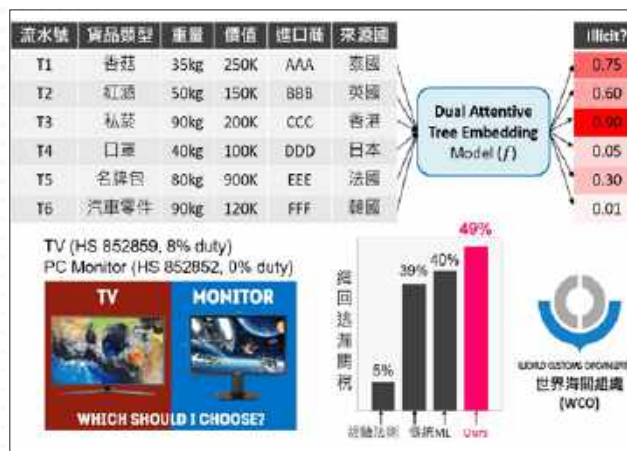
3D Object Referring and Grasp Detection Networks

National Taiwan University | Prof. Winston Hsu

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 time-consuming 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 text-based 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.

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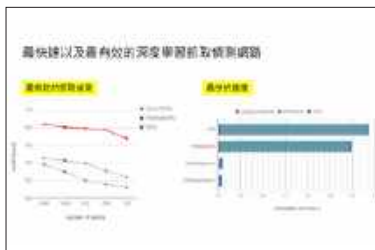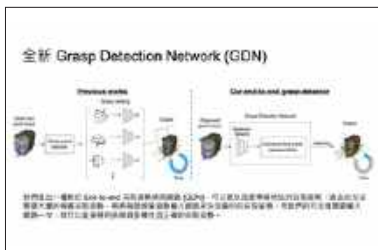
Intelligent In-Situ Monitoring of Membrane Fouling

National Taiwan University | Prof. Kuo-Lun Tung
Chung Yuan Christian University | CMT Director Ching-Jung Chuang

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 monitoring techniques and physical model of clogging, the fouling 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 operational costs.

Scientific Breakthrough

An integrated technique of process-oriented online fouling monitoring is capable for:
1. in-situ measurement of fouling layer thickness
2. dynamic analysis of fouling layer structure
3. monitoring and predicting potential membrane fouling
The analysis of its real-time changes can optimize appropriate cleaning parameters and operating conditions for subsequent operations thus reducing various operational 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 when developing this technology is the fouling of membrane. When membrane fouling occurs, the filtration rate will significantly decline which in turn increases the operation costs. With in-situ real-time monitoring technology, the probability of membrane fouling 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.

AI & AIoT Applications

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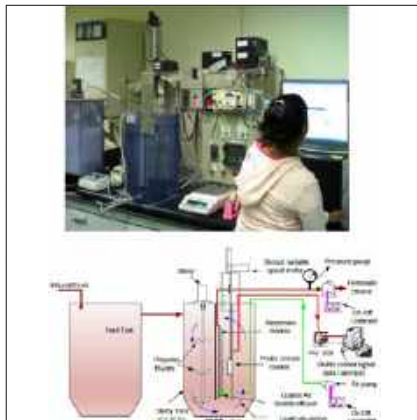
AI 2 Robot City

National Taiwan Normal University | Ting-Chia Hsu

Technical Introduction

"AI2 Robot City" is a game-based learning kit for primary and secondary school students, which combines AI image-recognition teaching tool of MIT App Inventor and the computational thinking board game named as "Robot City." Through this learning kit, users will learn to make smart cars, create image-recognition models, write and perform mobile application. Users will learn to write a program to recognize the personal cards in the board game, and furthermore to control the smart cars with blue-tooth and compete in the computational thinking board game.

Scientific Breakthrough

"AI 2 Robot City" provides the creatively original integration in the teaching and application of image recognition. Users can not only learn to interact with each other, but also gain new skills. This learning kit has the characteristics of computing thinking, AI education, and Maker. Compared with the computational thinking board games and coding robots on the market, this technique focuses on integrating interdisciplinary knowledge construction. In the future, "AI 2 Robot City" can also assist in the teaching field, and provide more intuitive and cohesive instructional material as a bridge between the Introduction of basic AI courses and advanced technology applications.

Industrial Applicability

"AI 2 Robot City" which combines AI image recognition, STEAM, and CT board games, provides good model of teaching materials for the education industry. It establishes introductory content for primary and secondary schools under game-based learning, allows students easier to learn interdisciplinary materials, and cultivates their AI concepts and practical skills. The learning kit is also extensible. Even for students with good capabilities or higher grades, there is still a diversified application space. AI 2 Robot City is highly in line with market needs, and provides the cohesive position for subsequent education.

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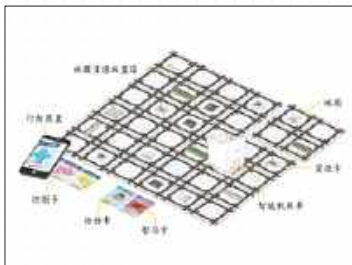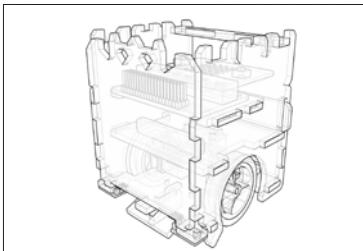
KarmaZone Strike Zone and 3D Markerless Motion Analysis System

National Taiwan University of Sport, National Taiwan University | Jyh-How Huang ; Yuh-Renn Wu

Technical Introduction

Six synchronized high-speed cameras were installed in the baseball stadium in NTUS. We established the calibration equation of the multi-camera system and established an electronic strike zone system, KarmaZone, that can automatically coordinates when the pitch crossed the home plate. From the slow motion videos recorded, the markerless 3D human posture estimation has been developed with the deep learning model. The estimated positions for each joint correlate well with ones after applying Particle Swarm Optimization.

Scientific Breakthrough

A baseball player's motion is captured by 6 high speed cameras and analyzed using deep learning models. We used YOLOv3, AlphaPose, k-means clustering, triangulation, and OpenCV to achieve the goal. Our goal is to run it real time during the game so both computation time and accuracy is very important. We use CNN to train and optimize multiple cameras in the baseball stadium. Using OpenCV to increase the quality of the border of the target object. For the points detected, we use k-means clustering to put them into several groups with different weights to increase the accuracy.

Industrial Applicability

We use high speed camera to construct electric strike zone to accurate strike/ball calls. The footage captured is also used for markerless motion analysis to improve the moving efficiencykinetic chain of the player. Along with the pitch-by-pitch scoring system, the KarmaZone system provides all the tools needed for Baseball Analyticstraining.

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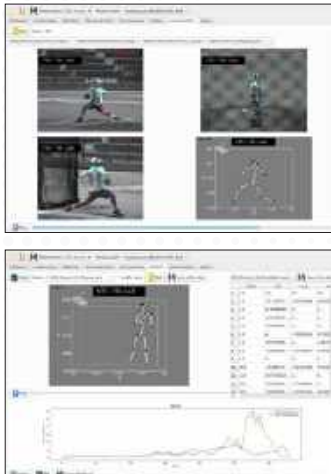
Air quality index (AQI) gas sensor service platform

Southern Taiwan University of Science and Technology | Prof. Yu-Zung Chiou/Prof. Chun-Kai Wang
National Cheng Kung University | Prof. Kuan Zong Fung/Dr. Shu-Yi Tsai
National Kaohsiung University of Science and Technology | Prof. Ting-Jen Hsueh

Technical Introduction

The platform included three inovation techniques, which the optical detection device for concentrations of nitrogen dioxide was designed. The module is fabricated based on the absorbtion of the wavelength of light from 400 nm to 550 nm by nitrogen dioxide. The detection range, resolution and sensitivity are related to design of light path. The light signals can be received by the photodetector convert to concentrations of nitrogen dioxide which transfer to computer or mobile immediately.
In addition, the all-solid sulfur dioxide gas sensor was developed by SSID team. The key technology is the special functionality of solid electrolyte and electrode materials, and then the layer material sequentially patterned design and planning. It can be used in high temperature and highly corrosive exhaust gas environment to achieve real-time monitoring of pollution emissions.
The final one is the NO_2 and SO_2 sensors developed and manufactured by Taiwan's strongest IC fabriaction technology and mass-produced vacuum coating technology. Therein, the 6"~8" MEMS technology service platform of TSRI was employed to develop the chip SO_2 and NO_2 gas sensors to improve reliability and productivity. Currently, more than 10,000 crystals can be fabricated in the area of 6 "wafers of 8cm*8cm, and the developed gas sensor module can detect up to ppb level.

Scientific breakthrough

1. The device used the optical method, and the internal band-pass photodetector and special light-path structure are developed. Compared with other benchmark companies, this device is superior to electrochemical products. For example, optical-type device has fast response time, higher detection accuracy, and no consumables are used.
2. All solid-state electrochemical SO_2 gas sensor can be employed to real-time monitoring under high temperature environment, and the sensor has characteristics of good sensitivity, response time and gas selectivity.
3. Using Taiwanese IC manufacturing technology to fabricate a high sensitive SO_2 and NO_2 MEMS gas sensor, and which combined the networking modules to achieve IoT functions.

Industrial Applicability

The air quality detection platform can supply to government, large enterprise, or special industrial areas for air quality monitoring, even use unmanned flying vehicle for checking the trace of gas pollution in real-time. In addition, we can set up more monitoring stations and build the visualization data map. Sulfur dioxide sensors are also used in many fields in industrial applications, including boiler combustion, freighter transportation, petrochemical and food processing industries, where the sensors are placed in harsh environments (e.g., high temperatures, high pressures, corrosive environments, high spatial velocity of exhausts, etc.). The sensor developed in this project can be integrated into mobile devices, such as mobile phones, to achieve "human-centered"environmental monitoring, which is to detect where we go. With above devices, the purpose of operational detection and smart safe living network can be achieved.

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FUTURE TECH, LEADING YOUR LIFE

Precision Health
Ecosystem

Antimicrobial peptide Epinecidin-1 promotes complete skin regeneration of methicillin-resistant Staphylococcus aureus-infected burn wounds in a swine model

Academia Sinica | Jyh-Yih Chen

Technical Introduction

Chronic wound infection is a leading cause of mortality in injured patients worldwide. At present, available systemic antibiotic treatments have an insufficient tissue penetration ability and allow the development of antibiotic-resistant pathogens. The identification of therapeutic agents with wound healing and antimicrobial functions is necessary to heal the wound and cure infections. Our report shows that the antimicrobial peptide (AMP) Epinecidin-1 (Epi-1) efficiently heals MRSA-infected heat burn injuries and provides protection from infection in mouse and pig model. Our results demonstrate that the biomaterial Epi-1 heals wounds through increasing epithelial cell proliferation, vascularization, and the formation of collagen and controls MRSA infection-mediated sepsis in pigs.

Scientific Breakthrough

1. We have demonstrated that epinecidin-1 exerts potent antimicrobial activity against methicillin-resistant Staphylococcus aureus (a MDR clinical isolate). The use of epinecidin-1 may complement the use of antibiotics. AMPs are unlikely to induce resistance. 2. Treatment with epinecidin-1 significantly reduces MRSA infection in pig model of wound infection compared to untreated controls and pig treated with conventional antibiotics. Given the prophylactic efficacy of Epi-1 and its inability to engender resistance, this AMP may be suitable for situations in which there is a high risk of infection. 3. Our model is valuable for future research on the pathophysiology of wound healing and testing new therapeutics for the treatment of bacterial infections during porcine wound healing.

Industrial Applicability

Our results demonstrated that the epinecidin-1 peptide promotes epithelial wound healing under in vitro conditions and effectively heals MRSA-infected wounds in a pig model. Application of epinecidin-1 can be in the area: 1. Anti-infective, wound healing 2. Acne catheter-related infections 3. Infections of diabetic foot ulcers 4. Oral candidiasis 5. Vulvo-vaginal candidiasis 6. Infectious complications of trauma and surgery 7. Anti-endotoxin and fungal infections 8. Systemic anti- pneumococcal infections

Contact | Jyh-Yih Chen / 03-9880544#15 / zoocjy@gate.sinica.edu.tw

Precision Health Ecosystem

Sub-nanometer gold sticker and methods for protecting against endotoxin-induced sepsis == Applied for the treatment of malignant wounds

National Health Research Institutes | Shu-Yi Lin / Investigator

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.

Precision Health Ecosystem

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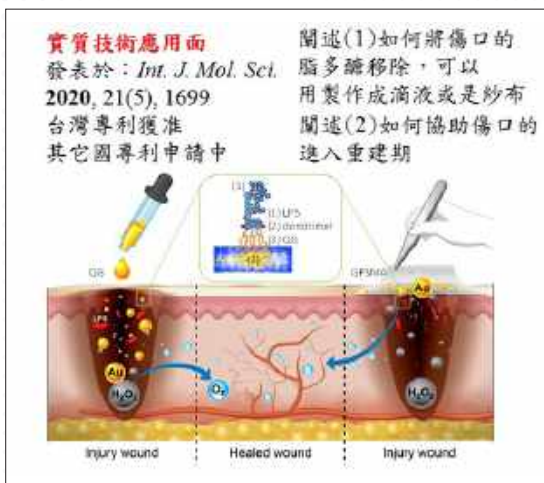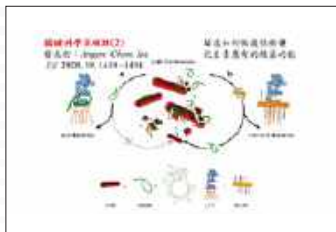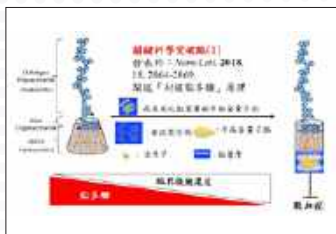
Dual application of Pt/Au nano-alloy electrode in neutral enzyme-free glucose detection and biofuel cell

National Chung Hsing University | Guo-Jen Wang; Chang-I Peng; Fang-Yu Lin; Wei-Jhen Wang; Tien-Fu Chu

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.

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. In the future, these two devices can be integrated together to form an autogenous power supply implantable continuous glucose sensor.

Industrial Applicability

The chip 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.

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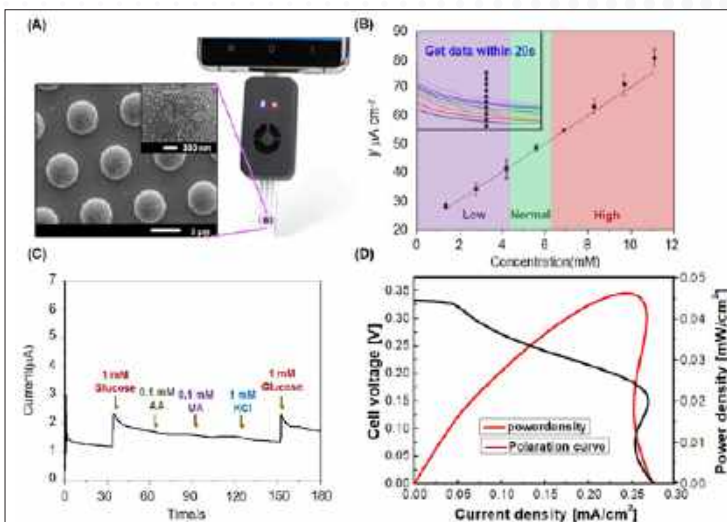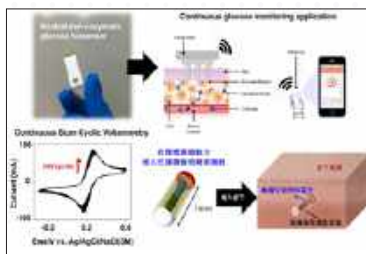
Wearable ultrasound device for diagnosis of sleep apnea

National Cheng Kung University, Catholic Cardinal Tien Hospital | Chih-Chung Huang; Jeng-Wen Chen

Technical Introduction

We developed a wearable ultrasound monitoring device to record the collapse of the tongue base in patients with obstructive sleep apnea (OSA) in the whole night, and completed clinical trials in the sleep center. The results showed that this device can effectively monitor tongue depth changes in OSA patients. The dynamic changes of the tongue can be integrated into commercial PSG systems, which will help clinical doctors to develop individualized treatment plan. The future application of our ultrasound system will be a new technique for the screening, diagnosis and treatment of OSA. Also, it has the potential to contribute to the Taiwan medical device industry.

Scientific Breakthrough

1. A customized wearable ultrasound transducer is developed for diagnosis of OSA.
2. The price advantage and the small size of the device are suitable for home or sleeping center bedside use.
3. The captured tongue deformation and elasticity information can be integrated into the PSG.
4. The image frame rate can be adjusted arbitrarily, which is beneficial to the back-end analysis and other advantages.
5. It can be used with negative pressure sleep apnea treatment device to help judge the treatment benefit.

Industrial Applicability

Current clinical medical ultrasound imaging systems cannot image the tongue base for long periods during sleep. This technology is based on our past foundation to develop a wearable ultrasound device to monitor tongue base deformation and elasticity overnight. This device can monitor without disturbing natural sleep and record long-term sleep for a long time, which is an epoch-making concept in sleep medicine. It can be said to consider the basic research of sleep and breathing physiology and the new medical device industry's commercialization value.
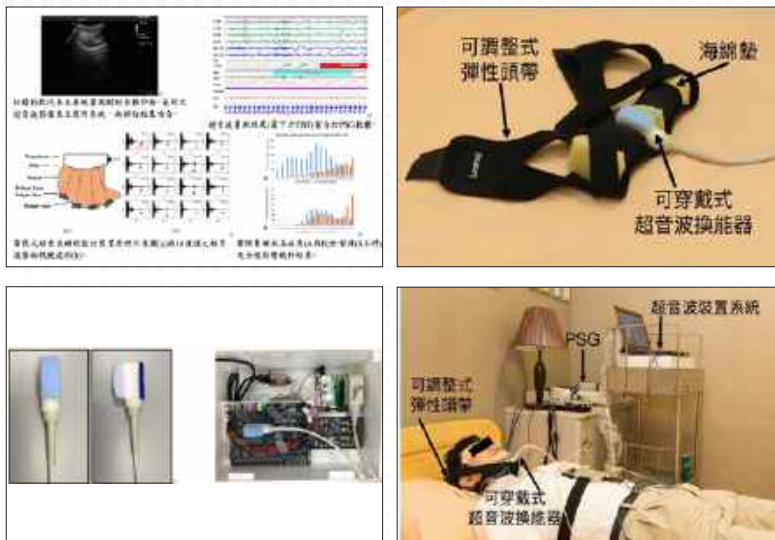
Precision Health Ecosystem

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

National Dong Hwa University, National Museum of Marine Biology and Aquarium, Kaohsiung Medical University, REALINN LIFE SCIENCE LIMITED, Medical and Pharmaceutical Industry Technology and Development Center | Han-Chieh Chao; Mei-Chin Lu; Shou-Ping Shih; Po-Shun Chen; Chii-Shiarng Chen; Fu-Wen Kuo; Yi-Chang Liu; Yu-Ming Hsu; Ying-Chi Du; Yu-Hsuan Lin

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.

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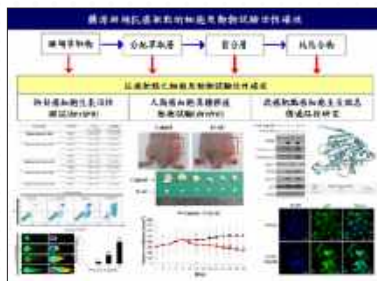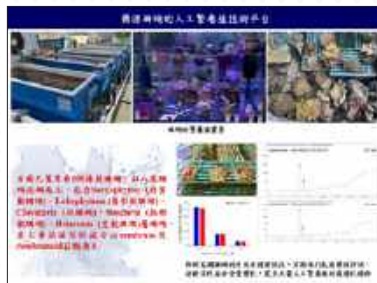
Influenza mucosal vaccine composition and preparation and application thereof

National Tsing Hua University | Suh-Chin Wu

Technical Introduction

Heat-labile enterotoxins are bacterial protein toxins, consisting of A and B subunits. The A subunit has the ADP-ribosylating activity, and the B-subunit pentamer is able to bind glycolipids on the surface of eukaryotic cells. The LT-based vaccine adjuvants used in previous studies are usually the LT holotoxins containing both A and B subunits or the pentamer of LT B subunit. This invenntion constructs a single fusion protein by conjugating the wild-type LT A subunit with an influenza virus antigen.

Scientific Breakthrough

Provided is an influenza mucosal vaccine composition and preparation and application thereof. This composition contains an antigen fusion protein which includes an influenza virus antigen and a Type IIb heat-labile enterotoxin A subunit. Immunization with the antigen fusion protein induces cellular and humoral immune responses, including systemic and mucosal immune responses, against a specific influenza virus in a subject, and thus protects the subject from viral infection.

Industrial Applicability

The market for seasonal influenza vaccines, sized at US$2.8 billion in 2008–2009 across the major markets, not including the potential of pandemic vaccines. The annual rate of influenza vaccine is approximately 12%. Our invention provides a mucosal vaccine composition for both humanpoultry vaccine markets. Our invention has already been granted for the patents in USTaiwan.

Precision Health Ecosystem

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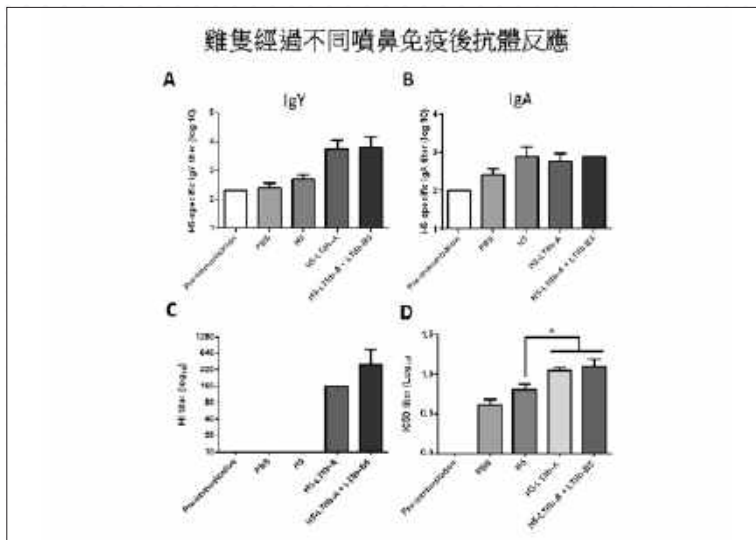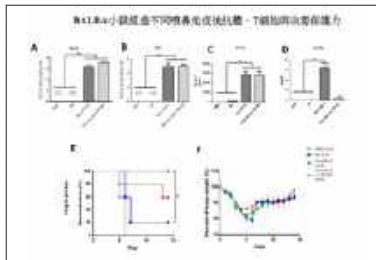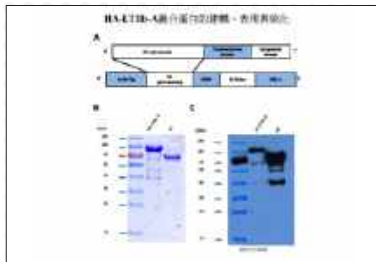
A Novel "Platform Technology" in Surgical Hemostasis

National Taiwan University | Dr. Abel Po-Hao Huang; Distinguished Professor Shan-Hui Hsu; Wen-Chi Feng; Hui-Chuan Yu; Chia-Shan Yeh; Yu-Hsuan Hsiao

Technical Introduction

"A novel "Platform Technology" in surgical hemostasis, based on biodegradable polyurethane particles with anti-inflammatory and nerve repair, not only accelerates wound healing but also provides solutions for hemostasis during surgery, and improve biocompatibility and adverse of commercially hemostats to achieve the best patient care. We are working on a personalized biosurgery platform for different diseases and moving toward constructive and regenerative surgical procedures.

Gelastop is the first application of platform in hemostatic agent with additional functions to surgeons, which shortens the operation time, reduces stay in the hospital, and decreases the chance of secondary surgery.

Scientific Breakthrough

The novel "Platform Technology" in surgical hemostasis is composited in degradable polyurethane particles and other polymers. It not only has hemostasis but also has wound healing, anti-inflammatory, anti-adhesion, and nerve repair potentials. According to product purposes, it is formulated in different proportions, such as hemostats and anti-adhesion barriers in surgical, dressings for diabetes and burn, or nerve repair products, providing multiple options for added value in surgical operations and wound care.

Industrial Applicability

The global wound care market is expected to expand from US$27.8 billion in 2019 to US$35 billion by 2025, and GRAS is 3.7%. In clinical medicine, wound care is not a disease, but in many cases, it will cause wounds, such as patients with general surgery, diabetes, and burns, etc., and wound care is required.

The novel "Platform Technology" in surgical hemostasis with multiple values could be able to produce different forms of products (such as gel, film, or foam) for different functional requirements and product markets. It will be used in hemostats, anti-adhesion, high-end dressing, or nerve repair products for surgical operations, burns, and traumatic wounds or nerve injuries to provide better care and life for patients.

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Infectious Disease Diagnosis and Water Quality Monitoring Using Nanomaterials Immobilized Paper and a Flow Controllable Microfluidic Device

National Taiwan University | Prof. Chien-Fu Chen

Technical Introduction

Here we present a portable microfluidic device that can perform immunoassay for infectious disease diagnosis or detect heavy metal ions in water samples. The device is composed of two major components: nanomaterials modified paper-based detection platform and semi-automated flow manipulator. A reusable 3D-printed device is used to hold a disposable detection pad that modified with functional nanomaterials for water quality monitoring or antibodies for disease diagnosis. Besides, the use of spring-containing 3D-printed syringes manipulates a large-volume sample without manual actuation. Meanwhile, by controlling the flow rate via the linked flow regulator at the syringe outlet, solutions can react stably with the paper platform, which provides detection and pre-concentration effects.

Scientific Breakthrough

Numerous effective techniques had been developed for infectious disease diagnosis or heavy metal ions detection in water samples. However, these methods are either time-consuming, costly or require sophisticated instruments and technicians. Here we present a portable microfluidic device that can perform immunoassay for infectious disease diagnosis or detect heavy metal ions in water samples. A reusable 3D-printed device is used to hold a disposable detection pad that modified with functional nanomaterials for water quality monitoring or antibodies for disease diagnosis. Besides, the use of spring-containing 3D-printed syringes manipulates a large-volume sample without manual actuation. Also, a flow regulator is linked to the syringe outlet to provide a steady flow rate.

Industrial Applicability

Here we present a portable microfluidic device that can perform immunoassay for infectious disease diagnosis or detect heavy metal ions in water samples. To provide versability for various applications, a reusable 3D-printed device is used to hold a disposable detection pad that modified with functional nanomaterials for water quality monitoring or antibodies for disease diagnosis. We expected these techniques can be widely used for the applications of personalized medicine, precision medicine, and environmental water quality monitoring.
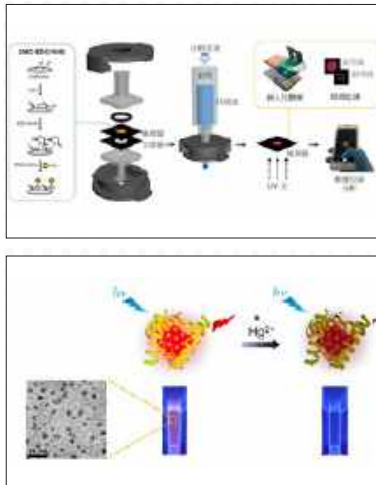
A composite ultrasound medical device for microbubble vaccines and the sputtering lysozyme microbubble for trachea therapy

National Taiwan University of Science and Technology | Ai-Ho Liao; Chih-Hung Wang; Cheng-Ping Shih; Yueng-Hsiang Chu

Technical Introduction

2018 Taiwan Innovation Award (two awards), our present invention firstly provides a new multifunctional microbubble (MB) which can be applied to a topical region of the body surface of organisms by applying, instead of using injection. We firstly provide a universal theranostic MB which can be applied to a topical region of the body surface or injected into the vessel for systemic treatment. This universal theranostic MB could be widely used in head and neck disease, to help strengthen the absorption of drugs. Some interesting topics have been explored: 1. US-aided MBs facilitate the delivery of drugs to the inner ear via the transcanal method, 2. drug-carrying modified MB combine with a new designed device to connect to US system for the application of hair growth promotion and clinical trial, and 3. US combined cisplatin loaded MBs to enhance tumor therapy and reduce the side effects. This invention is further designed as a composite medical device for MBs vaccines and pulmonary therapy.

Scientific Breakthrough

TIn December 2019, a novel Coronavirus disease 2019 (COVID-19) has spread globally. It causes clusters of severe pneumonia, evolving into respiratory failure and
death through bilateral pulmonary involvement. Recent works in the literature have highlighted the possibility that a transthoracic or contrast enhanced ultrasound (US) examination of the viral pneumonia.Our previous invention firstly provides a new multifunctional MB which can be applied to a topical region of the body surface of organisms by applying or sputtering, instead of using injection. To prevent COVID-19 further spread of infection, it is necessary to develop a viable, safe and non-invasive delivery platform for vaccines with potential use in a primary care setting or personalized self-vaccination at home is necessary. US has been previously shown to enable skin permeabilisation for transdermal drug and vaccine delivery. Our multifunctional MBs could be conjugated with RNA or therapeutic antibody to enhance US mediated vaccine delivery. Moreover, the preliminary results also investigated the feasibility of the drug loaded multifunctional MBs for theranostic applications inhalation on airway diseases.

Industrial Applicability

Our present invention firstly provides a new ultrasound-microbubble needle free injection system and the external type microbubble (MB) which can be applied to a topical region of the body surface of organisms by applying, instead of using injection. This external type MB can be conjugated with RNA for ultrasound mediated RNA vaccine delivery. The MB also can be widely used in medical or beauty fields, to help strengthen the absorption of painkillers after surgery or the absorption of beauty care ingredients. MBs also can be a drug carrier for inflammatory disease that affects the airways.

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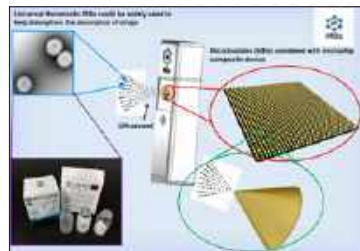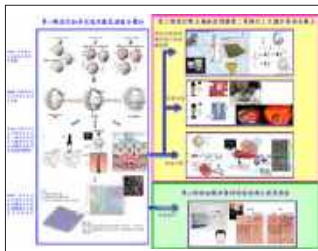
Using Herbmedotcin technology to solve the antibiotic abuse problem

National Taiwan Ocean University, National Taiwan University | Han-Jia Lin; Chih-Ching Huang; Han-You Lin

Technical Introduction

The "Herbmedotcin" technology platform is a major breakthrough in the several thousand years history of herbal medicine knowledge. Use patented technology to find potential natural functional molecules, with appropriate additives and optimal processing conditions, to achieve a significant increase in their efficacy. This technology is also known as "molecular herbology". They have high efficiency comparable to small molecule drugs, but still retain the mild and safe properties of natural herbs. It has been confirmed by large-scale field trials that it is the best solution to replace antibiotics in farmed livestock.

Scientific Breakthrough

The "Herbmedotcin" technology has opened up a whole new field of therapeutic charcoal materials. With the selection of materials, matching of appropriate additives and the most suitable processing method, it can concentrate natural bioactive ingredients on the surface of tiny carbon particles. It produce materials with enhanced antibacterial ability, while maintain their mild and non-toxic properties. We mastered this technology and published 80% of scientific papers in this new field. In addition, this technology has also been commercialized and used to replace animal antibiotics in aquaculture farms already. Scientific evidence indicate that products with Herbmedotcin inside can improve animal intestinal health, increase survival and growth rate. Solve the problem of antibiotic abuse.

Industrial Applicability

The "Herbmedotcin" technology is applied to develop "food grade" antibacterial and antiviral agents, which are not only safe for humans/animals but also has extremely high efficacy. Our products are the best animal antibiotic alternatives on the market. This technology has been licensed and commercialized. Many products, which are actually sold in aquaculture, livestock, and cosmetics industries, are using "Herbmedotcin" now. Especially in the aquaculture industry, these products actually help farmers increase total harvest and solve the antibiotic abuse problem.

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Novel Therapy for Critical Limb Ischemia

National Cheng Kung University | Distinguished Professor Lynn L.H. Huang

Technical Introduction

Grace-001" is the first regenerative drug in the world to fulfill an unmet clinical need for treating critical limb ischemia (CLI) effectively. This novel therapy evolved from three core technologies of regenerative medicine, embedding drugs in biomaterial carriers, and a regeneration-deficient animal model with severe hind limb ischemia. Grace-001 can promote neovascularization, neonervation, tissue regeneration and restore blood flow as well as tissue functions. This new drug Grace-001 can effectively retain patients' non-necrotic tissues and prevent limbs with severe ischemia from amputation. This new drug not only saves patients' limbs and lives but also rescues economics and heavy burden on national health care.

Scientific Breakthrough

This case is the first new concept of a novel regenerative drug in the world. Using FDA-approved small molecular drugs and biomaterials to develop a new specialty drug product "Grace-001", it can therefore follow the regulatory path of 505(b)(2) and is safe to be applied to human. Besides, a harsh assessment platform of a regeneration-deficient murine model with severe ischemic hindlimb proves the success of Grace-001 for ischemic treatments. We have broken through the bottleneck of the existing technologies and have evaluated the efficacy of the drug stringently. We should have avoided the problem of global failure rate of more than 86% from animal to human trials during drug development by incorporating more stringent evaluation of drugs' efficacy.

Industrial Applicability

The new drug product "Grace-001" fulfills an unmet clinical need for treating critical limb ischemia. As it comprises a series of FDA-approved ingredients, its approval can be achieved under the 505(b)(2) regulatory pathway and applied to human through a Fast-tract Act. Grace-001 can greatly reduce costs, risk and time to the markets, making it highly advantageous over its competitive therapies such as stem cell therapy and gene therapy. Because of that, it does save trial funds, improve success rate, enhance product competitiveness, and facilitate the development and promotion to industry and commerce. There are more than 8.9 million CLI patients at an annual growth rate of 4.6% in 8 advanced countries. The therapeutic market was worth USD 3.1 billion by 2018.

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First-in-class anti-diabetic drug, PS1
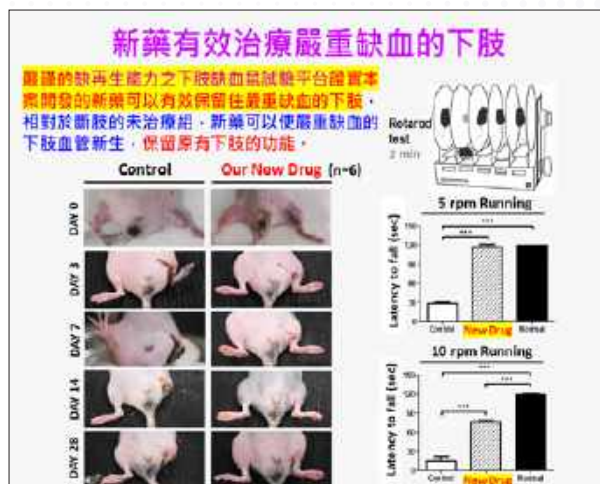
Academia Sinica | Tien-Fen Kuo; Tzung-Yan Chen; Greta Yang; Wei-Jan Huang; Keng-Chang Tsai; Wen-Chin Yang

Technical Introduction

Diabetes is now still an incurable disease. Beta cell failure is one of common causes. No prescription drugs for this failure have been developed. This invention is to develop and apply PS1 to treat and reverse diabetes. PS1 is a first-in-class small-molecule drug, which targets beta cells by improving their survival and function. As a result, PS1 can treat and reverse diabetes. The anti-diabetic mechanism of PS1 involves novel anti-diabetic modes of action, such as reduced oxidative stress, reduced cell death, and increased insulin expression.

Scientific Breakthrough

We identified a novel anti-diabetic protein target in beta cells. This protein negatively regulates beta cell pathogenesis and diabetes. On the other hand, PS1, an inhibitor of this target, can treat and reverse diabetes via maintenance of beta cell mass and function involving oxidative stress. PS1 is a first-in-class small-molecule drug with unique anti-diabetic mechanism. PS1 also has both academic value and industrial application.

Industrial Applicability

Diabetes is a disease implicated in different pathways in several organs. Despite tens of anti-diabetic drugs, diabetes is still incurable. PS1 is a small molecule drug that maintains beta cell survival and function. It can be used to treat and cure patients with slight and modest diabetes alone and in combination with other drugs. Compared to GLP1/DDP inhibitors, PS1 is a first-in-class drug that target a new pathways for diabetes. PS1 is valued at 12.5 billion US dollars.

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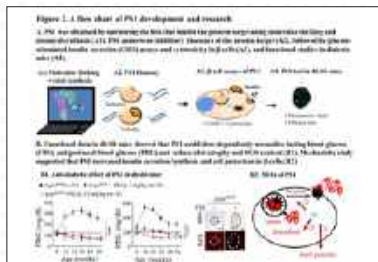
Figure 3. Milestones of PS1

This project has been sponsored by Taiwanese MOST. We are under way to complete preclinical trial of PS1 in order to file its IND application. The data on CMC, GLP toxicity, and PK are ongoing. PD data was done. After its IDN is approved, a spin-off company, Pharmasaga, will take over and continue the clinical trial of PS1.

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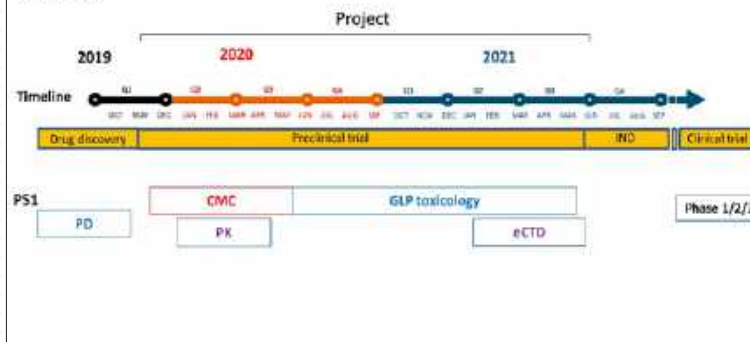
Intelligent Scalp Detection System

Southern Taiwan University of Science and Technology | Wan-Jung Chang; Jian-Ping Su; Chia-Hao Hsu; Yi-Chan Chiu; Ming-Che Chen

Technical Introduction

This system uses the innovative AIoT application to target annoying scalp maintenance problemsdevelops an intelligent scalp detectionmanagement system. The core of the technology is to use deep learning-based object detection models. Tens of thousands of microscopic image data sets that are labeledtrained for scalp symptoms. As a result, the scalp image recognition module is develop, such as dandruff, hair loss, oil, and inflammation, etc. Hence this system can provide scalp detection, and maintenance effectiveness tracking functions lead scalp maintenance services to a new level of intelligent management.

Scientific Breakthrough

The scientific breakthrough of this system is described in 3 parts as follows: 1. Different from similar systems on the market that uses image processing technology as the core only fixednon-symptomatic characterization test items. 2. At present, this system creates the industry's unique scalp symptom microscopic feature object image data set. 3. This work can be used as an example of cross-domain intelligent networking application R&D engineering, primarily through the joint research and development of cross-field experts in AI scalp symptom interpretation technology.

Industrial Applicability

-It reduces the high cost and time of education and training for scalp hair physiotherapists. -It reduces the mistakes and inconsistent judgments of different human interpreters. -It provides an automatic and highly accurate AI-based recognition method whereby people can know their current status of scalp hair health problems. -The diagnosis result from each scalp hair inspection can be sent to an online cloud-based management platform, which can help related enterprises (such as scalp hair therapy and beauty salons) track the progress of scalp hair care, treatments, and customer therapies. -It maintains cloud-based scalp hair records for customers, helping scalp hair physiotherapist regularly track and analyze the scalp hair health status their customers.

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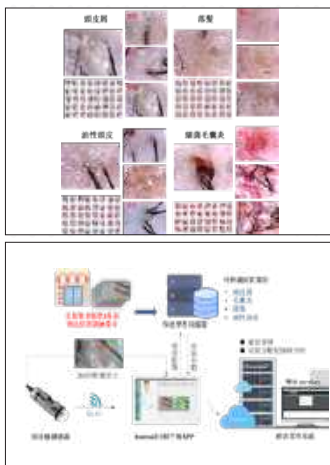
BPRSJ338: Therapeutic Applications for COVID-19

National Health Research Institutes | Shiow-Ju Lee; Cheng-Wei Yang; Yue-Zhi Lee; Yu-Sheng Chao

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.

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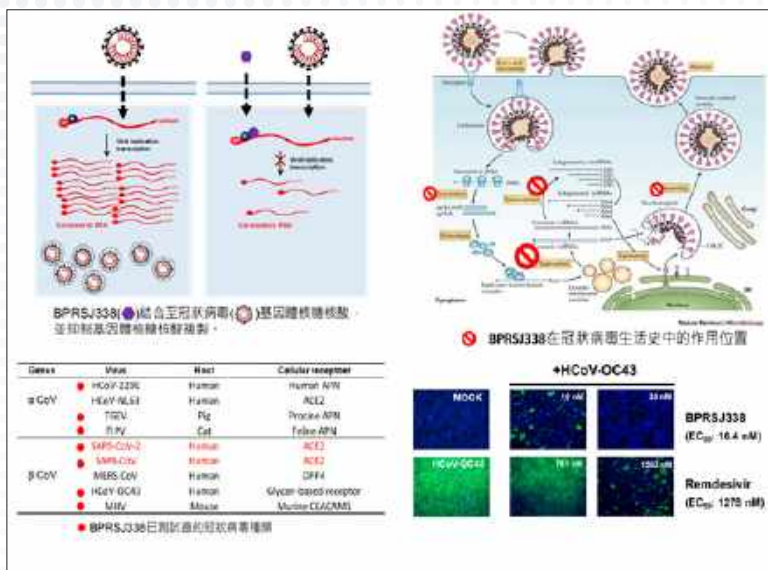
DBPR807: a CXCR4-Targeted Antagonist

National Health Research Institutes / National Tsing Hua University, Institute of Biomedical Engineering |
Kak-Shan Shia; Yunching Chen

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 therapeutic strategy and may also have a great impact on other advanced cancers of high metastatic incidences.
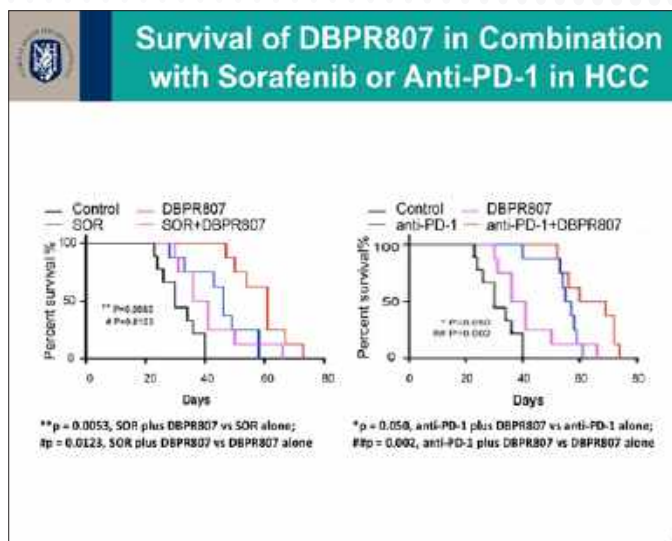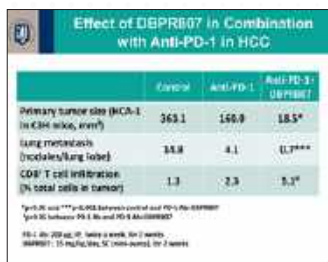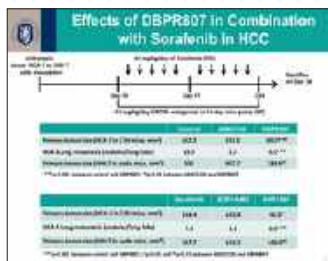
A Kinase Inhibitor that Induces Degradation of MYC Oncoprotein

National Health Research Institutes | Ya-Hui Chi; Teng-Kuang Yeh; Chiung-Tong Chen; Chun-Ping Chang; Yi-Yu Ke; Chuan Shih

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.

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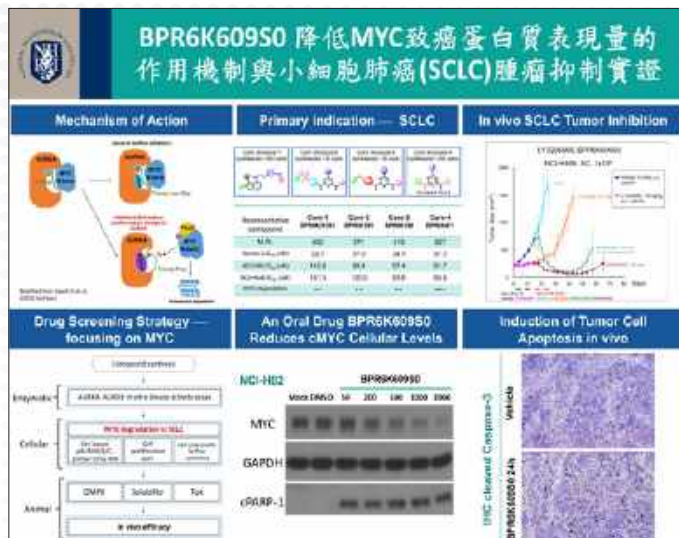
The establishment of National Biobank Consortium of Taiwan (NBCT)

National Health Research Institutes | Huey-Kang Sytwu, Vice President

Technical Introduction

This project will establish a National biobank consortium of Taiwan through the fund support from the government. The National Health Research Institutes will establish a Central Office for the collaboration works, which includes collecting the number of samples of the human biological database in each biobank that agreed to join the Consortium. All Alliance need to follow the same SOP for the collection process and the quality of the biosample. Adequate and consistent clinical data will also be established under the Information Security Management Treaty. Since the contents of the biobanks from different institute are quite different, we will be able to quickly establish a large and comprehensive biobank network. In line with the needs of biotechnology pharmaceutical, artificial intelligence, auxiliary medical and other industries.

Scientific Breakthrough

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 biobands to join and the total research participants is more than 310 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.

Industrial Applicability

Since the contents of the biobanks from different institute are quite different, we will be able to quickly establish a large and comprehensive biobank network.Once this huge and comprehensive biomedical big data network research is completely established, which will be fit with the needs of not only the academic reserchers, but also biotechnology pharmaceutical, artificial intelligence, auxiliary medical and other industries.

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Heterocyclic compounds and use thereof

National Health Research Institutes | Shau-Hua Ueng; Shiu-Hwa Yeh; Po-Kuan Chao; Chuan Shih

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.
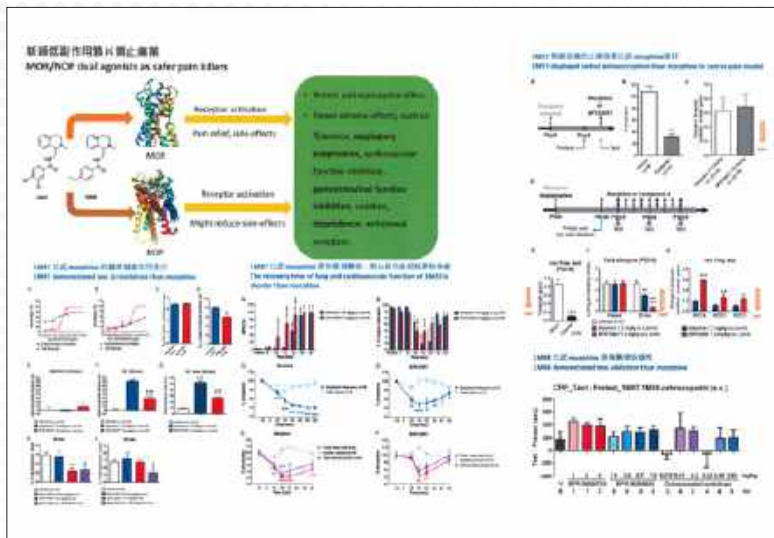
Low-dose nanoscale biomimetic cell structure – Next-generation platform technology for advanced precision immunotherapy

National Chiao Tung University, China Medical University Hospital | San-Yuan Chen; Long-Bin Jeng; Woei-Cheang Shyu; Chih-Sheng Chiang

Technical Introduction

We developed a biomimetic triple-antibody-immobilized magnetic fucoidan nanomedicine as a multifunctional artificial antigen presenting cell, which possessed the ability to not only inhibit immune checkpoint but activate tumor infiltrated T cells. In contrast to the complex cell expansion process using microbeads in adoptive cell therapy, the nanoplatform can be i.v. administrated to shorten the course of therapy from several weeks to days. With the development of the platform technology, an artificial immune system family can be built to pave the way for personalized immunotherapy.

Scientific Breakthrough

The nanosystem provides breakthrough in the following aspects:
1). Inherently therapeutic nanostructure for immunomodulation; 2). Integrating multiple mechanism of actions in a single system for synergistic immunotherapy; 3). The surface antibody can be changed easily to treat different indications for precision therapy; 4). Potentially increasing the quality of life for patients by substantially shortening the course of treatment; 5). Magnetic navigation for localized immunotherapy.

Industrial Applicability

The disclosed nanoscale multifunctional artificial antigen presenting cells (nMa-APC) that simultaneously targets various mechanism of actions can boost the anticancer immune responses. Compared with checkpoint immunotherapy, nMa-APC offers not only brake release of immune system but T cell expansion to augment therapeutic efficacy. Moreover, the substantially reduced course of treatment from several weeks to days indicates the superiority of nMa-APC to adoptive cell therapy. As the revenues of OPDIVO® listed 7,200 million at 2019, nMa-APC is expected to penetrate the market with respectable potential. Additionally, the platform technology allows the efficient establishment of pipelines to achieve artificial immune system, making personalized immunotherapy in the foreseeable future.

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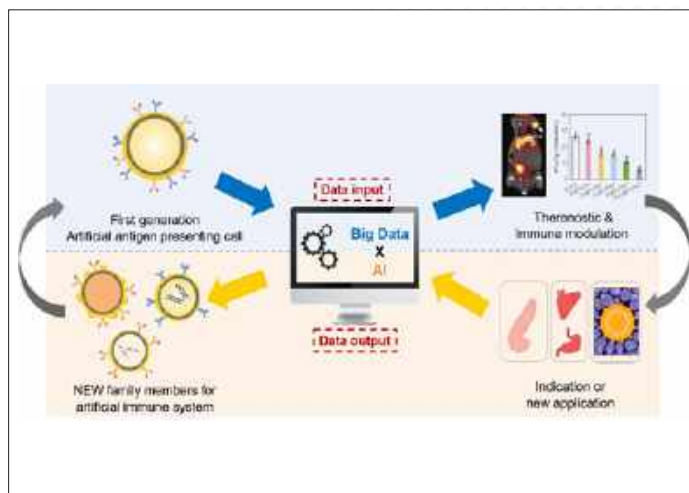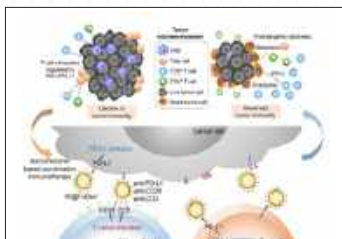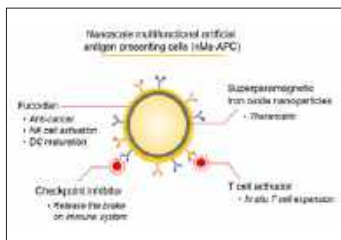
A High Frequency Ventilator and Electrical Impedance Tomography for Respiratory Treatment

National Chiao Tung University | Yu-Te Liao; Shao-Yung Lu; I-Te Lin; Siang-Sin Shan; Wei-Cheng Liu; Mou-Wei Chang

Technical Introduction

The high-frequency jet ventilator uses the solenoid valve and feedback techniques to control the operational parameters of the ventilator. The proposed dual-mode control mechanism allows dynamic adjustment of the tidal volume, pressure, and duration of ventilation simultaneously. The system has been verified in animal experiments and demonstrated a significant improvement in the gas exchange efficiency. Besides, the bioelectrical impedance measurement can provide real-time and accurate regional information of the lungs, which helps to monitor the patient's condition during respiratory treatment. This work also adopts wireless communication and remote-control technology to reduce the risk of infection of medical professionals.

Scientific Breakthrough

Compared with traditional positive pressure ventilator, the high-frequency ventilator can achieve better gas exchange rates in specific lung conditions without pressure-caused damages to the lungs. Due to the small tidal volume and the treatment method without intubation, the high-frequency ventilator system is more suitable for portable treatment and emergent conditions. This technology provides real-time and accurate regional information in the lungs through bio-impedance measurement that helps to adjust parameters of the ventilator to achieve optimal ventilation efficiency.

Industrial Applicability

More than 50-million people rely on a ventilator for sustaining their lives. About 10% of the patients suffer from lung damages or complications due to operation mistakes in the treatment. High-frequency jet ventilator has advantages in (1) small tidal volume, (2) low intrathoracic pressure, (3) small size, and (4) medium alveolar expansion. The low-tidal volume and pressure can reduce the chances of complications during respiratory treatment. Electrical impedance tomography provides a noninvasive and radiation-free method to observe lung contraction information in real-time. Besides, this method can monitor food spoilage, noninvasive tumor detection, and mechanical structure detection.

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Cisd2 activators: Novel therapeutics for non-alcoholic fatty liver diseases (NAFLD) and steatohepatitis (NASH)

National Yang-Ming University, National Health Research Institutes | Prof. Ting-Fen Tsai; Dr. Jinq-Chyi Lee; Prof. Chao-Hsiung Lin; Dr. Shiu-Feng Kathy Huang; Dr. Zhao-Qing Shen

Technical Introduction

Our previous studies suggested that increase Cisd2 levels may attenuate the pathogenesis of NAFLD/NASH. Accordingly, potent Cisd2 activators with the capacity to enhance Cisd2 levels were identified through the screening of skeletally diverse collections and structural optimization. So far BPRCD0001S0 is the most potent Cisd2 activator obtained, which has been studied extensively. Data obtained revealed that BPRCD0001S0 has no detectable toxicity in vivo, can activate Cisd2 in liver and ameliorate obese-related and fructose-induced NAFLD/NASH.

Scientific Breakthrough

The work of discovery of Cisd2 activators targeting NAFLD/NASH is entirely based on the original findings of our team and therefore, is highly innovative. The identified Cisd2 activator has no detectable toxicity in vivo, can activate Cisd2 in liver and ameliorate obese-related and fructose-induced NAFLD/NASH. Our results revealed that the beneficial effects are mainly dependent on a molecular mechanism/pathway involving Cisd2.

Industrial Applicability

NAFLD and its more severe form NASH are a significant threat to global health. Currently no approved therapies specifically for NAFLD or NASH; therefore, the need to find appropriate therapeutics is urgent. In view of the efficacy and safety observed, the development of highly innovative Cisd2 activators may offer a glimmer of hope for patients with NAFLD/NASH. The potential market for NASH medications is forecast to be as large as USD 35 billion per year. We believe that Cisd2 activators will have a place in the field of NAFLD/NASH because of their uniqueness, novelty, and necessity.

Precision Health Ecosystem

Figure 3. BPRCD0001S0 attenuates obese-related NASH and alleviates fructose-induced glucose intolerance, insulin resistance and ameliorates NASH in a Cisd2-dependent manner. (A) CISD2 activators ameliorate fatty liver. (B) For the genetic obese-related NASH, 2-mo old db/db (JAX 000642) mice were treated with BPRCD0001S0 (20 mg/kg/day provided in food) for 3 months and sacrificed at 5-mo old. (C) H&E staining of livers reveals that BPRCD0001S0 can rescue the obese-related NASH in db/db mice. (D) For the fructose-induced NASH, 2-mo old WT and Cisd2 hKO mice are treated with BPRCD0001S0 (20 mg/kg/day provided in food) for 5 months and sacrificed at 8-mo old. The glucose tolerance test (GTT) and insulin tolerance test (ITT) assays were performed at 7-mo old. (E) and (F) The GTT (D) and ITT (E) assays for WT and Cisd2 hKO mice treated with Veh or BPRCD0001S0 for 6 months at 7-mo old. (G) H&E staining of livers reveals that BPRCD0001S0 can attenuate the fructose-induced NASH in WT mice. However, BPRCD0001S0 has no obvious beneficial effect when Cisd2 is absent in the hepatocyte-specific Cisd2 knockout (Cisd2 hKO) mice. Vehicle, 0.5% Dimethylacetamide and 0.5% Cremophor EL. *p<0.05; **p<0.005.

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Harmoscope

National Taiwan University | Chi-Kuang Sun

Technical Introduction

Harmoscope is a virtual biopsy technology for dermatology. The superior performances of in vivo Harmoscope has been clinically validated by NTU hospital for 14 years, with the deepest penetration, super-resolution, and the highest contrast all at the same time. Without imaging processing and labeling, Harmoscope raw images provide the same level of resolution and information as the time-consuming gold standard H&E histopathology, allowing dermatologists and pathologists to grade and classify various skin lesions for immediate therapeutic decision without physical biopsy. This award-winning technology will release the saturated loading of skin biopsy examination, greatly improve the quality of point of care, while providing a trauma-free real-time alternative for skin lesion patients.

Scientific Breakthrough

Optical virtual biopsy aims to provide the same dual H&E contrast and image resolution as the invasive histopathology. Utilizing the endogenous second harmonic generation and third harmonic generation signals of skin tissues to generate dual contrasts, harmonic generation microscopy is the only technology invention capable of providing the same dual color contrast and super-spatial resolution as the physical biopsy while highest penetration and lowest laser energy deposition can both be achieved in human skin all at the same time. With no need of any extensive optical signal processing, different from OCT, FFOCT and RCM, the innovative Harmoscope provides 3D ultrahigh resolution virtual images through virtual transition processes, thus surpassing all other state-of-the-art technologies.

Industrial Applicability

1 out of 5 Americans suffer from skin cancer and it takes 2-3 months to see a dermatology doctor. A more time-saving way is needed. Harmoscope is dedicated to solve the time consuming and labor-intensive issue of the dermatological histopathology. It has been clinically proven that with Harmoscope the one-week pathological biopsy process can be reduced to within half an hour, thus significantly reducing the labor requirements of inspectors and the waiting time of patient, while reducing the cost per diagnosis. Further more, the trauma-free Harmoscope is not only an attractive alternative for patients but is suitable for sensitive skin and multiple lesion diagnosis, aesthetic medicine, as well as the emerging chronic pain market.

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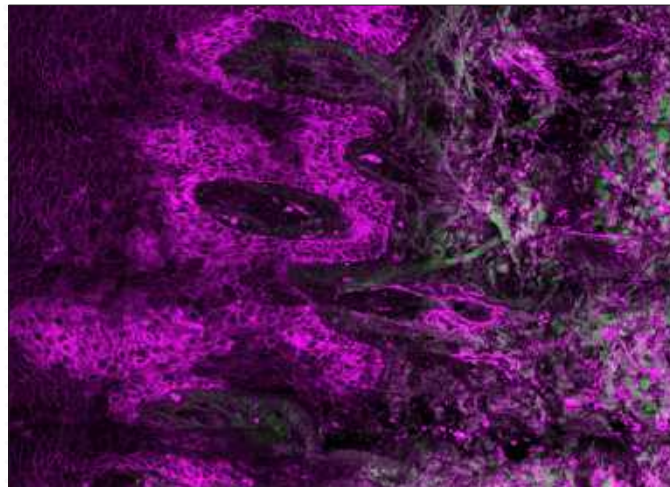
Precision blood test for detection of breast cancer

Taipei Medical University, Taipei Medical University, Taipei Medical University | Lin, Ruo-Kai; Hung, Chin-Sheng; Wang, Sheng-Chao

Technical Introduction

EPICAn is a novel technique that uses liquid biopsy for epigenetic analysis. Using methylation-specific PCR to analyze genes 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 continuous detection 6. Monitoring cancer changes 7. Aided diagnosis 8. Automated process 9. Easy-to-operate 10. Rapid analysis. We expect it can increase the accuracy of early detection of breast cancer and aid clinicians' diagnosis.

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%, specificity 93%, AUC is 0.930, the accuracy is 93%. And it can be used to detect early breast cancer. Combined with current imaging examinations to improve the accuracy of early diagnosis.

Industrial Applicability

According to the report, the Global Breast Cancer Screening Market is anticipated to reach US$ 51.8 billion by the end of the year 2026, with double-digit CAGR during the forecast period. The previous study reveals that is about 75 million women undergo breast cancer screening each year. The market of EPICAn technique is expected to reach US$ 22.5 billion. EPICAn technique will be commercialized as a detection kit to enter international markets. We will authorize the GMP reagent manufacturer to produce EPICAn detection kit and collaborate with LDTS labs in providing detection services to earn for operating at first, then sell the kit by agents.

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Real time wireless diagnostic system

Chang Gung Medical Foundation | Dr. Chien-Hung Liao; Dr. Don-Ru Ho

Technical Introduction

PressureDOT team will develop the first intra-abdominal pressure monitoring and localization micro internet device of things, to integrate into critical care vital sign monitoring system and take care of the critical patients. This will ensure our role in the market and set up market barrier in this type of medical devices.

With this platform, we can collect the continuous physical signal from critical patients who need the most closely monitoring in their status. By the assistance of the Data-driven algorithm, we can help the clinical physician take the proper action with the support of medical artificial intelligence.

Scientific Breakthrough

The world's smallest wireless intra-abdominal pressure sensing capsule (D <10 mm, H <15 mm) can continuously measure intra-abdominal pressure (error <±0.1 mmHg). The capsule adopts advanced packaging technology and is designed with a high-efficiency antenna suitable for the body, and transmits signals with extremely low acceleration. The external system receiver system uses a special antenna array to track the capsule position and gastrointestinal motility speed in real time.

Industrial Applicability

2020 is the most important year for the development of remote digital health system, and now it is necessary to find the correct direction of healthcare in the next decade. The possibility of telemedicine lies in the creation of the first equipment to implement the remote critical monitoring. Because PressureDOT is aimed at the irreplaceability of special patient groups, it just happens to be the stepping stone for digital critical care and be the first product of a continuous wireless detection system. It combines the electronics industry, Internet of Things, medical industry and information industry to create a digital health ecosystem.

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

National Health Research Institutes | Chao A. Hsiung Distinguished Investigator

Technical Introduction

This project aims to incorporate the state-of-the-art Information 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 administrative process, to realize the idea of Aging in Place emphasized in the Long-term Care Policy 2.0 in Taiwan.

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 person-centered 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.

Industrial Applicability

1. Establish local person-centered health database to fulfill subject-oriented health care services in multi-tier intervention care models by the Long-term Care Policy 2.0 in Taiwan. 2. Linkage of multi-tier ABC services to optimize care delivery. 3. Facilitate communication between different care givers and professions to improve care efficiency. 4. Develop periodic statistical reports for performance- assessment of long-term care services.

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Digital self-injection-locked ultrasonic Doppler radar for accurate non-contact vital sign monitoring

National Sun Yat-Sen University | Tzyy-Sheng Horng

Technical Introduction

A highly sensitive and linear ultrasonic radar was realized using digital self-injection-locking (SIL) technique. It can remotely monitor the vital signs of a human in motion, which will be demonstrated in this expo by upgrading a low-cost ultrasonic radar for reverse parking to support high-value telemedical applications. In the future it will further combine phased-array technology to implement non-contact 4D ultrasound system, which will bring disruptive innovation to medical technologies.

Scientific Breakthrough

The present self-injection-locked (SIL) radars use the centimeter-wave signal because it must operate under the condition that the range of physical or physiological movements is much less than the wavelength to avoid the nonlinear distortion phenomenon. This invention resolves the nonlinear distortion problem by digitalizing the SIL mechanism and has been successfully applied to the SIL radar using a millimeter ultrasonic wave. The breakthroughs are: 1) The SIL mechanism was digitalized for the first time to make Doppler sensing technology no longer limited by the signal wavelength. 2) The all-digital Doppler radar was realized for the first time for non-contact monitoring of vital signs. 3) The ultrasonic radar was realized for the first time for non-contact monitoring of vital signs.

Industrial Applicability

The embodiment of this invention implements an ultrasonic Doppler radar using digital self-injection-locking (SIL) technique to remotely monitor the vital signs of a human in motion. The invention can be now used in medical and healthcare industries for the vital sign monitoring, life detection, and medical ultrasound applications. In the future, the invention will combine phased-array technology to realize a 4D ultrasound system that can observe the interior of the human body without contact.

Fig. 1 System architecture of digital self-injection-locked ultrasonic radar

Fig. 2 Prototype radar system on an FPGA board

Fig. 3 Chest movement detected by radar for correlation with PPG signal

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Rapid Detection of AIoT Platform for Food Safety and Epidemic Prevention

National Central University | Chen-Han Huang, Hsing Ying Lin

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 anti non-specific binding effect, and successfully increase the accuracy of biosensor system. 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 anti 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.

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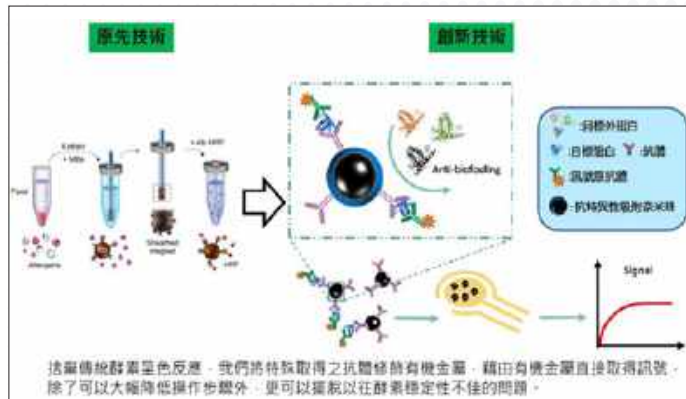
Combining Augmented Reality and Remote Real-time Notification Intelligent Bed Exit Alarm System for Predicting Elderly Falling

National Cheng Kung University | Prof. Chih-Lung Lin; Dr. Chou-Ching Lin; Prof. Chien-Hsu Chen; Prof. Peng-Ting Chen; Dr. Pi-Shan Sung; Zong-Lin Yang; Po-Ting Lee; Wen-Ching Chiu; Meng-Hsuan Wu; Sung-Chun Chen; Wen-Yen Shieh

Technical Introduction

With the rapid growth of the aging population, the safety of the hospitalized elderly has become an important issue. Therefore, our team proposes an innovative bed-exit alarm system using multiple sensors for bed-exit detection. With data fusion, IoT, and AI technologies, the system can achieve early detection and significantly reduce false alarms. In addition, it can realize real-time video streaming with AR display, which facilitates the remote care for the elderly and provides qualified medical services.

Scientific Breakthrough

The traditional pressure sensing bed-exit alarm systems often make false alarms owing to the different bodyweight of the patients. According to the medical journal report, this kind of product has a high false alarm rate of 30%. The high rate of false alarms interrupts the caregivers from time to time, increasing the burden of caring and discouraging them from using bed-exit alarm products. Therefore, our team proposes the system combining machine learning and multi-sensor design to reduce the false alarm rate to less than 7%. In addition, real-time remote video and voice streaming are both implemented with AR display, so that medical staff on duty can receive the alarm remotely and go to check the condition as soon as possible, providing a complete solution to prevent bed-exit falls.

Industrial Applicability

It is estimated that the system will significantly reduce the annual medical expenditure of NT$ 2 billion due to reducing fall accidents and create NT$ 1 billion in medical care output value to assist in the safe management of elderly care. The developed supervised AI algorithm technology can also be applied to other fields of fall prevention, such as chairs, stairs, and bathrooms. Besides, through the cooperation with NCKU Transfer and Business Incubation Center, our team will facilitate the establishment of a medical assistive device startup company. Furthermore, creating a medical care output value of more than NT$ 5 billion will achieve the goal of promoting the core technology development of our country's assistive device industry, and enhance the international competitiveness of medical care field.

多階段偵測與熱成像離床偵測系統實體圖

多階段離床風險顯示介面

即時離床影像串流AR應用

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Building A Deep Learning-based Chest X-ray CADe Platform MedCheX

National Cheng Kung University | Jung-Hsien Chiang, distinguished professor

Technical Introduction

As we continue to face the rapid increase in confirmed Coronavirus cases around the world, we created an AI-based pneumonia detection platform for COVID-19. The system is able to automatically detect high-risk patients with pneumonia that will then send information to doctors. With that information, the doctors are then able to make follow-up decisions and provide a treatment plan after the diagnosis. In specific, doctors from the Department of Medical Imaging provided us thousands of positive and negative chest x-rays for pneumonia as a training set. Our system has already been tested with and adopted by doctors at the NCKU Hospital. The system achieved 95% accuracy to detect the pneumonia symptom, based on 1400 test images.

Scientific Breakthrough

AI-based disease detection is usually considered as a pattern classification task. In general, it uses a classification model with Convolutional Block Attention Module (CBAM) as a common way to handle it. Instead of observing the last feature map in the model, we design the image segmentation stage as our target task. With radiologists' manually labeled images as the target, we utilize the segmentation model as the first stage to identify potential hot spot areas. The following stage with a simple threshold to determine if any pixel is predicted as positive(diseased). If there existed at least one positive pixel, the image is considered as infected cases.

Industrial Applicability

We aim to help with the COVID-19 pandemic around the world. In this project, we use AI technology to determine if the patient is infected with pneumonia from a chest x-ray. Our system assists doctors with diagnosis to find out confirmed cases earlier, leading to a decrease in the risk of community spread. If the lack of medical personnel is serious, our system may be the first line helper for filtering COVID-19 suspected cases. Inexperienced doctors or medical personnel can learn the infected patterns of COVID-19 on chest x-ray while they obtain the initial prediction from our system.

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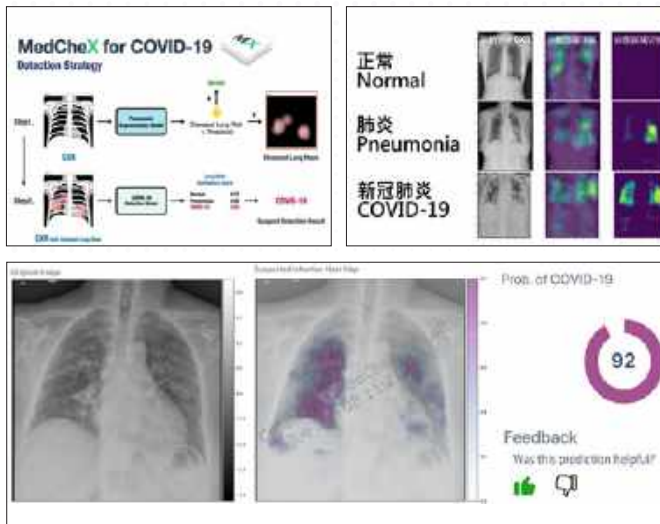
Intelligent image-guiding needle puncture

National Yang-Ming University, Taipei Veterans General Hospital | Dr. Wen-Chuan Kuo; Dr. Meng-Chun Kao; Dr. Chien-Kun Ting; Dr. Yi-Hsiu Huang; Dr. Wei-Nung Teng; Dr. Yu-Te Wu

Technical Introduction

An optical imaging probe with a diameter of 0.9 mm, combined with the 14-18 gauge needle, is used for clinical needle puncture. Using the real-time image obtained from the tip of the needle in the tissue, the needle position can be identified. Combined with artificial intelligence (AI) classification can achieve objective, accurate and automatic identification of the tissue, which has been successfully verified in anesthesia and laparoscopic surgery.

Scientific Breakthrough

Needle puncture is an indispensable technology in clinical medicine, such as in pneumoperitoneum establishment, epidural blockade and fascia plane block procedure, etc. It's very depends on the doctor's experience and touch feel. Our system provides the real-time imaging and automatic classification to guide the needle puncture procedures, thus achieve to precise positioning and required safety. This method will greatly reduce the failure rate of traditional needle punctures and other complications.

Industrial Applicability

Our core technology is providing real-time optical tomographic images and an automatic classification method to guide the needle puncture surgery. This innovative technology has been successfully studied in the pneumoperitoneum establishment and epidural blockade using animal models and has published papers and patents. This method will improve safety and greatly reduce the complications of difficult patients (e.g., for elderly, obesity, spinal deformity, or children).

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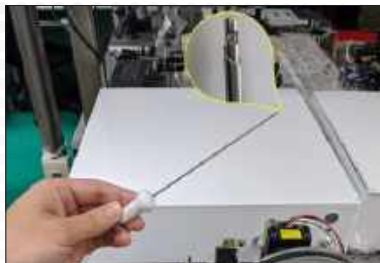
Zero Contact Detection-Facial Stroke, Heart Rate and Breath Detection Technology

National Yunlin University of Science and Technology, National Taiwan University Hospital Yunlin Branch |
Chuan-Yu Chang; Man-Ju Cheng; Hsiang-Chi Liu; Min-Xing Chang; Hui-Ming Ma

Technical Introduction

We use features such as asymmetric expression and crooked eyes to assess the risk of facial stroke. Observing the micro vibration of the head caused by the contraction of the heart, and develop a zero-contact facial heart rate and respiration rate detection technology in conjunction with the camera. The technology can accurately measure heart rate and respiration rate in real time.

Scientific Breakthrough

The proposed "zero-contact" detection technology combines face stroke, heart rate, and respiration detection. Through observing the symmetry of facial features of subjects' faces to estimate the risk of stroke. And observing the micro-vibration caused by the heartbeat and breathing to estimate the subject's heart rate and breathing rate. Compared with the facial skin color method, this technology can overcome the influence of ambient light and accurately detect heart rate and respiration rate.

Industrial Applicability

This technology is the world's first "zero- contact " detection technology, which can estimate the risk of facial stroke and measure heart rate and breathing rate at the same time. This technology has obtained five patents (two US patents, three ROC patents). The technology can achieve real-time measurement to reduce the risk of infection of medical staff. This technology can be integrated into systems or devices such as physiological signal measurement systems, baby monitors, and magic mirrors, and is actually used in hospital negative pressure isolation wards, postpartum confinement centers, and homes.

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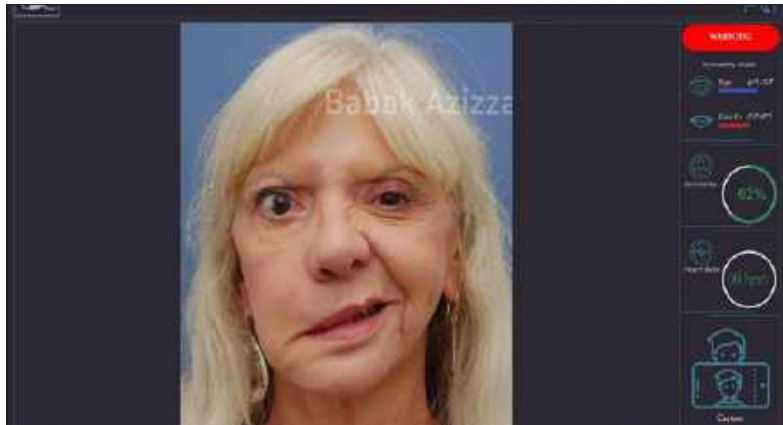
Bio-inspired sweat collection for health monitoring during physical activity

National Taiwan University | Prof. Ying-Chih Liao

Technical Introduction

A wearable sweat sensing device is developed for health monitoring during exercises to prevent illness caused by fluid losses. By using a biomimetic design and choosing a textile material with high permeability, the sweat collector possesses high sweat collection efficiency, rapid transport and fast response time. Inside the channel, salt concentration and sweat rate are deduced by electric property analysis. Finally, the data could be visualized on a smart phone app by using Bluetooth wireless transmission. This integrated intelligent system could acquire real-time information for health monitoring. The users can then adjust exertion intensity or intake some supplements based on the suggestions from the app.

Scientific Breakthrough

The major challenges of sweat collection are the limited sweat amount due to slow secretion rates and the need of real-time monitoring. Inspired by the fractal network widely seen in nature, we design a sweat collector with high collection efficiency, low flow resistance, fast response times (< 1 min compared to 10 minutes in literatures). The sweat flow velocity is much faster than those in conventional paper microfluidics to enhance the time resolution for ion sensing. Besides, with the variation of capacitance in the absorbent layer, the sweat rate can be measured accurately.

Industrial Applicability

The core technique of the 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. These devices only need to integrate with tiny microchips for health monitoring and data transmission. These wearable devices can effectively increase the added value of intelligent clothing.

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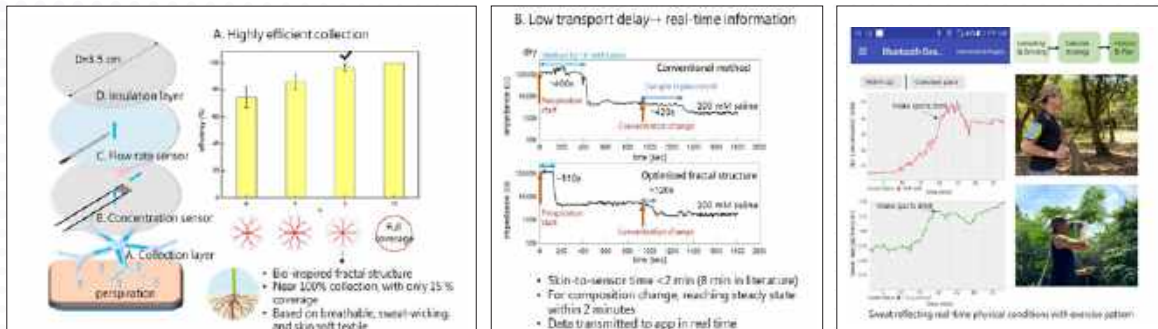
A Non-Invasive AI Imaging Technique for Quick Risk Assessment of Stroke and Cardiovascular Diseases

National Taiwan University | Hao-Ming Hsiao; Hsien-Li Kao; Ching-Chang Huang; Mao-Shin Lin

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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AI_Variant Prioritizer

National Taiwan University | FeiPei Lai

Technical Introduction

The interpretation of next generation sequencing is a big challenge. In order to improve the molecular diagnosis of the patient, we developed the AI_Variant prioritizer, a machine learning based variant prioterization system that can help to prioritize candidate variants for human disease. This module highlighted the possible disease causing variants to help clinician to increase the disease diagnostic yield and decrease the load of manpower.

Scientific Breakthrough

The is AI_Variant prioritizer was a machine learning based module that can facilitate variant prioritization. It added the value of our previous produce - MViewer, that can increase the diagnostic yield shorten time to find candidate variants. It is optimized by integrate with text mining machine learning to improve the variant interpretation efficiency. We had comapred our ranking reuslt to other open web software. The result showes our algorithm can have highest top 1 ranking. In adidtion, we succeed in 92.6% of the cases to locate the causative variant in the top 10 ranking.

Industrial Applicability

The software can help in precision medicine, pharmacogenomics, diagnosis of genetic diseases, risk factor prediction, cancercardiovascular risk evaluation. It will facilitate the development of healthcare system.

Precision Health Ecosystem
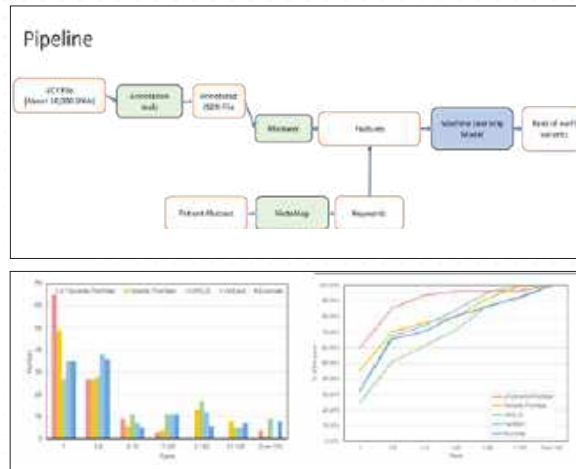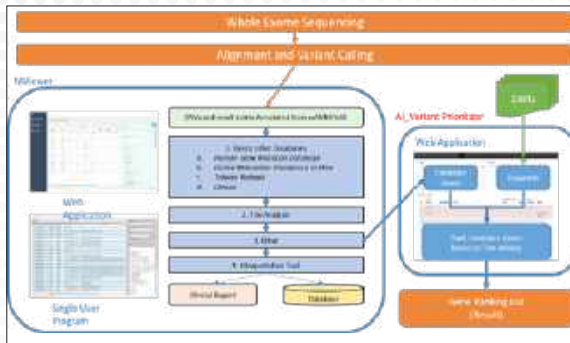
Video-based blood pressure and respiration measurement and its applications in the home sleep apnea and health management system

National Chiao Tung University | Bing-Fei Wu, Chair Professor

Technical Introduction

The technology utilizes image continuity and contactless monitoring of blood pressure and respiration state to help patients avoid wearable pressure when detecting sleep apnea and reduce the complexity of detection. The system can help users to easily detect sleep status in their lives, contactlessly measure and make daily health records, as the real-time management monitoring of daily homecare. This technology conducts IRB clinical trials, establishes a large database, joins physician professions, and optimizes AI solutions.

Scientific breakthrough

Technical highlights of this system for image-based sleep apnea measurement:
1. Non-contact continuous blood pressure and respiratory detection technology is applied to the sleep apnea syndrome measurement
2. Suitable for home healthcare for sub-healthy patients who have sleep disorders and sleep apnea syndrome.
3. Cooperate with the hospital sleep laboratory for clinical trials to collect actual physiology and respiration data to optimize the AI algorithm
4. Join the professional knowledge of physicians and use AI to predict the risk of respiratory cessation.

Industrial Applicability

Image-based blood pressure and respiration detection technology is applied in the home sleep test, which can solve the problems of insufficient sleep laboratory and the wearable devices affecting sleep detection. The testees do not need to wear any device nor change their sleep habits. It is easy to use under the daily sleep status at home, which can achieve the same test results as in the professional sleep laboratory for further diagnosis. This technology integrates low-cost equipment and can be applied as home health management system to provide a multi-functional use mode for potential patients and family members.

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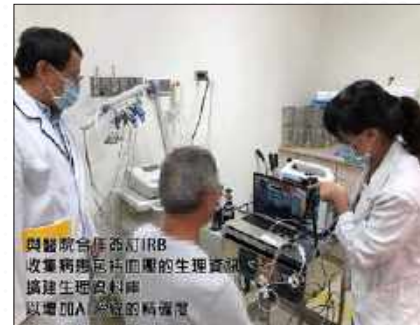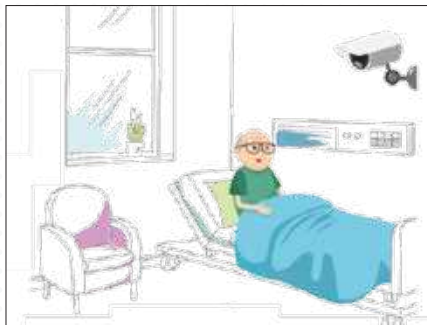
Startup Acceleration and International Promotions for the Medical Device Industry

Biomdcare / Han-Wei Zhang；**MOBIOSENSE /** Sam Chou；**Cyper S /** Yi-Chun Du，Peng-Ting Chen，Ching-Feng Liu，Chia-Yi Lin，Wei-Siang Ciou，Wei-Chih Lu

Technical Introduction

1. AI Osteoporosis Screening Assistant
2. Semiconductor biosensor for portable, high sensitivity detection of infectious diseases
3. Smart Hearing Solution

Scientific breakthrough

1. Biomdcare's AI Osteoporosis screening system determines whether the femoral neck T-score is > or $\leqq$ -2.5 in the X-ray image by training the hip X-ray image compared with DXA T-score, and the accuracy has reached 90%.
2. Mobiosense's patented sensor design achieves higher sensitivity towards weak electrical charges while employing standard wafer processes.
3. In order to overcome the problem of the cocktail party effect, we designed an innovative, intelligent hearing system, which can identify the target speaker by visual signals, assist the target speaker through the image.We use advanced tools such as beamforming for hearing aids, innovative architecture and noise reduction technology for spatial filtering, and AI technology for deep neural networks with instant speech noise reduction for speech reconstruction."

Industrial Applicability

1. With hip X-ray images as identification targets, it needs no extra hardware cost and conforms to the medical guidelines. It will fill the osteoporosis screening market gaps.
2. Mobiosense's technology is applicable to industries with biosensing needs, such as healthcare and biomedical research.
3. The team will carry out cross-industry cooperation with manufacturers in the auditory auxiliary industry chain, through the integration of software and hardware and the overall solution of the service model, to assist the upgrading and development of the auditory auxiliary.

Precision Health Ecosystem

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Electronic & Optoelectronics

Low-Temperature Defect Elimination Technology for Semiconductor Devices

National Sun Yat-sen University | Chair Professor:Ting-Chang Chang

Technical Introduction

The low-temperature defect passivation technology developed by our team can effectively eliminate defects in materials under 250°C, leads to the improvement of the performance and reliability of devices. The technology has demonstrated the significant performance improvement when using on wide band-gap devices.

Scientific Breakthrough

The low-temperature defect elimination technology has novel principles. We can introduce specific reactant into semiconductor materials, and significantly passivate material defects with this technology. Then the performance and reliability of semiconductor devices are both improved. The technological breakthrough lies in the effective elimination of defects at low temperatures (250°C).

Industrial Applicability

This novel technology has many potential applications, including Si devices and wide band gap semiconductors (LED, GaN HEMT, SiC MOSFET). It can be introduced into both the front and back end process of IC manufacture due to the low temperature.

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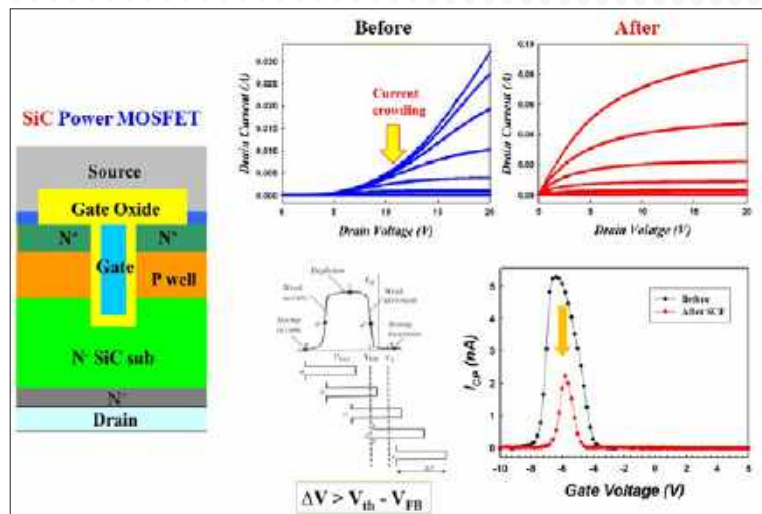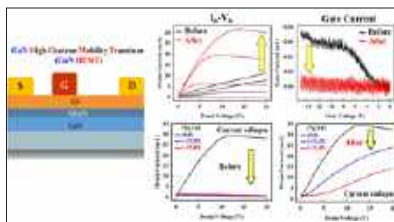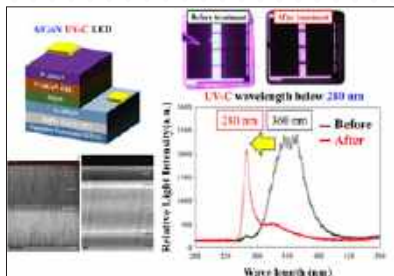
Global Ionospheric Tsunami Monitoring and Early Warning System-Space Buoy

National Central University | Jann-Yenq Liu

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.

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.

Industrial Applicability

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 and global ionospheric tsunami monitoringearly warning system.

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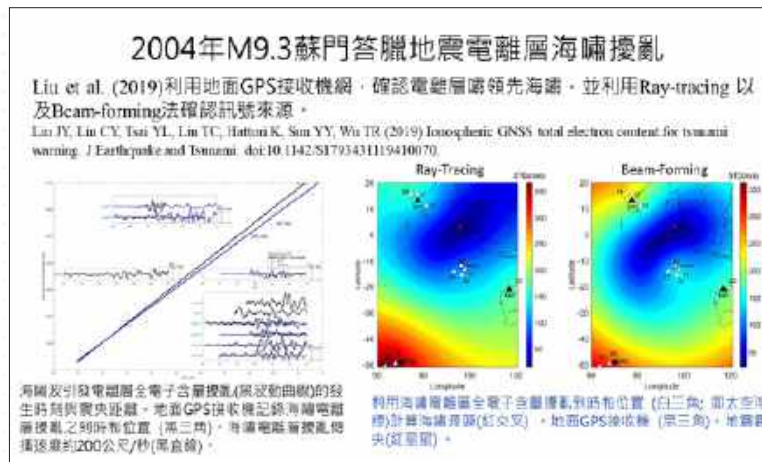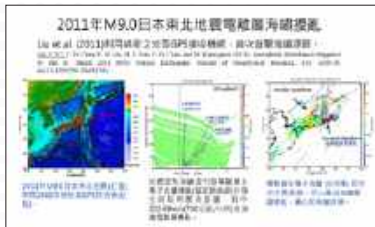
Satellite Remote Sensing of Aerosol Profile in 3D PM2.5 Construction for Regional Air Pollution Monitoring

National Central University | Professor Tang-Huang Lin, Tsung-Ting Lee, Yu-Te Tsai, Distinguished Professor Neng-Huei Lin

Technical Introduction

Concerning the uncertainty of assuming well-mixed aerosols within the planetary boundary layer, a sensible aerosol vertical distribution described by a log-normal fitting function is proposed to provide more realistic single-peak extinction profile with a decadal MPL in situ dataset. The performance of fitted single-peak aerosol profiles can reach up 0.8973 of correlation coefficient when considering the seasonal variations in PBLH and the surface layer height of well-mixed aerosols. Eventually, not only the aerosol extinction profile but also the 3-dimensional distribution are promising to be created from satellite AOD retrieval with PBLH information for providing accurate PM2.5 monitoring over a regional scale.

Scientific Breakthrough

In terms of the planetary boundary layer height (PBLH) and the total column aerosol optical depth (AOD), the single-peak aerosol profiles can be well described by the proposed log-normal distribution model with the following breakthrough, 1. New satellite retrievals in aerosol extinction profile 2. Enable satellite observation to prov 3D aerosol distribution (from columnar 2D) 3. Improve satellite remote sensing of surface PM2.5 with high temporal observation every 20 minutes 4.Overcome the international limitation in constructing 3D PM2.5 initial for modeling air pollution forecast.

Industrial Applicability

The proposed model for single-peak aerosol profile fitting will facilitate the advantages for industrial application as the followings. 1. Associated with multiple satellite observations, the unique 3D aerosol distribution highly increases industrial competitive capability internationally 2. Very practical with high performance and low cost for operational 3. The near real-time air pollution monitoring is enable to a large scale which well qualified for the warming of public health issues 4. User friendly 5. The technology can be applied in environmental protection agencies, weather industrial (e.g., Weather Risk Explore Inc.) or satellite image processing companies, including National Space Organization, SpaceX, Chung Hsing Surveying, LIDAR Technology, Spot Image in France, etc.

Figure 3. The schematic application of satellite observation in constructing 3D initial for PM2.5 forecast using WRF-Chem model, and feed back to the improvement on numerical weather prediction (NWP).
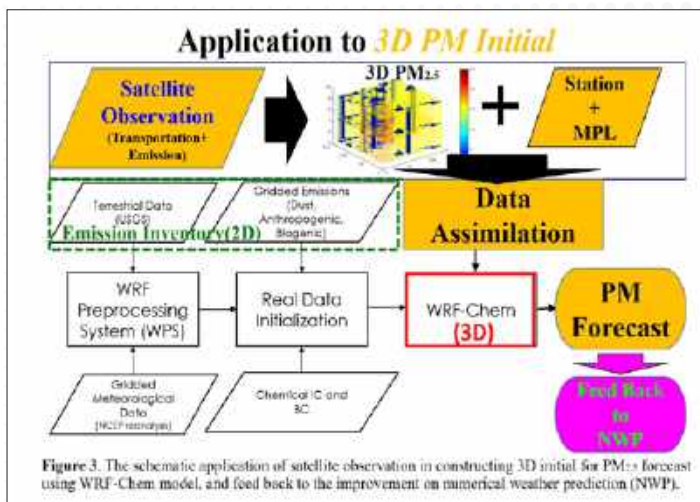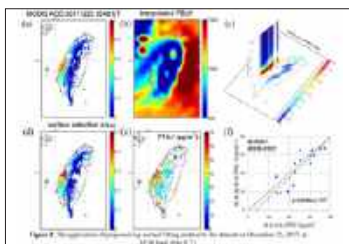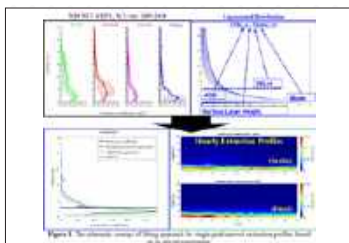
A Transparent Deployment Solution for 4G/5G Edge Computing Platform

National Chiao Tung University | Chair Professor Ying-Dar Lin; Assistant Professor Chi-Yu Li

Technical Introduction

This transparent deployment solution for 4G/5G MEC (Multi-access Edge Computing) platforms is standard-compliant and does not require any changes on 4G/5G base station or core network. Its MEC deployment is just plug-and-play. It contains five major components to gracefully interact with cellular protocols : ARP proxy, MEC packet gateway, GTP states tracking module, GTP traffic engineering module, and platform manager. It integrates them with the virtualization technology K8S and OpenStack to enable dynamic deployment of app servers. This platform has been successfully built and tested with several commercial and experimental 4G/5G testbeds including a Wistron small cell, OAI core/eNB, NextEPC core, etc. Its low-latency gains have been shown based on video stream, AR, and V2X applications.

Scientific Breakthrough

The transparent deployment solution is the first technique that is not only standard-compliant but also transparent in the world, to the best of our knowledge. To deploy an MEC platform in 4G/5G cellular networks, the transparent solution does not require any major changes or specific configurations on base stations, core networks, and user devices. It enables the MEC deployment to be just plug-and-play, so it can be easily achieved in 4G/5G networks. Compared with traditional cloud services, MEC can reduce frame loss and image jitter up to 98% and 67%, respectively, for an HD video streaming service, and reduce video delay up to 73% for an AR application.

Industrial Applicability

The MEC deployment solution can benefit both industrial computer and networking communication industries. Cellular network equipment market has been monopolized by few international companies. The solution provides other companies with an opportunity to join the market, since it can deploy MEC platforms without any support from original cellular vendors. It can be applied to three major scenarios. First, cellular operators can reduce the cost of MEC deployment at their networks by working with other non-traditional cellular vendors. Second, the private 5G network can be built based on the solution with low cost. Third, it can be used to develop a mobile MEC platform for combat and disaster scenes, which require many connected IoT devices and intelligence support at non-static locations.

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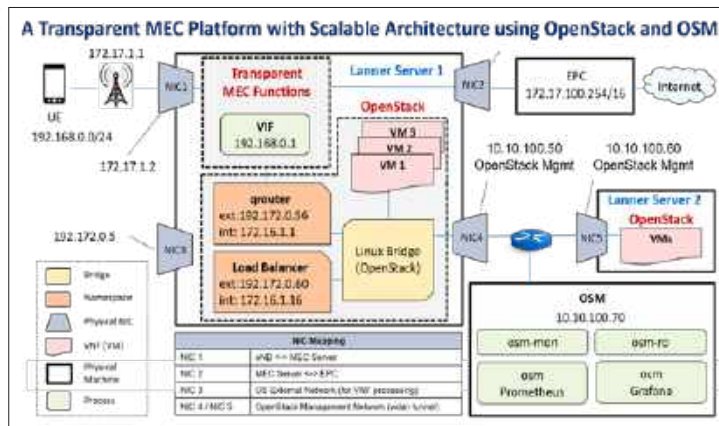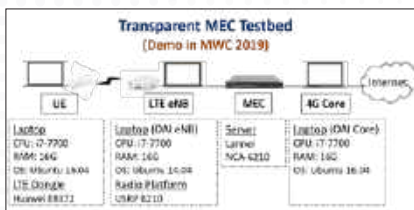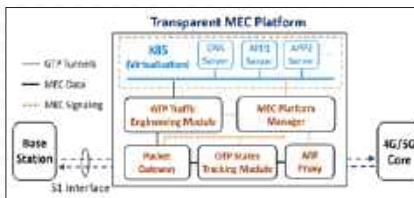
Large-area and color pure viloet and green provskite light emitting devices

National Chiao Tung University | Yi-Jhen Chen; Tzu-Hsin Hong; Kien Wen Sun

Technical Introduction

By combining the thermal evaporation and spin-coating techniques, we are able to demonstrate synthesis of 3 cm square and 1.5 cm square organometallic halide perovskite light-emitting diodes with electroluminescence at 538 nm and 405 nm, respectively. To our best knowledge, the demonstrated violet LEDs have produced the shortest emission wavelength available from current hybrid perovskites. The luminance of our green and violet LEDs reach a maximum value of 9967 and 138 cd/m2 with EQEs of 0.88% 0.24% and color purity of 95% and 98%, respectively.

Scientific Breakthrough

Currently the area of perovskite LED components is still limited to a few mm square. Our team breaks this barrier by combine solution process with thermal evaporation to produce a large-area component with a size of 3 cm square. The quality of the as-prepared perovskite film was carefully examined with various characterization techniques. In this work, parameters of the original device structure were modified, such as uniformity of the active layer, thickness of the electron injection layer, electron transport layer, and Ag cathode electrode to improve uniform injection of electrons. Area of the fabricated LEDs was significantly increased from mm to cm scale. We also demonstrated a first violet perovskite LED with electroluminescence at 405 nm.

Industrial Applicability

Our perovskite LED manufacturing process is simple, less time-consuming and cost-effective. The demonstrated devices are large in area but very lightweight due to a thickness of only a few mm. A large number of perovskite LEDs can be made in a short period of time, which is favorable for mass production. Apart from the aforementioned advantages, these perovskite LEDs are uniformity in morphology with high color purity. Therefore, it can be used as a backlight for liquid crystal displays, or can be applied in monitors, TVs, automobiles, smart wearable devices, biomedical sensors, etc. Moreover, the violet LEDs can combined with visible light phosphors to generate white light emission for lighting purpose.

Electronic & Optoelectronics

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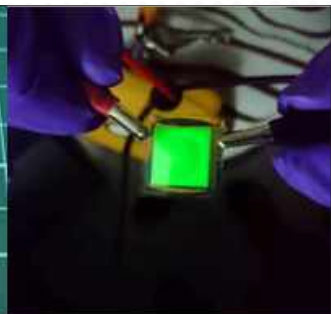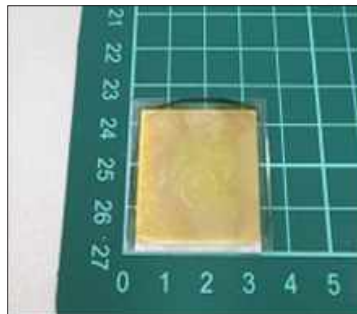
An 1.6Tb/s Silicon Photonics Chip

National Kaohsiung University of Science and Technology | Tien-Tsorng Shih; Distinguished Professor; Dean of College of Electrical Engineer & Computer Science

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/s silicon 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 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 providers, such as Facebook, Amazon, Apple, Google, and Microsoft invest a lot of resource to build hyperscale data center. Servers inside these hyperscale data centers might be 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 powerful data transmission capability of 1.6Tb/s in such a small chip area of 5mm x 5mm.

Industrial Applicability

This silicon photonics chip enables 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.

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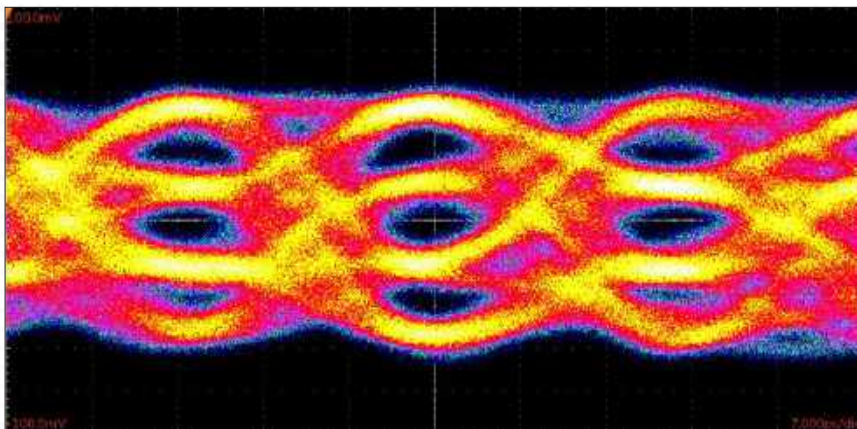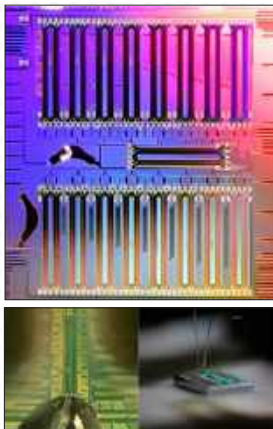
Fast Beam Calibration and Forming for Phased Arras of Antennas at Millimeter Wave Frequencies for 5G/B5G Applications

National Taiwan University | Professor Hsi-Tseng Chou

Technical Introduction

Active phased arrays of antennas suffer from fabrication discrepancy at mmW frequencies for 5G/B5G. To accelerate the piece-by-piece calibration procedure, a bottleneck to cause high fabrication cost, a highly efficient electronic-scan based technique is developed. By avoiding the time-consuming mechanical probing, the developed technique is particularly applicable to production line operation to enhance production yield rate. It allows the system architecture significantly simplified while its calibration efficiency is tenfold better than conventional technique, a tremendous reduction from hours to seconds. Its applications not only enhance system performance, but also significantly reduces mass-production cost for effective commercialization of 5G services at mmW frequencies.

Scientific Breakthrough

This technology utilizes active RF devices to calibrate the array antenna beams, which breaks through traditional iterative mechanical architecture scanning. This electronic-scan based technology can achieve unidirectional beam correction, implement a space reduction of 70%, and reduce the calibration time from "hours" to "seconds" Level (less than 1% of conventional mechanical scan technique), system cost reduced by 60%. In addition, this adjustment can simplify the layout of the beamforming circuit to reduce losses and improve characteristics. Its implantation into the production line system, may reduce significantly the system production cost. In particular, its "second"-level calibration speed can improve yield, significantly reduce production line costs, and increase production speed.

Industrial Applicability

The proposed technique can be applied in various scenarios at mmW frequencies. It may simplify antenna system architecture for low power consumption at R&D stage, and reduce development efforts for various RF components. At production stage, it can be applied to production lines for space-saving, cost reduction and good yield rate enhancement. Combining with existing production automation flow using robots, the high calibration efficiency also accelerates the system production in tenfold efficiency comparison to mechanical-probe based techniques. Production speed and cost saving can be assured. This technique has high applicable scenarios, and can be extended for field system to pair with user equipment, performing fast beam forming and tracking for easy use of commercial systems.

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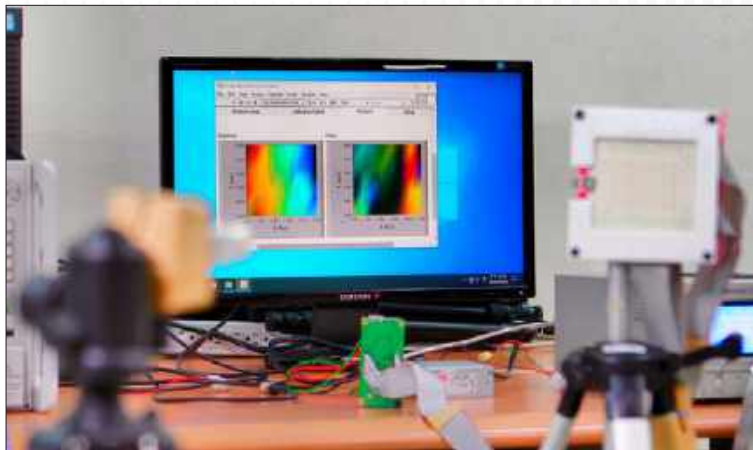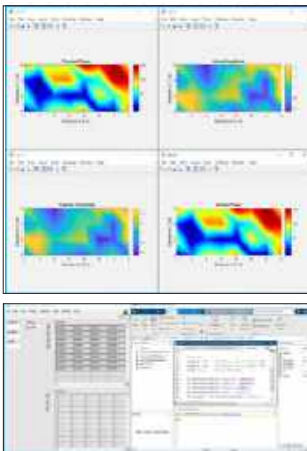
SS-MRAM: A superlattice based STT-MRAM with extra-high performance

National Taiwan University | Prof. Wen-Jeng Hsueh

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, fast reading and writing, easy manufacturing, and high reliability. Thus, SS-MRAM will be a dream next-generation memory with ultra-high 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 writing, fast writing, compatibility with current manufacturing processes, and high reliability.

Industrial Applicability

SS-MRAM can be applied in the fields of internet of things, microcontrollers, machine learning and artificial intelligence, and industrial machine control. Due to high performance and less weakness, SS-MRAM can be used to replace traditional STT-MRAM. In the future, traditional memory SRAM, DRAM, and Flash may be replaced by the SS-MRAM in various fields.

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Towards Automatic Hyperspectral Imaging via the Combination of Sample Navigation Mapping and Laser Scanning Spectral Microscopy

National Taiwan University | Yu-Ming Chang

Technical Introduction

Photonic_Workshop@CCMS.NTU has successfully developed a motorized micro-mapping system to explore and navigate samples. This system is able to acquire high resolution images to produce a sample map automatically. This map is also synchronized with the coordinates of motorized stages. This achievement allows users to explore and position their hotspots from the map, and precisely deploy the hotspot to the central field of view by motorized stages. In addition, this mapping system can combine with a laser scanning confocal spectral microscope (LSCSM) to acquire sample spectral mapping. Our result has shown the capability to improve the efficiency of hotspot positioning and data acquisition process.

Scientific Breakthrough

This micro-mapping system aims at producing a sample map for navigation instead of directly exploring from an objective. This sample map can provide a complete picture and prevent the drawback of narrow field of view from an objective. Our system belongs to a multidisciplinary achievement including microscopy, customized mechatronics system, and geospatial information system. This system can capture sample images from different locations to mosaic a larger scene. The spatial resolution of scene can reach 0.4 um currently. Furthermore, we also integrate this scene with coordinates and attributes as a map for positioning and sample navigation. This system can also combine with the laser scanning confocal spectral microscopy to acquire spectral mapping at the precise location.

Industrial Applicability

The measuring performance is a crucial index in industrial circles including semiconductor, electronic component, two-dimensional material, biomaterial, etc. Our micro-mapping system used a low-magnification objective to produce the whole scene for sample navigation. A high-magnification was then selected to acquire sample spectra, i.e. photoluminescence or Raman, at each hotspot. This technique has the capability to automatically measure multiple areas on a surface instead of sampling measurement.

AS2 3D

National Taiwan University of Science and Technology | Tzunghan Lin, Associate Professor
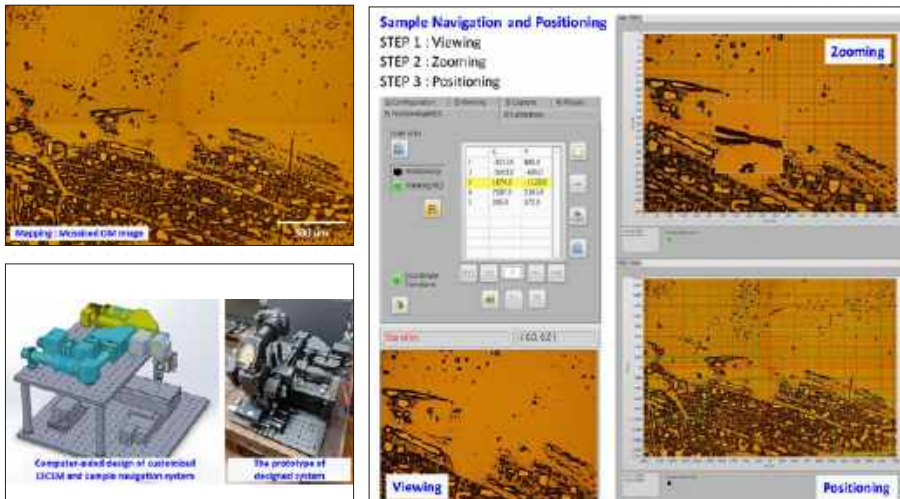
Technical Introduction

We developed a Multiview 3D capturing system based on camera array for generating stereoscopic 3D printing. Based on the framework, we are capable to create well aligned 3D content and calibrated color images. The depth perception of content can be manually adjusted for preview, and for generating quality 3D stereoscopic printing.

Scientific Breakthrough

This proposal discloses a multi-view stereoscopic camera system by integrating the software and hardware technologies for camera array. It involves several essential methodologies including camera color calibration, camera synchronization, 3D calibration el. al, and optimization of perception disparity. We make the system as simple as taking photos as commercial cameras to generate multi-view stereoscopic data, preview, data management, large-size autostereoscopic print, to feed the need in specific scenarios such as wedding photos, family photos, advertising et. al.

Industrial Applicability

This solution is suitable for high quality wedding photography, family photography, advertising portrait photography,3D stereoscopic printing. It integrates all eco-system including photo studio, logistics, printing company, information manager system.

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Wireless Power Transfer System for Electric Vehicles

National Taiwan University of Science and Technology | Huang-Jen Chiu

Technical Introduction

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

Scientific Breakthrough

Moremore 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 shipAGV to solve the inconveniencesafety 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.

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Breakthroughs and achievements of key technologies of six-axis force/torque sensor

National Sun Yat-sen University

Technical Introduction

Multi-axis force/torque sensors are key components of precision machines and robot arms. Development of the multi-axis force/torque sensor is a popular research topic in Taiwan. This research developed design methods, calibration machines and calibration algorithms for multi-axis force/torque sensors. These efforts contribute the enhancement of precision of 0.20% (1.25 times than commercialize product). The sensing range of three-axis force is ± 200 N and torque is ±15 N-m. It is published in IEEE Sensors Journal 2020 with DOI:10.1109/JSEN.2020.2999156.

Scientific Breakthrough

When the dual frame force/torque sensor developed by this study is integrated with the proposed artificial neural network calibration method and the six-axis synchronous calibration machine, the force measurement range for Fx, Fy, and Fz was ± 200 N, and the torque measurement range for Tx, Ty, and Tz was ±15 N-m. Most crucially, a calibration precision level of 0.20% was achieved. This precision level constituted a substantial breakthrough because it was approximately 1.25 times better than those of leading international factories such as ATI (precision 0.25%), JR3 (precision 0.25%), and WACOT (precision 3%). Technical Figure 1 presents the comparisons. Four novel break through techniques are developed.

Industrial Applicability

We are developing industry chains of multi-axis force/torque sensors in Taiwan. Upstream companies provide multi-axis force/torque sensors to enhance multi-applications for downstream companies. The effects are in-depth. We have collaborated with four companies and industry research institutes in recent years. Two patents are granted. The pilot run of the sensors is verified and has integrated in two robot arms.

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Mass production technology of fluorinated graphene and its multi-functional applications on surface coating

National Central University | Prof. Ching-Yuan Su; Cheng-Chun Huang; Yu-Yu Sin

Technical Introduction

In this invention, the fluorinated graphene(FG) is obtained by the fluorination of electrochemically exfoliated graphene (ECG), which is found to be a one-step approach for the scalable preparation of FG. The precursor with fluorine atoms is mixed with the ECG followed by applying lower energy to produce the fluorinated graphene. This process demonstrates an eco-friend and safe as well as scalable features. We have demonstrated their multi-functional applications on surface coatings, including the outperformance anticorrosion passivation, hydrophobic surface with ultra-strong adhesion, and high safety energy storage device. This technology provided a new strategy for next-generation functional and atomic layered coatings.

Scientific Breakthrough

This invention shows a novel, simple, and safe method to produce the fluorinated graphene(FG) with a one-step and industrial scalable approach. By using our designed F-based precursor and process conditions, the graphene can be successfully converted to FG under lower reactive energy. For the application of anti-corrosion coating, the additive of only 1 wt % FG as a filler in epoxy can achieve the highest reported anticorrosion performance (corrosion rate (CR) = 7.83×10^{-8} mm/year, which is due to their excellent dispersibility, super-hydrophobicity, high electrical insulator. Also, the calculated diffusion coefficient is two orders lower than other reported work, indicating excellent corrosion inhibition.

Industrial Applicability

1. Surface self-cleaning (hydrophobic) coating with nano-scaled thickness and strong adhesion. 2. Severe anti-corrosion coating in infrastructure, such as the components of the offshore wind power. 3. The high-end passivations on advanced electronics, such as the high-reliable PCB, server, and the electronic components with military regulation. 4. Surface coating for thermal management applications, including heat dissipation, two-phase heat transfer enhancement. 5. The surface modifier for enhanced performance and safety on battery

Evolutionary Materials

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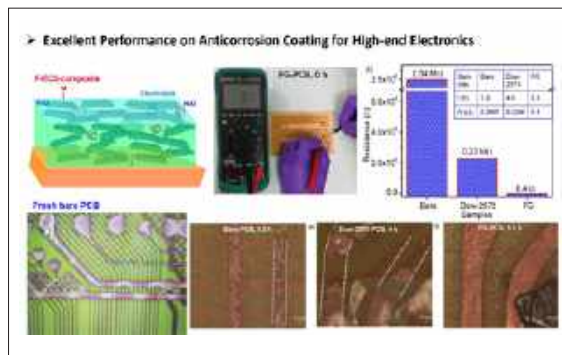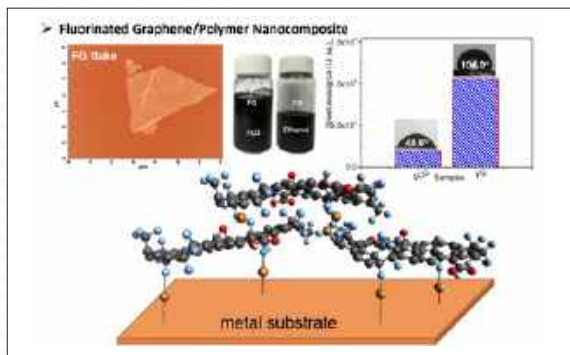
UV-resistant Self-healing Emulsion Glass as a New Liquid-like Solid Material for 3D Printing

National Central University | Chair Professor Heng-Kwong Taso; Professor Yu-Jane Sheng; Dr. Ssu-Wei Hu

Evolutionary Materials

Technical Introduction

Directly writing 3D structures into supporting mediums is a relatively new developing technology. The dilute dispersion of Carbopol in the aqueous solution has been the most frequently used materials for supporting mediums in which to write 3D structures. However, photo- and thermal- degradation of Carbopol may be inevitable during the solidification of ink material, limits the usage of a polymer-based supporting medium. The liquid-like solid (LLS) materials are developed as supporting mediums, that possesses the self-healing ability and tunable yield stress. Because the components of this emulsion glass are mostly water and oil, it exhibits chemical stability when exposed to UV radiation and high temperature. Based on the above features, this emulsion glass can be regarded as a new kind of LLS material for supporting mediums.

Scientific Breakthrough

In this work, durable and recyclable liquid-like solid (LLS) materials are developed as supporting mediums that are stable for both UV-thermal-solidification. Its elastic nature emerges from the jammed structure of oil droplets, offers this LLS material rapidly self-healing ability. The capability of the emulsion glass as supporting mediums is successfully demonstrated by directly writing and then curing designed structures.

Industrial Applicability

Embedded 3D printing is a recently emerging technology. This technology has been utilized to create various complex 3D architectures, which would be difficult to make solely by typical 3D printing methods. For example, supporting mediums have been applied to 3D-photopolymerization and the production of PDMS elastomer and liquid metal. After writing, the whole system including written inks and supporting medium is exposed to UV or high temperature for a while to obtain a solid structure. If the medium is degraded before solidification, the written structure will sag or fall apart due to the failure of the elastic solid-like support. To prevent the occurrence of this scenario, the LLS material must exhibit good thermal and UV stabilities. The emulsion glass has been repeatedly used at least 6 times upon exposure to UV irradiation and heat, implying it can expand the applications of supporting medium to the writing process involving UV- and thermal-curable inks simultaneously.

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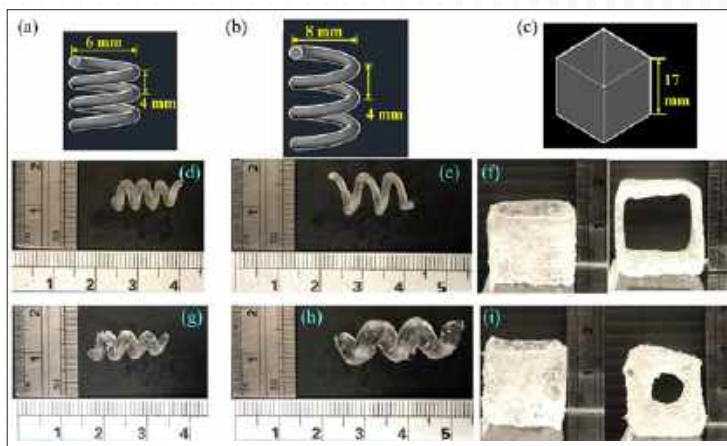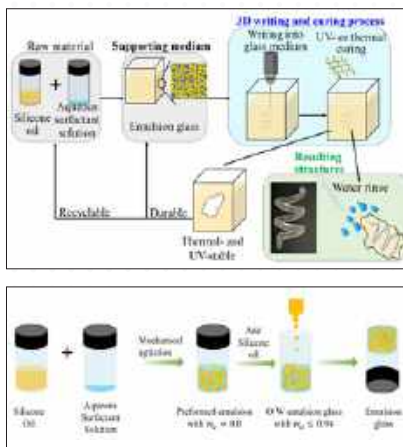
Self-healable, Self-powered, Stretchable, and Transparent Electronic Skin (human-device interfaces) and Nanogenerator

National Chung Hsing University | Ying-Chih Lai

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 self-generating 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 super-stretchable.

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, self-healing panel, next-generation human-device interfaces.

Evolutionary Materials

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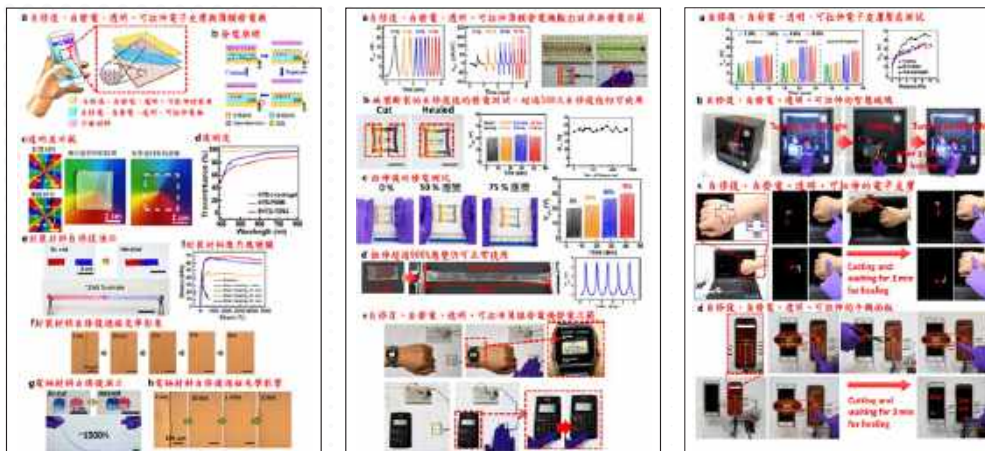
High-value recycling waste materials to produce lightweight aggregate

National Chung Hsing University | How-Ji Chen, Professor

Technical Introduction

Based on fully recyclable concept to create real benefits for domestic ecological environment. High value and energy saving construction material (lightweight aggregate) is manufactured by using environmental and industrial waste, such as paper sludge, textile sludge, organic waste solvent from semiconductor industry, and reservoir sludge, etc.

Scientific Breakthrough

High value and energy saving lightweight aggregate is manufactured by using environmental and industrial waste, such as paper sludge, textile sludge, urban sewage sludge, and reservoir sludge, etc. The relevant front-end manufacturing equipment and process technology are understood, 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 has published at international journal.

Industrial Applicability

The target market of this technology can be divided into waste treatment and lightweight aggregate products. Waste materials have high treatment processing income. Lightweight aggregate products such as ready-mixed concrete, pre-cast components, etc., are for sale. The business model provides enormous market value, hence the waste treatment is the blue ocean market of Taiwan waiting to be developed.

Evolutionary Materials

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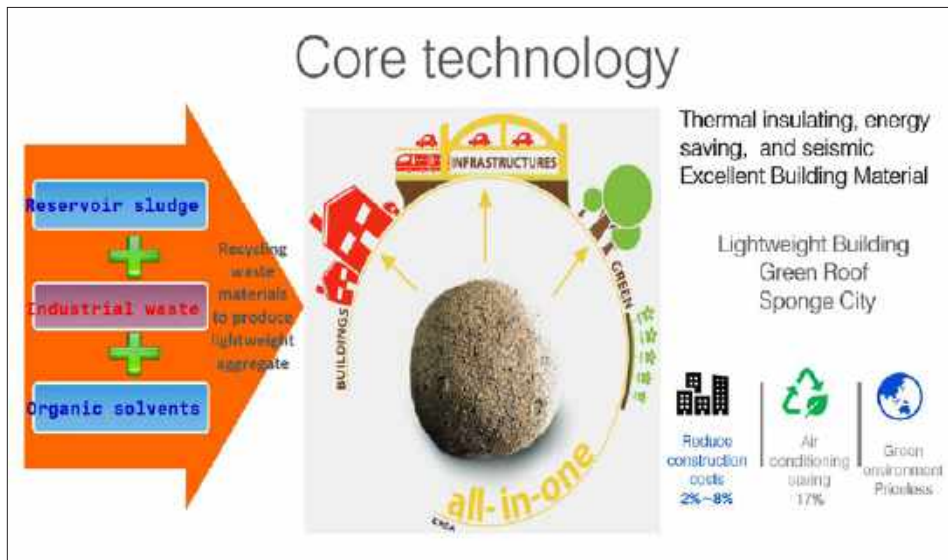
Development of cutting knowledge base to enhance machine tool performance

National Cheng Kung University | Yeau-Ren, Jeng

Technical Introduction

Tool selection and tool life diagnosis are vital for the quality of workpiece and the efficiency of the manufacturing process. This technology combines on-site monitoring data, laboratory analysis and deep learning to provide best tool selection and processing parameter combinations for different workpiece materials and production capacity situation, enhancing the effectiveness of machine tools.

Scientific Breakthrough

Based on the online diagnosis of cutting process establish a machining knowledge base with (a) cutting thrust and (b) motor current as the core, combined with laboratory analysis environment, collect (c) workpiece surface roughness (d) chip characteristics (e)cutting temperature, and the other relevant data, for deep learning process. This methodology can provide optimal tool selection and opertaion parameters according to the machinability of the workpiece, and the situation and production capability.

Industrial Applicability

This machining knowledge base can provide tool selection and optimized processing parameter combinations of different workpiece materials under various production capacity requirements as well as tool life prognosis during processing. This technology vastly reduces the time and cost of experience accumulations needed in traditional machining and as a result, enhances the efficiency of the machine tool and the overall logistic management of the operation.

Evolutionary Materials

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Using innovative microbial technologies as a high-efficiency valued-added total solution for industrial livestock wastewater treatment

National Cheng Kung University | Chun Yen Chen; Jo Shu Chang; Yu Han Chang

Technical Introduction

The innovative microbial wastewater treatment technology of our team can effectively reduce the COD, BOD, total nitrogen and total phosphorus in livestock wastewater to the emission standards in a short period of time, and the generated microorganisms can be developed for feed additives and organic fertilizers. In terms of industrial wastewater, this technology can also effectively clean petrochemical, ammonia nitrogen and heavy metal wastewater by degrading COD and ammonia nitrogen even adsorbing heavy metals, showing the excellent treatment performances.

Scientific Breakthrough

The microorganisms of our team are completely isolated and purified by ourselves, that are different the current biological methods. Therefore, the treatment items are more diverse, and the biological instability is improved. It can also be used in harsh environments (high salinity, COD, and ammonia-nitrogen concentration) to carry out wastewater cleansing; in addition, the microorganisms of our team can also effectively remove a variety of heavy metals, and develop unique and suitable formulas according to the characteristics of wastewater in each factory.

Industrial Applicability

The microbial treatment technology of our team can be applied to livestock and a variety of industrial industries, greatly reducing treatment costs. In terms of livestock wastewater, the microbial technology of our team can reduce all indicators to emission water standards. There are four to five animal farms undergoing field test. It is estimated that will have a market share of more than 1% in Taiwan; while in industrial wastewater treatment, the global industrial wastewater market will reach nearly NT$10 trillion. Therefore, the huge scale can be predictable for the economic efficiency.

Evolutionary Materials

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Self-healing ultra-high performance concrete

National Cheng Kung University | Prof. Chung-Chan Hung

Technical Introduction

The self-healing ultra-high performance concrete is a green construction material. It has the key characteristics of self-healing ability, high deformability, and ultra-high strength. The material composition contains a high proportion of by-products from industrial manufacturing. The particle packing density of the developed material is optimized to make this new multi-functional concrete material also have the ability of self-healing and deformability.
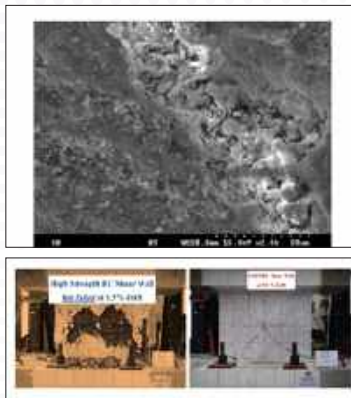
Scientific Breakthrough

The use of the multifunctional concrete can effectively delay the development of cracks under external loading. The deformable ability, ultra-high strength, and crack suppression ability of the developed concrete can significantly improve the structural toughness. Its application can effectively reduce the amount of reinforcing steel and cross-sectional size of members for new constructions. It can also greatly reduce or even completely eliminate structural damage and the associated repairs after hazards, thus improving the service life of structures.

Industrial Applicability

Its ultra-high strength can reach more than seven times the strength of ordinary concrete, which is close to that of steel. It can be used to retrofit seismic-deficient structures in millions of old buildings in Taiwan. Its appliations include buildings, bridges, tunnels, and other civil infrastructres. The use of the developed multifunctional concrete can greatly reduce the amount of reinforcing steel and the cross-sectional size of structural members. Even without using reinforcing steel at all, it can effectively strengthen the deformation toughness, strength, and stiffness of the member, which is an important breakthrough in practice. The shotcrete technique has also been developed to simplify the construction method by eliminating the need of formworks. The developed ultra-high performance concrete materials can be widely used in "building engineering", "transportation engineering", "hydraulic engineering", "civil infrastructures", "protection engineering", and "3D printing".

Evolutionary Materials

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Multiple High-Entropy Oxide as Piezocatalyst in Organic Dye Degradation

National Tsing Hua University | Jyh-Ming Wu, Hsuan-Yu Chen,

Technical Introduction

Multiple functional high-entropy oxide as piezoelectric type catalyst, composed of numerous metal ions, owning capability to tuning physical properties, and capturing various external energy, such as thermal energy, light irradiation and mechanical force. Therefore, it can be widely utilized in complex environments for energy conversion and environmental purification without light irradiation.

Scientific Breakthrough

Apart from conventional photocatalyst, piezoelectric catalyst: high entropy oxide, owning multiple energy applications, such as pollutant degradation, hydrogen revolution and environmental purification. Through adopting the coupling design principles with functional heterojunction, our group can design highly functional catalyst according to the specific demanding requirement, also owning the eco-friendly characteristic: low cost and non toxic.

Industrial Applicability

High entropy oxide is available in mass production, realistic industrial application, which owns the better control in releasing the organic pollutant, and related toxic gas which came from the factory and high-tech industry while in daily operating. Besides, the technique is based on the sol-gel synthesis, which is equipping with the highly replaceable merits, capable of switching the precursor system in the actual requirement, which owns the characteristic in highly economical effect, and low cost in systematic application. Moreover, high entropy oxide owns the high

Evolutionary Materials

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Building energy conversion and ventilation device

National Chin-Yi University of Technology | KUO-LIANG WENG
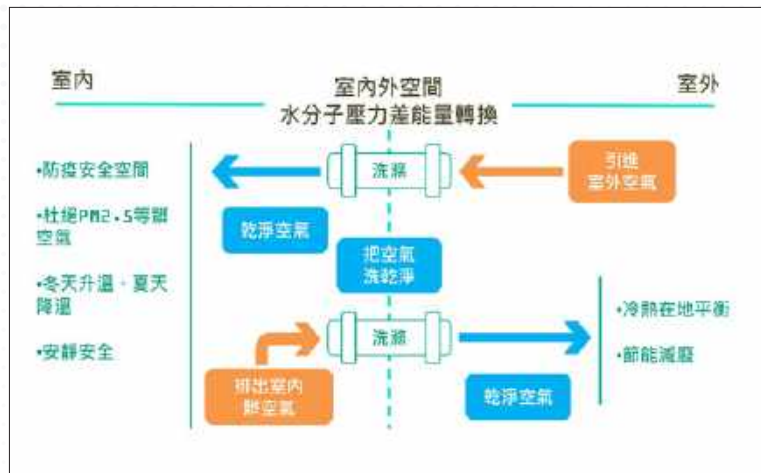
Technical Introduction

The present invention relates to a building natural energy conversion ventilation device, which has cleaning indoor and outdoor air, also has air-conditioning cooling heating supplies, which can make the intake air closer to the dew point temperature of the indoor side air after heat exchange, thereby reducing the heat load of the heat source unit, Enhance its operating efficiency, achieve energy saving avoid waste heat emission.

Scientific Breakthrough

In this case, the principle of water molecular pressure difference water two-phase energy conversion are used to convert the internal/external heat balance of the building, a large amount of fresh external air is introduced. Technical features: (1) Indoor-outdoor energy conversion device, (2) Indoor dirty air cleaning exhaust mechanism, (3) Fresh air intake mechanism.

Industrial Applicability

The market positioning of this case is to prioritize the service industry commercial air-cleaning and natural energy conversion ventilation device market under 200 square meters, especially for clinics, small medium-sized offices, middle primary schools, kindergartens, classrooms gymnasiums, etc., also to undertake new factories customized markets for medium large buildings.

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Dual-Core Self-Centering Energy Dissipation Brace

National Taiwan University | Chung-Che CHOU, Ping-Ting CHUNG, Ying-Chuan CHEN, Yu-Tsen CHENG, Tsung-Han WU, A. R. Ovalle Beato, Ze-Bang CHEN, Chia-Hung HSIAO, Yu-Ting LING
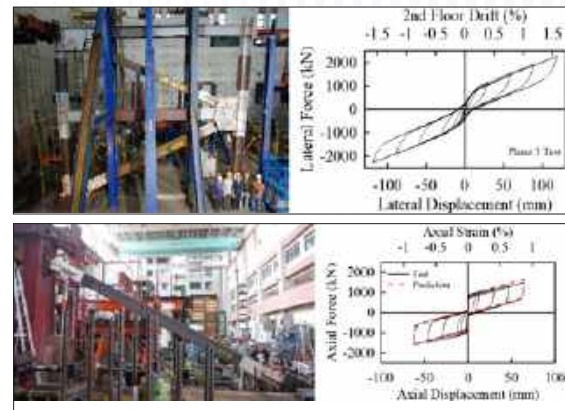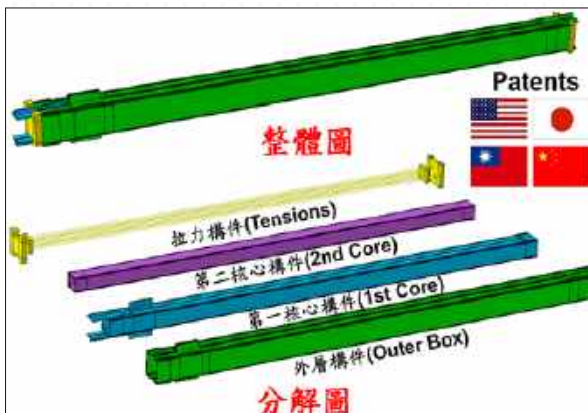
Technical Introduction

Conventional building frames use beam or brace members to dissipate seismic energy. However, these members may cause residual deformation of buildings after earthquakes, which affects the building performance and increases the difficulty of repair. In order to improve the seismic performance and reduce the residual deformation of buildings in earthquakes, a novel Dual-Core Self-Centering Brace, called DC-SCB, was developed. The DC-SCB uses tendons to provide the restoring force and friction devices or steel bars to provide energy dissipation so that the building can return to its original position after earthquakes. Two sets of tendons are arranged in parallel to double the elongation of the brace. The DC-SCB has been patented in Taiwan, United States, Japan and China.

Scientific Breakthrough

A novel DC-SCB is an earthquake-resisting brace with three steel members and two tensioning element sets in parallel. The left end of the DC-SCB is an extension of the first core, and a tensile force is applied to the right end of the plates extending from the outer box. When the initial PT force and the force required to activate the friction device are surpassed, the outer box and the first core begin moving with respective to the second core. The relative displacements δ between the outer box and the second core and between the first core and the second core result in an axial displacement of 2δ in the brace, which doubles the elongation δ of the outer and inner tendon sets. The brace has similar behavior in compression and returns to its original position when the load is removed.

Industrial Applicability

The dual-core self-centering brace has been patented in USA, Japan, China and Taiwan. Ten research papers have been published in well-known international journals so researchers have frequently cited the work. Recently, the Carleton University in Canada, Harbin Institute of Technology, Beijing Jiaotong University, Nanjing Southeast University in China and Mejio University in Japan have adopted the proposed theory to develop similar braces for reducing the residual deformation of buildings during earthquake loading.

Evolutionary Materials

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Air-stable luminescent organic-inorganic perovskite nanocrystal-polymer composites

**National Taiwan Normal University** | Yu-Chiang Chao

Technical Introduction

The technology realizes a perovskite nanocrystal-polymer composite material, which has great stability at high temperature. It can be used for 3D printing, shaped into fluorescent microfilaments, and utilized for white light-emitting diodes. The application of this air-stabile perovskite nanocrystal-polymer composite material in the 3D printing, textile and electronics industries has subverted the impression that the characteristics of perovskite nanoparticles are extremely prone to decay.

Scientific Breakthrough

The instability of perovskite materials in the air indicates a limitation in any kind of industrial applications. Thus, the contribution of this technology lies in the realization of a perovskite nanocrystal-polymer composite that has a high stability in the air at room temperature. It can also emit light even if it is placed in boiling water. Because of this property, the fabrication of this composite material has been a big breakthrough compared to the current stability of materials. It is unprecedented that this composite can be used for 3D printing and fluorescent microfilament fabrication.

Industrial Applicability

The technology realizes a perovskite nanocrystal-polymer composite that shows high stability in room temperature air. It can also emit light after putting in boiling water for more than 10 minutes. After reforming the composite material into a linear wire, it can be used for 3D printing to prepare the desired pattern or objects. This technology also uses this composite material to prepare fluorescent microfilaments and white light-emitting diodes, contributing to the 3D printing, textile, and electronics industries.

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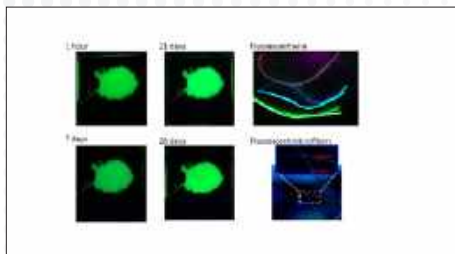
Green Energy Technology Joint Research and Development Program

National Taiwan University | Wei-Fang Su R&D team
Institute of Nuclear Energy Research | Yung-Ruei Chang R&D team, Chun-Liang Chang R&D team
National Taiwan University of Science Technology | Bing Joe Hwang R&D team

Technical Introduction

1. Toward All Slot-Die Fabricated High Efficiency Large Area Perovskite Solar Cell Using Rapid Near Infrared Heating in Ambient Air
2. Fault Current Indicator
3. Plasma Sprayed Metal-supported Solid Oxide Fuel Cell
4. Sulfide-based Solid-state Lithium-ion Battery with High Capacity and Safety

Scientific Breakthrough

1. We are the first group in the world to be able to fabricate large area perovskite solar cell using automated once through equipment of slot-die and NIR with novel solution formulations in ambient environment.
2. The permalloy CT is used to harvest energy from distribution feeders or laterals to provide power supply for FCI and charge super-capacitor. The super-capacitor supports the system load when the power grid fails.
3. INER's large size (10×10 cm^2) MS-SOFC products can be operated under low temperature as low as 550°C. The power output at 0.7V of large size MS-SOFC products can achieve 350, 690 and 780 mW/cm^2 at 550, 600 and 700°C, respectively.
4. Low moisture sensitive sulfide-based SSE film (10 x 10 cm^2, > 2 mS/cm) has been fabricated. The SSE film is integrated with high-Ni composite cathode and self-healing Si/C composite anode to developed high safety, high performance ASSLIB with the energy density of > 250 Wh/kg.

Industrial Applicability

1. We have demonstrate an automated once through slot-die coating machine to fabricate large area perovskite solar cell. The established technology can be also used to the fabrication of other electronic devices such as light emitting diode, transistor, capacitor, etc., especially in the flexible electronics.
2. The technology is integrated with power manufacturers and information technology for the predictive maintenance management of distribution facilities. The developed FCI enables fault locating and reduces outage durations of distribution systems.
3. The MS-SOC device also operates in reverse, converting electricity into chemical fuel. In this mode, a solid oxide electrolyzer cell is useful for storing redundant energy such as generated by wind turbines in the form of hydrogen fuel by electrolyzing water.
4. The developed techniques can not only improve the cycle life and safety of the batteries for future EVs and electric scooters, but also can be easily transferred to domestic industry and improve the international competitiveness regarding the development of next-generation ASSLIB technology.

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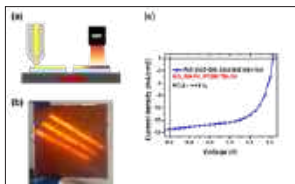
Advancement Project for Smart Machinery and Aerospace Industries in Central and Southern Taiwan

AWEA MECHANTRONIC CO., LTD. / Bruce Kang General Manager, Yung-Chieh Lai Assistance Manager ; National Tsing Hua University / Dr. Yu-Bin Chen

Technical Introduction

The developed technology is a cross-platform interface demonstrates its capabilities via the machining center VP2012. The interface is able to synchronize operating systems for diversified controllers. It integrates multiple functions, such as intelligent thermal balance, intelligent vibration analysis, and artificial neural network learning responsive technique. The developed technology advances software, hardware and firmware of a MIT machining center, setting up a representative example of smart machine for local manufactures, even the whole industry.

Scientific Breakthrough

1. Display diversified information from all controllers and sensors in one user interface only.
2. The thermal displacement of tool cutting point is less than 25 μm and the tilting of a 10-cm-long testing mandrel is less than 5 μm along the x-z plane.
3. Identify natural resonance frequency and vibration modes within 10% relative error using self-developed software and hardware.
4. Automatically detect the weight of workpiece and meet criteria ISO 10791-6 standard when conducting ball bar testing.

Industrial Applicability

The outcome of developed technology "Intelligent Bridge Type Machining Center with a Cross-platform User Interface " is an upgraded machining center VP2012 equipped with a cross-platform user interface. Moreover, the machining center is able to actively thermal balance, intelligently analyze its vibrations, and learn from artificial neural network model. The success of this developed technology sets up a role model for mechantronics industry and mechanical equipment manufactures in Taiwan.

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Lithium battery energy storage system development and new generation of solid-state battery materials

Academia Sinica | Maw-Kuen Wu, Distinguished Research Fellow

Academia Sinica | Maw-Kuen Wu, Distinguished Research Fellow
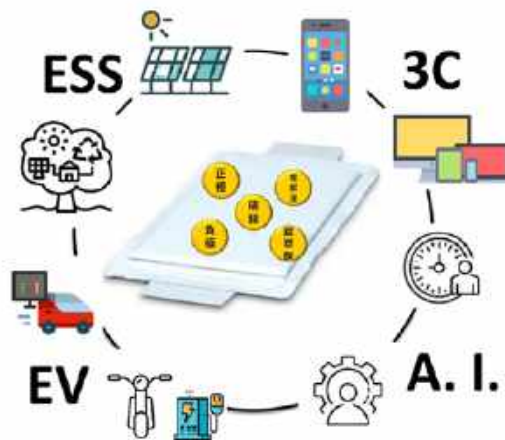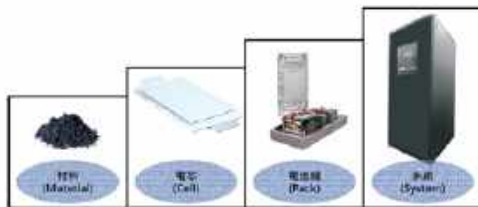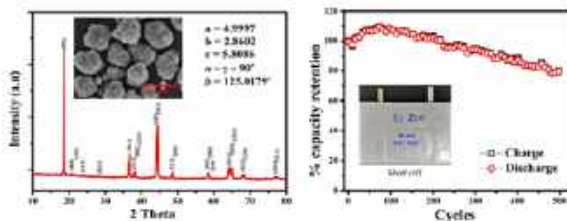
Technical Introduction

The next generation of lithium-ion battery materials must have characteristics of high specific capacity, high power, and reasonable price for applications. Our work has achieved breakthrough results in the lithium excess non-stoichiometric material and found that it can operate at a high voltage of 4.6V. Moreover, the specific capacity of this new lithium-ion battery cathode material is greater than 200 mAh/g.

Scientific Breakthrough

Voltage fade is the main reason for decreasing the energy output of lithium-rich cathode materials to unacceptable levels too early in cycling. However, we modify the band structure accordingly to improve this phenomenon. A 60 mAh pouch cell was utilized in testing the efficiency of the material apart from the preliminary tests carried out in the form of coin cells. A 205 mAh/g reversible discharge capacity was attainable with more than 85% capacity retention after 400 cycles of charge/discharge.

Industrial Applicability

The development of large cell technology has greatly reduced the difficulty and cost of the battery management system. In addition, it can cooperate with local raw material suppliers to produce the required raw materials.

Evolutionary Materials

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Low-temperature magnesium hydrogen storage materials and energy storage applications

Yuan Ze University | Shih-Hung Chan

Technical Introduction

The goal of this project is to study "low-temperature magnesium hydrogen storage materials and energy storage applications". Mg hydrogen storage materials with a hydrogen storage capacity of 5.0 wt% is developed, and their dehydrogenation rate at 250℃ will be significantly enhanced using a forcible pump. The Mg hydrogen storage powders are inserted into a tank for cyclic hydrogenation-dehydrogenation tests. The H_2 gas desorbed from the tank is supplied to a high-temperature proton exchange membrane fuel cell (HT-PEMFC,160℃) for power generation.

Scientific Breakthrough

This project has developed a 5.0 wt% hydrogen storage material. Traditionally, the dehydrogenation temperature of MgH_2 hydrides is still higher than 350℃ . The use of dry diaphragm pump assisted dehydrogenation can reduce the operating temperature to 250℃ . The low temperature hydrogen storage tank is conducive to combining with the waste heat feedback of high temperature proton exchange membrane battery (160℃) to improve the overall conversion efficiency of hydrogen energy. In addition, we specialize in low-cost water electrolysis hydrogen production technology. The pressure and flow rate of hydrogen production will help the development of magnesium hydrogen storage tanks.

Industrial Applicability

The global commercial fuel cell market in 2018 was 2.39 billion US dollars, and the market in 2022 is expected to reach 6.25 billion US dollars. The project uses "low-temperature magnesium hydrogen storage materials and energy storage applications" in industrial applications, which can be used in the information and communications industry, emergency backup power supply system, charging stations and hydrogen refueling stations in the new generation of transportation energy industry, and long-term energy storage equipment.

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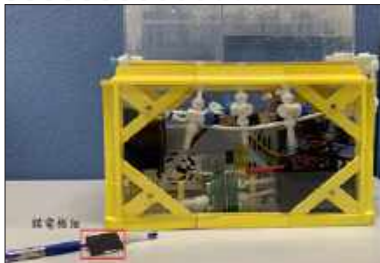
2020 FUTEX 未來科技館

FUTURE TECH, LEADING YOUR LIFE

Excellence Research
Center

P-SERS: Rapid and Sensitive On-site Detection Platform

Frontier Research Center on Fundamental and Applied Sciences of Matters |

National Tsing Hua University / Liu, Rai-Shung / Wan, Dehui

Technical Introduction

Surface-enhanced Raman spectroscopy (SERS) is a useful analytical technique for detecting extremely small amounts of molecules. Herein, we designed a paper-based quasi-three-dimensional SERS substrate (P-SERS) that can provide potential to improve Raman analyses for food safety, pesticide poisoning, precision medicine, drug abuse and DNA/RNA testing. The sensitive, low-cost, flexible and disposable SERS substrate could be easily fabricated by physical deposition of gold nanoparticles array onto a filter paper. In this case, we are able to create non-continuous Au islands on the fiber surfaces, where the gaps between AuNPs can dramatically generate the high electric field to enhance Raman signal of target molecules.

Scientific Breakthrough

In recent years, some studies demonstrate that three-dimensional substrates perform better than two-dimensional planer substrates. Three-dimensional substrates break the two-dimensional limitation and extend the hotspots into the third dimension along the z-axis. For example, papers intrinsically exhibit a quasi-three-dimensional morphology consisting of cellulose nanofibers and microfiber matrices. which significantly enhance the Raman signals of target molecules within the depth of focus of the Raman optical system. Thus, thanks to the enriched hot-spots and target molecules attributed to the increased Z-direction and concentrating effect, our P-SERS could perform a SERS enhancement factor up to 1010 and the detection limit of methylene blue is 1 pM.

Industrial Applicability

"SERS is a useful analytical technique for detecting extremely small amounts of molecules. Over the past few years, SERS has been believed as a molecular fingerprint technique and widely applied in health and environment monitoring. Our sensitive (~pM), low-cost (~300 NTD), stable (> 6 months) flexible and disposable P-SERS could significantly improve the detection techniques for food safety (Rhodamine B, Allura red, New Coccine, etc.), pesticide poisoning (Chlorpyrifos, Paraquat, Thiram, etc.), precision medicine (Vancomycin, Cefazolin, Levetiracetam, etc.), drug abuse (Methamphetamine, Mephedrone, MDPV) and DNA/RNA testing. For example, the level of Paraquat (> 1 ppm) in the serum from poisoning patients could be rapidly determined in 1 hour, with our P-SERS platform."

Excellence Research Center

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Highly Efficient Quantum Key Distribution System

Center for Quantum Technology | National Tsing Hua University Chung-Yu Mou
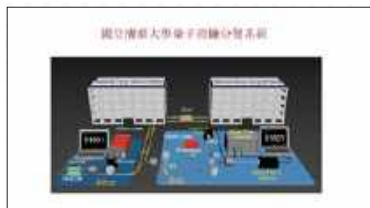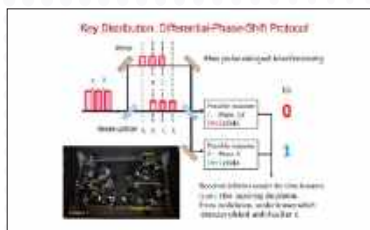
Technical Introduction

Quantum key distribution exploits the transmission and detection of single photons' quantum states to generate and distribute secure keys, allowing absolutely secure communication. We use a self-developed miniature single-photon source, together with the single-photon wavepacket engineering, to implement a highly efficient protocol of differential-phase-shift quantum key distribution. Using the Campus Fiber Network between National Tsing Hua University and National Chiao Tung University, we demonstrate Taiwan's first outdoor quantum key distribution. The technology not only benefits the development of distance unlimited absolutely secure communication networks for the commercial and military uses, but also opens up new opportunities for the R&D and markets in industry.

Scientific Breakthrough

Current quantum key distribution suffer from the low efficiency of creating a key bit from a photon. The key creation efficiency is determined, in good part, by the quantum efficiency of single-photon detectors. Our self-developed miniature single-photon source uses monolithic doubly resonant parametric down-conversion to prolong the coherence time of the single photons. Together with the single-photon wavepacket engineering, we distribute a photon equally in three pulses to implement a highly efficient protocol of differential-phase-shift quantum key distribution (90% key creation efficiency). Using the Campus Fiber Network between National Tsing Hua University and National Chiao Tung University, we demonstrate Taiwan's first outdoor quantum key distribution. The technology not only benefits the development of absolutely secure communication networks for the commercial and military uses, but also opens up new opportunities for the R&D and markets in industry.

Industrial Applicability

Quantum key distribution allows the users with the keys to implement the uncrackable symmetric key algorithms and absolutely secure communication. The technology not only can replace the need of key distribution by courier but also benefits the development of distance unlimited absolutely secure communication networks for the commercial and military uses by the government, corporations, or military. The development of quantum key distribution will also spur the development of the high-efficiency single-photon detectors, the high-speed intensity and phase modulators, and even the highly efficient single-photon sources, which are also the essential elements for applications such as the optical communication, optical LIDAR, observatory astronomy, and biological imaging.

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Rollable and soft photonic meta-device

Advanced Research Center for Green Materials Science and Technology |
National Taiwan University Wen-Chang Chen/Yang-Fang Chen/ Hung-I Lin

Technical Introduction

With the development of photonics, there has been a push towards optoelectronic devices that are flexible, rollable, wearable, user-friendly, and robust to improve human-machine interfaces. To be integrated onto human body, these devices must be biocompatible and be able to withstand mechanical deformation and different bending curvatures. Left Figures (a,b) show the rollable and soft photonic meta-device.

Scientific Breakthrough

The rollable and soft photonic meta-devices are composed of polymer and metal multilayers on paper substrate. This design enables to exhibit high photonic density of states and scattering efficiency to enhance stimulated emission and induce laser action. The rollable and soft photonic meta-device remains well its functionalities on freeform surfaces with curvature radius of 1 mm, and can withstand repeated bending without performance degradation (Right Figures (a-c)). The intensity of laser action is enhanced by 3.5 times as compared to the flat surface.

Industrial Applicability

High elasticity and super hydrophobicity polymers make rollable and soft photonic meta-device to integrate with the fabrics materials as a firm, impermeable and wear-resistant photonic skin and optical communication devices. This device is lightweight, able to control of surface wettability and surface free energy to eliminate the external flow effect from the atmosphere as a packaging protection, as well as for in vivo implantable biosensors and detecting explosive molecules on freeform surface.
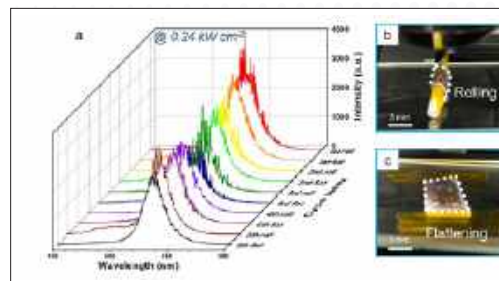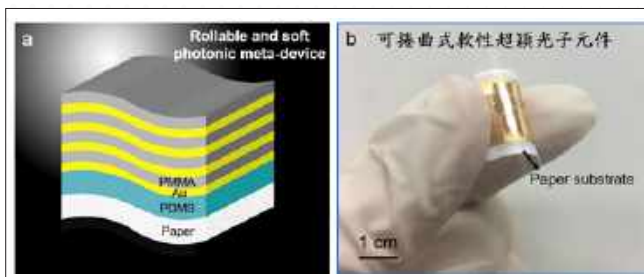
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Advanced institute of manufacturing with high-tech innovations |

National Chung Cheng University De-Shin Liu
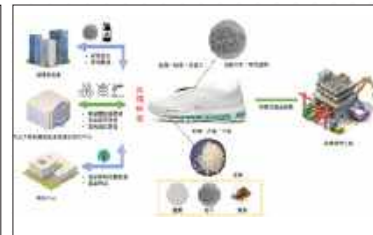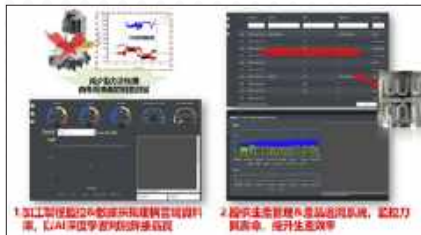
Technical Introduction

1. Demonstrate Virtual Manufacturing/AR/VR technology, integrate product design and process planning processes (simultaneous engineering).
2. 3D printing design system: Utillized Rhino's built-in calculation editor Grasshopper and infinite element method to generate complex lattice microstructures. The lattices model could directly transfer to all types additive manufacturing machine to fabricate the designs, allowing for rapid prototyping and lattices shapes iteration.
3. The AI expert system for friction stir welding (FSW) manufacturing integrates the following technologies. The expert system will be trained using the AI machine learning. During the FSW manufacturing, the AI expert system of FSW will be applied to update the welding parameters to the controller after the AI decision adaptively.

Scientific Breakthrough

1. Through the virtual processing analysis of the virtual HA500II four-axis machine tool and the CT350 five-axis machine tool, many product process and design problems can be observed with various viewpoints in the virtual simulation, effectively shortening the development cycle of new processes.
2. The big data prediction system and software developed by the 3D printing design system can fast calculate the mechanical properties and characteristics of the complex lattice design structure after the 3D printing process.
3. The welding history record also makes the product traceable. The life of welding tools can be predicted by accumulating enough data. The AI expert system of friction stir welding manufacturing can save substantial cost of production and management.

Industrial Applicability

1. Virtual manufacturing can assist the manufacturing industry in product development and plant planning more efficiently.
2. The mechanical properties of the novel lattice design microstructure developed by 3D printing software can be used in robotics, aeronautics, biomedicine, sports protection and other fields.
3. The AI expert system for friction stir welding process can cover the shortage of technology and manpower, and optimize the welding parameters so as to speed up the application of the FSW process. The more recent application of FSW had penetrated into the semiconductor and private industry. Especially for the aluminum and copper light metal, the corresponding product has high additional value.

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A smart monitoring system for shrimp growth

International Center for the Scientific Development of Shrimp Aquaculture |

National Cheng Kung University Chu-Fang Lo / Pei-Yin Chen/Kiat Siong Ng/Jiun-Yan Huang

Technical Introduction

This technology uses a customized high-resolution saltwater proof video camera that operates underwater for months on end without maintenance. The captured images are pre-processed to adjust the brightness and maximize the sharpness, after which the images are input into a region-based convolutional neural networks (R-CNN) for training and identification. This technology is currently able to reliable identify shrimp in these images and to distinguish between the shrimp's head and tail in order to conclude whether the image shows a complete shrimp.

Scientific Breakthrough

Like other sectors in the global aquaculture industry, shrimp farming depends on human judgement and experience and requires observation of the conditions in the pond as well as removal of the shrimp from the water to conduct observations and measurement of the body length. In order to allow the breeder to observe the growth of the shrimp more efficiently in their natural underwater environment, this system uses a seawater channel to corral the shrimp in front of an underwater camera, which then sends a stream of images to a host computer for shrimp identification. Shrimps are identified by the presence of both a head and body part, and the weight of the shrimp is obtained by using a formula that converts length to weight. This system has achieved more then 90% recognition accuracy, additional training on a much greater number of shrimp images is expected to achieve higher recognition accuracy.

Industrial Applicability

By developing an artificially intelligent (AI) system that recognizes shrimp images and automatically measures the shrimp's length and weight, this technology is intended to free shrimp breeders from traditional methods (i.e. human eyes and experience) of observing growth in shrimps. This system will not only reduce labor-force requirements in the future, but also allow for more immediate observation of larger quantities of shrimp. This in turn will allow farmers to quickly adjust the feed supply to optimize the growth rate of the shrimp.

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The gender discrimination of income distributions

Center for Research in Econometric Theory and Applications, National Taiwan University |
National Taiwan University Larry Y. Tzeng

Technical Introduction

We develop a test for discrimination and apply it to analyze the change in income distributions between female and male. We then classify our data into married and single groups to trace the sources of income differences between female and male from 2005 to 2015.

Scientific Breakthrough

With Michael Hoy, our researcher, Rachel Huang, published a paper in the Journal of Economic Theory on a new measure for income discrimination in 2017. On basis of this theoretic work, two of our researchers, Rachel Huang and Yu-Chin Hsu, further develop a new test for income discrimination. This new technology could enhance the application of research in income discrimination.

Industrial Applicability

On basis income distributions from 2005 to 2015 in Taiwan, we find that differences of income distributions between male and female in the married group could be attributed to "marriage effect" which is an internal decision between husband and wife. On the other hand, we find that differences of income distributions between male and female in the single group could be attributed to "industry effect" which is a choice for career long before they get into job market.

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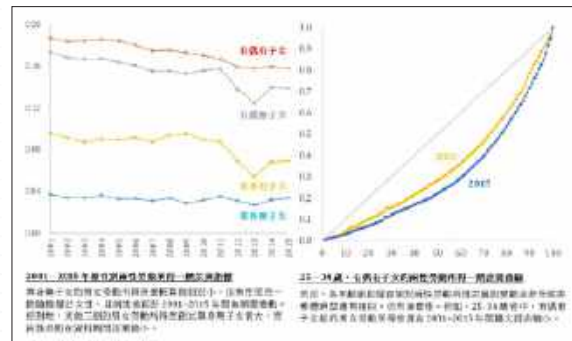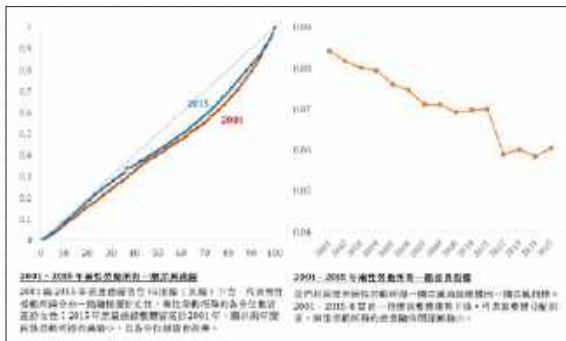
High-Entropy Non-Sparking, Anti-Bacteria, and High-Endurance Alloy Technology

High Entropy Materials Center | National Tsing Hua University Jien-Wei Yeh

Technical Introduction

High entropy materials were proposed and developed by Professor Jien-Wei Yeh in 1995. He named, defined, and elucidated "High-Entropy Alloys," as well as established High-Entropy Materials Center to develop critical materials for smart machine, green technology, biomedical technology, and national defense. Alloys with high strength, corrosion resistance, and anti-bacterial capability are also developed for manufacturing knives, door handles, handrails, etc. to prevent infection during the post-epidemic era.

Scientific Breakthrough

1. Non-sparking tools and stainless anti-bacteria copper knife
   Non-sparking and beryllium-free high-strength medium-entropy alloy has been developed to substitute Cu-Be alloy for non-sparkling tools in consideration of the high cost and toxicity of beryllium. It can be also used in making knives and cutting boards having anti-bacteria function.
2. Bearing for oil well
   High-entropy alloy with low cost and superior performance has been developed to replace high cobalt Stellite® 6 alloy for bearings used in submerged pumps in oil well.
3. Turbine engine
   High-entropy superalloys have been developed to have superior strength, density, cost, ductility, and high-temperature strength over traditional superalloys. They can be used in turbocharger and turbine engine.

Industrial Applicability

1. High-strength high-entropy copper alloy - Non-sparking tools and stainless anti-bacteria copper knife
   It can be used in tool industries producing non-sparking hammers, wrenches, screwdrivers, pliers, and shovels. It can also be used in commodities industries producing anti-bacteria knives, forks, bowls, scissors for raw foods, straw, etc.
2. Extreme high-entropy alloy - Bearing for oil well
   It can be used in industries including oil well, energy, machine, chemical plant, geothermal power plant, etc.
3. High-entropy superalloy - Turbine engine
   It can be used for transportation industries producing drone, micro-turbine engine, generator, turbocharger, etc.

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Virus and Cell Culture Platform for Vaccine Production Technology

Research Center for Animal Biologics | National Pingtung University of Science and Technology Hso-Chi Chaung; Guan Ming Ke

Technical Introduction

The "Viral Vaccine Cell Production Technology Platform" of this exhibition is based on 1. Host cell and virus match and colonization technology; 2. Cell-expressed virus receptor technology; 3. Blocking antiviral mechanism of host cell; 4. Immortalization technology of host cell; 5. Serum-free suspension cell culture technology to produce high-immunity virus vaccine strains containing intact virus antigens.

Scientific Breakthrough

Through gene editing and transfection, these techniques block the host cell's antiviral mechanism, and let the host cells express the specific viral receptor, reduce the immune response and apoptosis after virus infection, and provides rapid propagation of the virus. This technique strengthens the susceptibility of host cells to viruses, increases virus productivity, and produces intact antigens for production of commercial vaccines. These techniques can effectively increase productivity (market technology/ high performance cell production virus system), such as **pseudorabies virus** ($10^{7.5}/10^{10}$), **porcine infectious diarrhea virus** ($10^{4.5}/10^{8.5}$), very virulent **infectious bursal disease viruses** ($10^{3.5}/10^{8.5}$), **Newcastle virus** ($10^{7.5}/10^{9.5}$), **avian reovirus** ($10^{6.5}/10^{8.5}$).

Industrial Applicability

The industrial application is as follows: 1. Manufacturing various vaccines. 2. Reducing the cost of vaccine preparation. 3. Virus production with high efficiency: The data shows that it can increase the output by 1000 times than other virus production methods. 4. Industrialization: This technology has been successfully applied to vaccine manufacturing. 5. Low pollution: This process uses culture virus without adding animal serum to diminish possible pollution in the vaccine production. 6. Rapid vaccine production responses to acute animal or human epidemics. 7. Development of antiviral drug screening platform is based on this technique. 8. It adapts animal welfare and humanitarianism and conducive to technology promotion.

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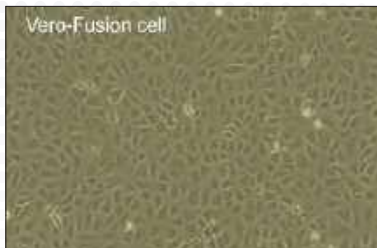
The application of next-generation sequencing in the genetic diagnosis of epidermolysis bullosa and the establishment of multidisciplinary clinic for epidermolysis bullosa

International Center for Wound Repair and Regeneration | National Cheng Kung University Ming-Jer Tang
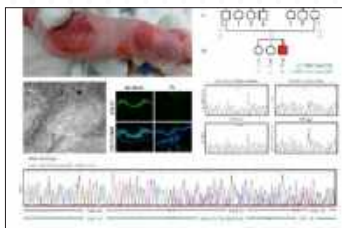
Technical Introduction

Epidermolysis bullosa (EB) is an inherited blistering skin disease and is also one of the most "urgent, severe, difficult and rare" diseases. Since there are at least 21 disease-causing genes involved in EB with markedly variable manifestations, it is particularly difficult for accurate diagnosis. In recent years, next generation sequencing (NGS) has been widely applied in the genetic diagnosis of rare hereditary disorders. The EB team in NCKU established the protocol of EB diagnosis by combining NGS and various tools of pathology and molecular studies. Till now, we have completed the genetic diagnosis for more than 50 Taiwanese EB patients.

Scientific Breakthrough

Traditionally, the genetic diagnosis of EB is made by immunofluorescence study and followed by Sanger sequencing for the suspicious genes. However, it is expensive, time-consuming, and not in line with clinical needs. NGS can complete genetic diagnosis is a more efficient way. Besides, the genetic background of Taiwanese EB is still unrecognized. We've applied whole exome sequencing to identify disease-causing mutations and verified the pathogenicity of the novel mutations by in vitro studies. These results are the stepping stones for the establishment of the Taiwanese EB genetic database in the future.

Industrial Applicability

1. iWRR has spin-offed the Ducolege Biotechnology Co. Ltd., which manufactures the marine collagen as raw material for medical cosmetic products as well as active wound dressing. The marine collagen, free of pigment and fish smell, shows high purity and bioactivity. It has excellent biocompatibility, high biodegradability, low antigenicity and high cell growth potential.
2. We have established the multidisciplinary clinics for epidermolysis bullosa patients in National Cheng Kung University Hospital, and provided a comprehensive platform for patient care, including wound care, itch/pain, nutrition, psychology, ophthalmology, dentistry, cardiology, hematology, etc.

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5G C-V2I Enabled Intelligent Real-time Trajectory Prediction and Warning System

Center for mmWave Smart Radar Systems and Technologies | National Chiao Tung University

Jenn-Hwan Tarng / Ta-Sung Lee
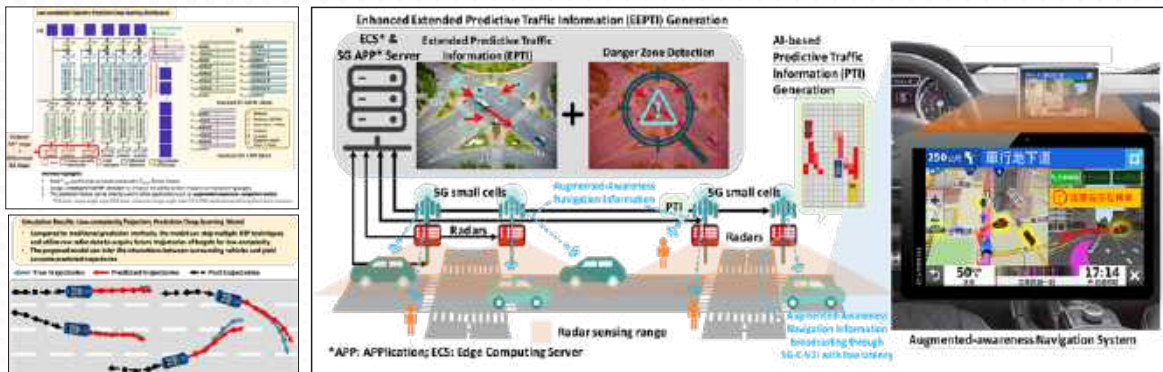
Technical Introduction

This study proposes a 5G C-V2I (Cellular Vehicle-to-Infrastructure) enabled intelligent trajectory prediction and warning system, which can be implemented in a framework including RSUs (Road Side Units) with radar detection ability and 5G edge computing servers. This study exploits artificial intelligence to predict instant trajectories of vehicles at crossroads. The resulting augmented-awareness navigation information is then broadcasted to road users through 5G C-V2I with low latency. In practical applications, road users can obtain real-time dynamics of surrounding vehicles so that their level of safety can be effectively enhanced.

Scientific Breakthrough

The proposed trajectory prediction system adopts mmWave radars as the detection devices, which is more reliable in harsh environments than using GPS and image-based systems. This study proposes a light-weight residual ST-LSTM (Spatial-Temporal Long-Short Term Memory) deep learning neural network to greatly enhance the model's capability of extracting parameters of moving targets. This technique can achieve real-time trajectory prediction by using RSU radars. Through 5G C-V2I, the resulting prediction information is transmitted to road users via URLLC network protocols with a low latency. The study is the first attempt to develop an intelligent trajectory prediction and warning system based on 5G C-V2I architecture and mmWave radars, and the proposed system can increase prediction reliability in harsh environments.

Industrial Applicability

The proposed intelligent trajectory prediction and warning system can provide more time margin for road users to conduct essential decision making and judgements. Road users can access this safety service through an easy-to-use APP operated on in-vehicle tablets or smart phones. The proposed system meets the specification of 5G C-V2I and can be integrated in existing traffic monitoring platforms for entering the intelligent transportation market. Road users can benefit from the system with augmented-awareness navigation and experience elevated level of safety. The proposed solution has great potential to open up a new 5G service market with a highly promising prospect.

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Low temperature/instant copper bonding and high toughness RDL lines using nanotwinned copper

Center for Semiconductor Technology Research | National Chiao Tung University Chenming Hu/ Chih Chen

Technical Introduction

Nanotwinned Cu possesses excellent electrical and mechanical properties. This is an essential material for the next generation copper interconnects. It can be applied in two major joints:
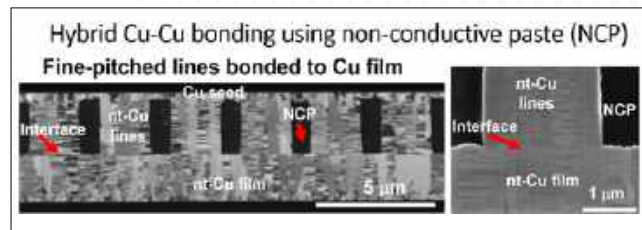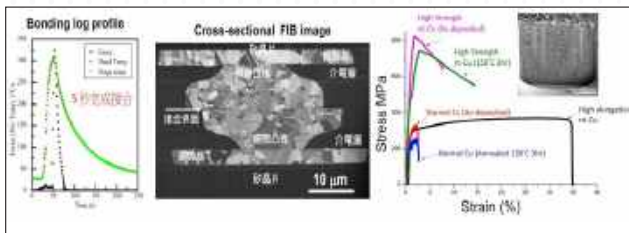1. Low thermal budget/ low resistance Cu bonding for high performance computing chip.
   We are able to achieve low temperature bonding and instant bonding. Low temperature bonding is performed at 150°C for 1 hour to achieve low contact resistance copper bonding. Instant bonding is performed at 300°C for 5 seconds under a pressure of 90MPa achieve low contact resistance.
2. High strength/ High ductility copper lines in 3D-IC packaging
   We are able to fabricate high strength foils with tensile strength of 800MPa while maintaining acceptable ductility. after annealing at 150°C for 3 hours, the foil retains a tensile strength of 750MPa. This exhibits the ideal thermal stability and ductility for 3D-IC application.

Scientific Breakthrough

We are able to DC electroplate highly (111) oriented nanotwinned copper films and fabricate high strength/high conductivity/ High toughness copper lines in 3D-IC packaging The tensile strength can be as high as 800MPa while maintaining reasonable ductility. After annealing at 150°C for 3 hours, the foil retains a tensile strength of 750MPa. This exhibits the ideal thermal stability and toughness ductility for 3D-IC application.

Industrial Applicability

Low temp Cu-Cu bonding appears to be the solution for next generation ultra-fine pitch packaging. Nanotwinned Cu lines can also be used as redistribution lines in 3D IC integration. This technology has drawn attention from TSMC, MediaTek, Applied Materials, LAM Research, and we have collaboration projects with them to co-developed some applications.

Hybrid Cu-Cu bonding using non-conductive paste (NCP)
Fine-pitched lines bonded to Cu film

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Thermoplastic Casting Tape

Research and Development Center for Smart Textile Technology |

National Taipei University of Technology Syang-Peng Rwei

Technical Introduction

The invention relates to a thermoplastic thin 2D mesh fabric composite structure, which particularly can be used as a medical protector or in connection with sporting activities with impact resistance, light weight and high air permeability, and has a reshapeable orthopedic support, or fixed support bandages for limbs and / or joints. The thermoplastic thin 2D mesh fabric composite structure mainly includes a breathable mesh fabric and a high molecular polymer coated on the breathable mesh fabric that can be reshaped and reused when exposed to heat.

Scientific Breakthrough

The invention discloses the application of a heating method to apply the high molecular polymer to the breathable mesh fabric, and to punch the composite structure including the coated high molecular polymer and the breathable mesh fabric to form a thermoplastic thin 2D mesh fabric composite structure that can be reshaped and reused when exposed to heat. The using temperature is between 70 to 90 ℃ . It is exactly the temperature value passing over the melting temperature, Tm, of the coated polymers.

Industrial Applicability

This product is targeted to replace the traditional cast material- CaO. Moreover, to replace the thermoplastic board (Orfit product) currently used by some hospitals. Furthermore, to replace the thermosetting tape manufactured by 3M Co., which was a composite with reactive polyurethane/glassy fabric. The remained isocyanate compound in the wrapped tape is really harmful to the humane skin. Two special characteristics make this bandage very special: the most light weight and the most breathable as a wrapping cast. We have obtained the vending allow number from the government : 008080.

Can be one time usage for medical applications.

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NCTU Sperm Sorter

Center for Emergent Functional Matter Science | National Chiao Tung University Chain-Shu Hsu / Bor-Ran Li / Chong-Sian Huang / Teng-Kuan Huang
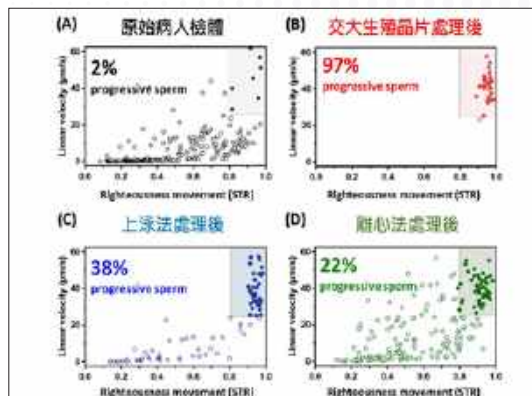
Technical Introduction

Infertility is a serious globe issue, especially in the developed countries, over 20%infertile male has sperm problems, that include instance immotile, abnormal morphology and low sperm quantity. Therefore, how to isolate high quality sperm for clinical use is extremely required. Up to date, activity sperm sorting is usually using Swiming-up and Density gradient centrifugation approaches. Unfortunately, both methods are detrimental to the sperm viability and elicits production of reactive oxygen species. Separation sperm by microfluidics has been put emphasis on and studied; however, it faced some challenge such as low throughput and an unacceptable recover rate.

Scientific Breakthrough

We developed a new type of microfluidic chip with utilizing the characteristic of sperm anadromous instinct for high-throughput sperm separation. The process can be finished in 10 min, which his 10 times faster than the conventional MFC design. Computer Assisted Semen Analysis (CASA) System was utilized to calculate sperm quality and visualize the sperm by spermac stain. Experiment reveals that the qualified sperm motility was raised upfrom30% to 99% and linearity (LIN) up from 0.2 to 0.85via sorting by our microfluidic chip (MFC chip).

Industrial Applicability

In this novel device, high quality sperm were sorted by their anadromous phenomenon and results in an ultra-rapid and effective sorting ability. Compared with traditional Swinging up, Density gradient or other microfluidic separation methods. Using the CASA system to analyze the sperm motion trail, we found sperm sorted by microfluidic have high linear velocity and linearity. The anadromous sperm grading chip provide high-throughput separation with live high quality sperm.

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EditCell Virology Platform

Research Center for Emerging Viral Infections | Chang Gung University Shin-Ru Shih
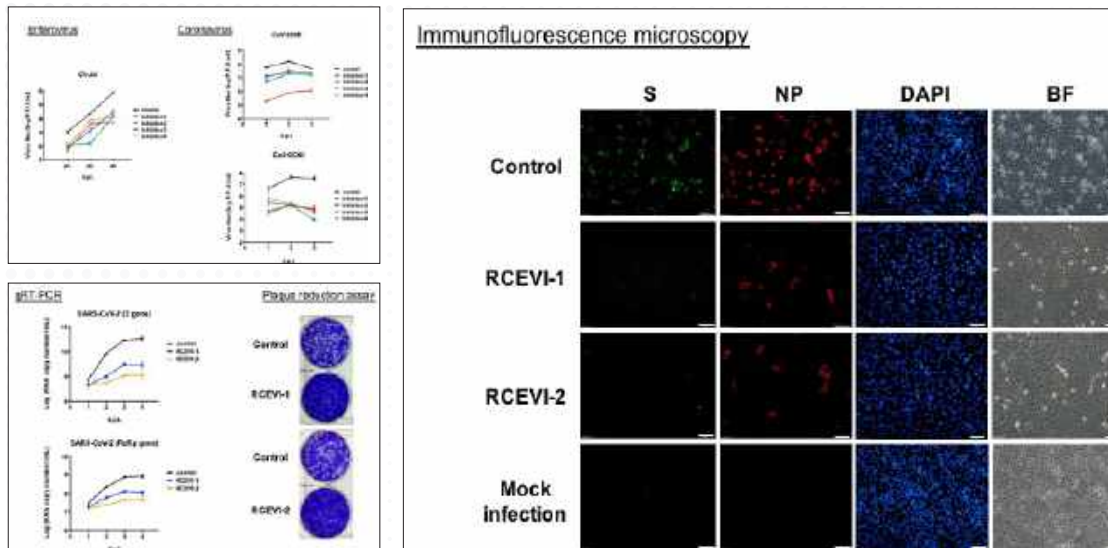
Technical Introduction

1. Identification of host factor, which is required for virus replication, by "EditCell Virology Platform".
2. The host factor will be as a target to develop antivirals.
3. The antiviral effects of the candidates can be validated in vitro and in vivo.
4. Two FDA-approved drugs are repurposed for COVID-19 treatment.

Scientific Breakthrough

There are still many viruses treat to human, but no effective antivirals against them. The "EditCell Virology Platform" can be used to screen the important factors involved in virus replication, and then these factors can serve as targets for antiviral development. Furthermore, we can verify the antiviral effects of the candidates in vitro and in vivo to identify effective antivirals against viruses. Based on our previous studies, we have successfully determined two FDA-approved drugs can reduce viral load of SARS-CoV-2. Now, we are seeking collaborations with pharmaceutical company for clinical trials.

Industrial Applicability

The development of antiviral is important for human to fight virus infection, and it is also closely related to global economy. Moreover, the rising number of COVID-19 deaths caused by SARS-CoV-2 around the world. COVID-19 pandemics is not only a threat to human lives, but also global economy. Therefore, the research and development of antivirals are important for application of biomedical or pharmaceutical industries and clinical treatment in the future.

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Center of Innovative and Sustainable Environment and Policy of Population Health |

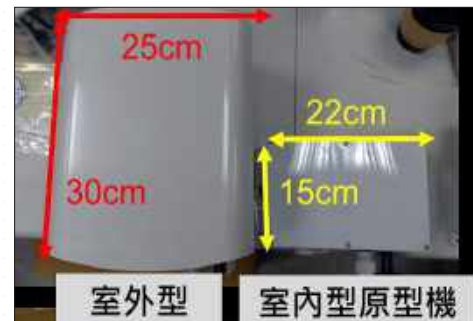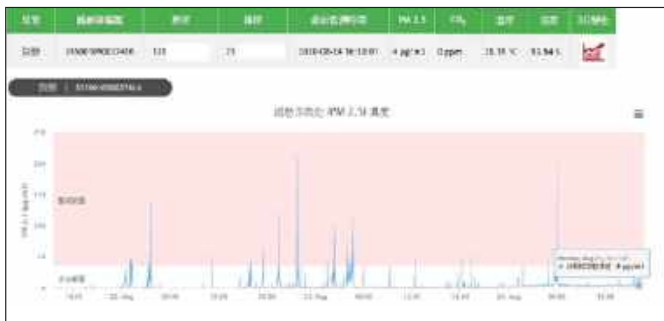National Taiwan University Chang-Chuan Chan ScD

Technical Introduction

1. Real-time monitoring of air quality in indoor and outdoor environments:
   Sensors based on laser light scattering and electrochemistry are used for monitoring PM2.5 and other air pollutants in indoor and outdoor environments. The collected data from the sensors are transferred to the data center at NTU PHRC by 4G LTE. The residents can obtain the real-time air quality information through the website.
2. Precision Prevention Application: an APP of CVD Risk Prediction:
   We developed an application for predicting CVD risk based on a Bayesian predicting model with personalized factors. With the precision risk of CVD, the health care workers can provide personalized suggestion for patients.

Scientific Breakthrough

1. Indoor monitors were designed through miniaturizing outdoor monitors with sensors having good performance. The monitoring data are automatically transferred into the data center at NTU PHRC every minute. The residents can log in our website and obtain the real-time air quality condition for the past 3 days.
2. Based on a Bayesian model with general factors (ex: lifestyle behavior) as well as personal factors (ex: history of MetS), we can predict and update the risk of CVD for each person step by step with the available information.

Industrial Applicability

1. Our study collaborated with a manufacturing company to create a miniaturized monitor with smaller volume and weight for indoor environment. Also, sensors related to other air pollutants indoors are added. With the IoT technology, we achieve collecting long-term and real-time environmental monitoring data, which is helpful for the indoor environmental management of long-term care institutions.
2. With the integration of the precision predicting risk into the APP, the health workers can provide a better suggestion for preventing CVD for patient according to their personal information.

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New insight into the brain: Optical imaging/stimulation and spiking neural circuit models

Brain research center | (National Tsing Hua University) Ann-Shyn Chiang/ Chung-Chuan Lo/ Shun-Chi Wu, (National Taiwan University) Shi-Wei Chu
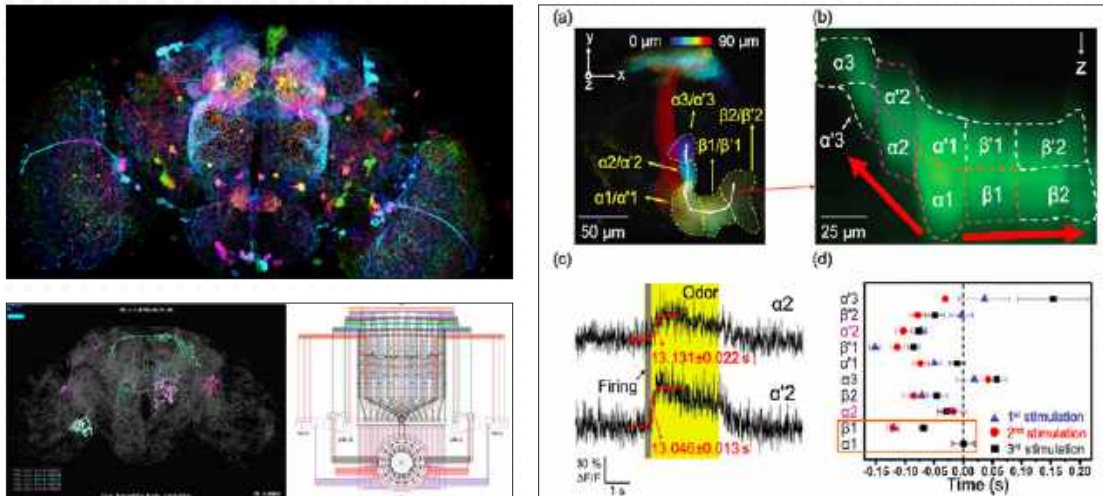
Technical Introduction

Constructing a functional connectome and its computational model is a crucial step toward understanding the mechanisms of brain functions. To achieve this goal, we developed two correlated technologies: (1) An all- optical physiology (AOP) that is capable of millisecond volumetric imaging and accurate stimulation in living animal brains. This system allows us to establish functional connectome and neural coding with a single-cell resolution. (2) A cellular-level spiking neural circuit simulation system that is capable of tuning itself based on the input data from the AOP system. We have demonstrated our technologies in the Drosophila late visual system and will apply them in the brains of larger species such as mice. We expect that our technologies will be able to greatly enhance our knowledge of the brain operation principles.

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 (iScience2019). 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.

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 AI algorithms.

Post COVID-19, novel critical green energy materials with local supply chains

Hierarchical Green-Energy Materials (Hi-GEM) Research Center | National Cheng Kung University (NCKU)

Jow- Lay Huang

Technical Introduction

(1) Gel-type solid electrolytes and All solid-state electrolytes for Lithium-ion Battery (LIBs)
(2) Fabrication of dye-sensitized solar cells by printing process and its applications on Internet-of-Things (IoT) - MOST 2019 Award
(3) Silicon-carbon coating anode materials for LIBs: SiLican startup company growth and global business layout
(4) Power enhanced Intermediate Temperature Solid State Fuel Cell (SOFC)
(5) Perovskite solar cells
(6) Industrial linking and Product design : LevioPole and Smart motorcycle suitcase

Scientific Breakthrough

(1) On-site coagulation: Applicable to current assembly line/ High safety/High efficiency
(2) Gel-electrolyte of DSSCs are prepared for operation by printing process.

(3) High capacity Silicon-based anode material was passed MIIT LIB qualification.
(4) The power performance of SOFC can be enhanced by high reaction area honeycomb structure of the micro tube type SOFC and advanced ceramics molded film process.
(5) The world's highest conversion efficiency (19.4%) perovskite solar cells.
(6) Harvesting power supply system for motorcycle suitcase with patented lighting function circuit.

Industrial Applicability

Hi-GEM's contributions to Taiwan industry:
(1) Supporting the long term R&D technology and researcher training for large-scale companies (CPC/CSC etc.) in LIBs industry;
(2) Providing novel green energy material technology to the market;
(3) Linking the upstream, midstream and downstream industry to enhance the local supply chain;
(4) Serving enterprises with industrial alliances;

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Precision Medicine in Post-pandemic Era-SARS-CoV-2 Virus Strain Analysis, Novel ctDNA Marker for HCC Detection, and Cancer Immunotherapy Study

Center of Precision Medicine | National Taiwan University Yen-Hsuan Ni

Technical Introduction

1. SARS-CoV-2 Isolation and Whole-genome Sequencing Analysis-The whole-genome sequencing was performed to examine 28 SARS-CoV-2 virus strains from patient tissue samples isolated by NTUH Department of Laboratory Medicine.
2. Vh-chimera DNA as a New ctDNA Marker for Detecting the Existence of HBV-related HCC-About one-third of patients suffer tumor recurrence within the first year after surgical resection of HCC and their overall survival is compromised. The study identified vh-chimera DNA as a novel ctDNA marker for HBV-related HCC detection.
3. The Application of Quantitative Slide Scanner Vectra® Polaris™ and Multicolor Flow Cytometry Analysis in Cancer Immunotherapy Study-By cross-referencing the results of tissue fluorescence labelling and multicolor antibody hybridization with clinical data, the research looks for targeted cells and relative biomarkers in cancer immunotherapy.

Scientific Breakthrough

1. The research compared the difference between virus sequences obtained from Taiwan and those from around the world using phylogenetic analysis to clarify the possible origins and transmissions of individual virus strains.
2. The results showed HBV integrations in >95% of HBV-related HCC patients and the copy number of vh-chimera DNA in plasma correlated with tumor size. Among patients with the ctDNA marker in plasma collected 2 months after surgery, 81.8% suffered from HCC recurrence within one year.
3. By observing distribution, distance, and numbers of certain cells as well as their protein expression, the techniques allow us to elucidate the special difference of different immune cells in tumor microenvironment.

Industrial Applicability

1. The research group was one of the firsts to isolate virus strains and completed sequence analysis. The obtained results have prepared us to become a major platform and material provider in relative virus studies in Taiwan.
2. By collaborating with TCM Biotech International Crop. , the study will be applied to quantify vh-chimera DNA in plasma samples and detect residual or recurrent HCC.
3. The techniques are utilized to discover predictive biomarkers for cancer immunotherapy efficacy and explicate certain cellular activation in cancer patients before and after receiving immunotherapy. Correlation analysis can be further performed with tumor response, clinical benefit, and overall survival.

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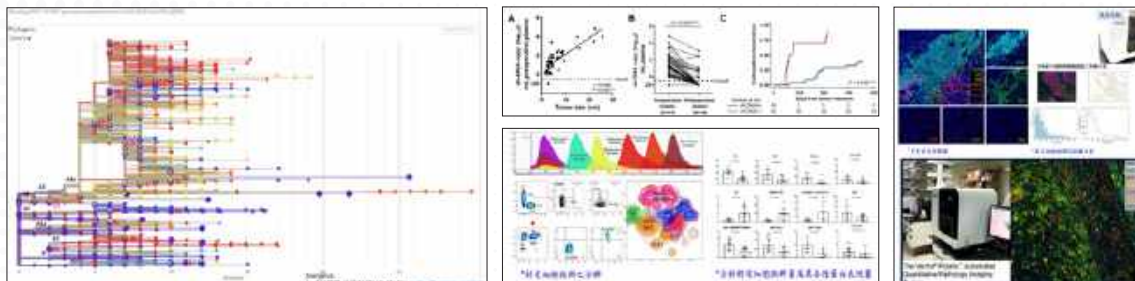
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National Applied
Research
Laboratories

5D Smart City—SmartES Platform

National Applied Research Laboratories, National Center for Research on Earthquake Engineering |
Ren-Zuo Wang

Technical Introduction

NCREE has originally developed 5D digital space—on the basis of 3D city models and connections of different kinds of sensors around the world—is an online to offline virtual space with a combination of rising 5G technology advantages. Collecting and reorganizing various 3D cartographic data with Building Information Modeling (BIM), satellite imagery, UAV 3D modeling with high-resolution cameras, LiDar point cloud data, etc., can increase the diversity of the building and landscape to make the city more realistic. 5D+5G smart city platform speeds up all aspects of value-add applications of smart cities, including Intelligent Transportation System (ITS), Smart Energy (SE), and Ambient Intelligent (AmI). We expect that the 5D smart city becomes the digital twin of a real city.

Scientific Breakthrough

1. 5D digital space: the integration of various technologies, including knowledge, sensory ability, reasoning ability, the transmissibility of neural network, decision making, and judgment ability.
2. The integration of GIS, BIM, and IoT: Collecting and reorganizing various 3D cartographic data with Building Information Modeling (BIM), satellite imagery, UAV 3D modeling, LiDar point cloud data, etc., can increase the diversity of the building and landscape to make the city more realistic. Furthermore, integrating with the Internet of Things (IoT) by collecting and synchronizing the sheer volume of sensors deployed at every corner in cities. It not only reinforces the functionality of the 5D+5G smart city platform but also speeds up all aspects of value-add applications of smart cities.

Industrial Applicability

1. Smart Disaster Prevention: 5D+5G smart city platform regularly detects and reports emergency when disaster happens. Not only earthquakes but also flood, landslide, fire disaster, and wind disaster, it helps administrators make decisions more efficiently and conducts rescue plans more completely.
2. Intelligent Transportation System (ITS) and Smart Environment: 5D+5G smart city platform applies in autonomous driving, shared vehicles, unmanned store, sensor real-time detection, and cultural heritage preservation. It assists people with more comprehensive public infrastructure management, facilitating cities to become smarter.

National Applied Research Laboratories

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Intelligent Multi-wavelength Lighting System

National Applied Research Laboratories, Taiwan Instrument Research Institute | Jiann-Shiun Kao, Yi-Cheng Lin, Hsin-Yi Tsai, Min-Wei Hung, Kuo-Cheng Huang, Chih-Yi Yang

Technical Introduction

An intelligent multi-wavelength lighting system was developed by NARLabs, NHRI, Kaohsiung Medical University ,and X-Loupe. The wavelength and brightness of the lighting system can be adjusted for clinical use by physicians. It is also equipped with several functions such as reminders of lighting, parameter records of use time, lighting brightness and wavelengths. The systems could help the patients adjust the physiological parameters based on the deployment of the lighting system. The using lighting parameters would upload to the database in the cloud, and which can compare with the psychological evaluation parameters for treatment physical impact analysis in the hospital. With the lighting system, the problem such as poor sleep quality can be greatly improved, and the occurrence probability of mild cognitive impairment and dementia can be deferred.

Scientific Breakthrough

The intelligent lighting system integrates multi-wavelength smart control technology, sensors and IoT technique. This system has R, G, B, W light sources for insomnia adjustment by professional physicians, and can adjust the wavelength and intensity of the light source. It also has a record of the time and frequency of use, which can be used as an evaluation by the doctor to evaluate the completeness and efficacy of the patient. The advanced technology of phototherapy has been successfully realized to solve the sleep problems of patients with sleep disorders and early dementia, achieving the goal of health care and preventive medicine aims.

Industrial Applicability

Through the integration of multi-wavelength intelligent lighting control equipment and the IoT technology, the innovative concept is proposed to intelligently adjust the lighting to improve the sleep of early dementia and mild cognitive impairment group and construct a healthy home environment. Connected to the Internet and using the big data analysis to optimize the distribution of lighting parameters in the home environment. Through the integration of different technologies, it promotes the improvement of sleep and health care of the testers. This technology will effectively enhance the health value benefits of the photoelectric LED industry and add value for health care and clinical phototherapy industry.

National Applied Research Laboratories

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Autonomous Vehicle Simulation System

National Applied Research Laboratories, Taiwan Semiconductor Research Institute |
Chi-Shi Chen, Yu-Tsang Chang
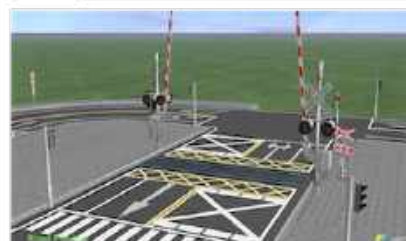
Technical Introduction

Autonomous vehicle test at a limited field or even on the public road has its limitations. Simulation is essential to increase the test coverage. Taiwan Semiconductor Research Institute(TSRI) develop an autonomous vehicle test system based on CarMaker, which is a simulation tool from IPG Automotive. 13 testing scenarios and 6 testing routes corresponding to the physical test at Shalun testing field are built and included in this autonomous vehicle test system. An AEB(Autonomous Emergency Braking) function will be demonstrated to show how this autonomous vehicle test system works.

Scientific Breakthrough

1. Support MIL(Model in the Loop), SIL(Software in the Loop) and HIL(Hardware in the Loop) simulation
2. A reference hardware design for HIL simulation
3. 13 testing scenarios and 6 testing routes corresponding to the physical test at Shalun testing field included
4. 10 testing suites related to common car accidents in Taiwan included
5. 3D models of Taiwan's traffic signs included

Industrial Applicability

1. Automotive industry: Complete and rigorous simulation system is required for car makers
2. Public transportation industry: e.g. autonomous bus for the suburb or off-peak time
3. Sharing economy: e.g. autonomous taxi or food delivery
4. Logistics industry: e.g. last mile delivery

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The technology of urban traffic control optimization platform

National Applied Research Laboratories, National Center for High-performance Computing |
Fang-Pang Lin, Jyh-Horng Wu, Chung-I Huang
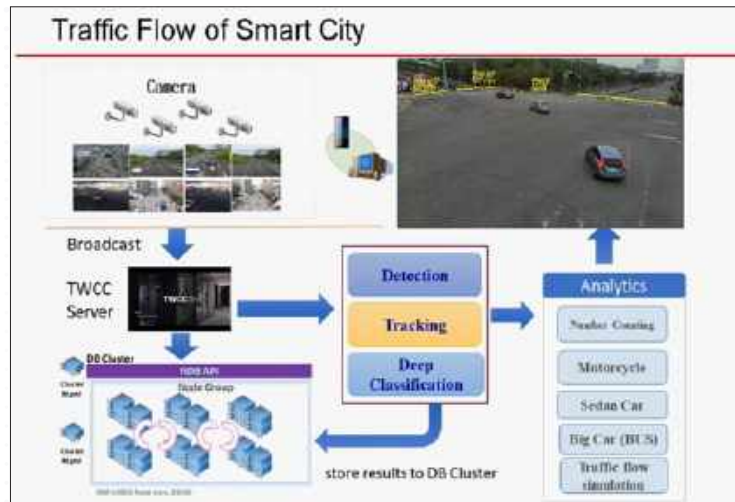
Technical Introduction

The urban traffic control optimization platform technology is developed by combining vehicle tracking and identification technology with traffic control factor simulation technology, the system is equipped with vehicle counting and vehicle type classification, regional intersection traffic simulation, light optimization and other functions. Through the combination of traffic information and deep learning analysis to help optimize traffic signals at each intersection, it promotes smoother driving for the public.

Scientific Breakthrough

This technology can be applied to traffic flow analysis at intersections, regional vehicle classification statistics, traffic signal optimization, and similar applications. Through the cooperation of regional traffic authorities, it can improve traffic congestion and optimize the average time of waiting and the speed of traffic flow.

Industrial Applicability

This technology can be applied to traffic flow analysis at intersections, regional vehicle classification statistics, traffic signal optimization and other applications. With the cooperation of regional traffic authorities, it can help improve traffic congestion and optimize the average waiting time and speed of traffic.

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Portable On-site Earthquake Early Warning System

National Applied Research Laboratories / National Center for Research on Earthquake Engineering |
Pei-Yang Lin, Hung-Wei Chiang

Technical Introduction

NCREE combined on-site and regional EEW to provide the hybrid EEW for the industries. As results, the fast and accurate earthquake warning message can be provided to the industry with low cost (No cost for the EEW hardware, only the receiver and disaster reduction system). Industry can combine the Hybrid EEW with their existing service and provide one more disaster service to their customer.

Scientific Breakthrough

· Detect the minor P-wave and predict PGA in 1~3s. The predict accuracy is up to 95%
· It can provide 5~15s of warning time for the region with 30~100km epicenter distance.
· No false alarm through the multiple backup sensor arrangement.
· Reduce seismic loss by automatically disaster-reduction control (gas valve, door luck, train brake, excavation guild light, warning sound, elevator stop)

Industrial Applicability

Security industry: EEW warning, disaster reduction control, to reduce the seismic loss of the customers.
Smart home devices: EEW warning, disaster reduction control with the existing IOT devices.
Insurance: provide EEW, disaster prevention services to customers to reduce the seismic loss.
Telecommunications: provide EEW and extra disaster prevention services through the existing channel.

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How on-site EEWS works
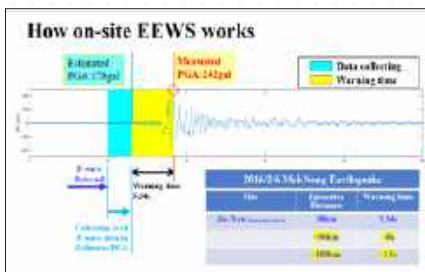
Typical arrangement of on-site EEWS

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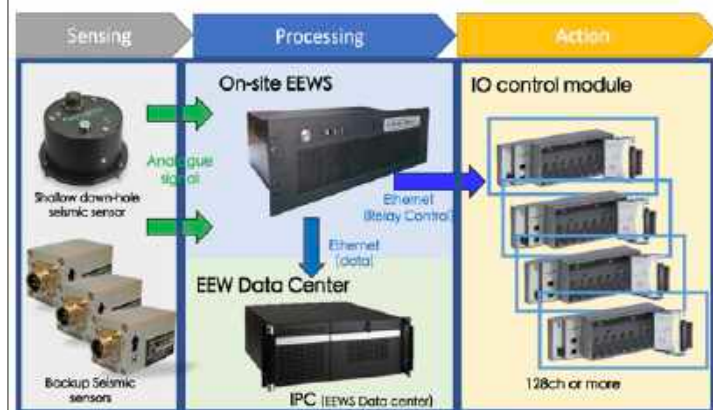
AI Video Analysis and Object Retrieval System

National Applied Research Laboratories / National Center for High-performance Computing |
Jyh-Horng Wu, Chien-Hao Tseng, Chia-Chien Hsieh, Meng-Wei Lin
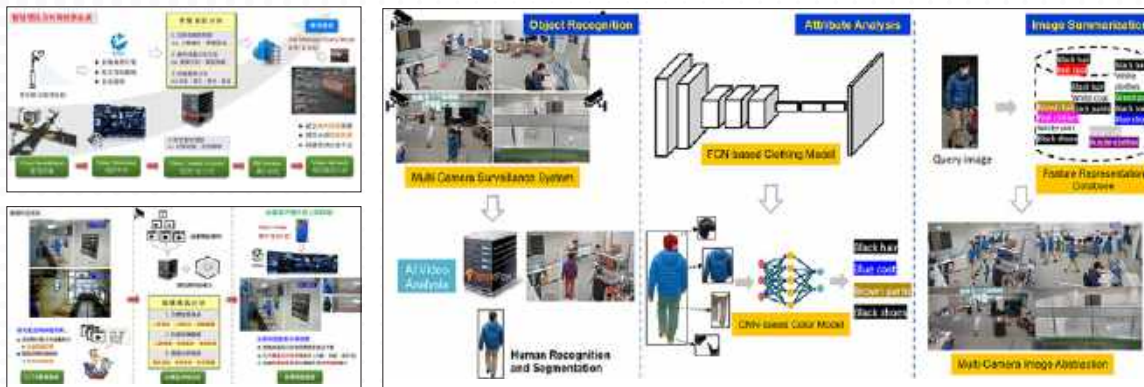
Technical Introduction

To resolve public safety and security issues, NCHC developed intelligent video analytics and retrieval system, which can integrate the attribute analysis and recognition of vehicles/pedestrians from CCTV surveillance cameras, utilize TWCC high-speed operation in developments such as AI image semantic analysis and video synopsis technique, to effectively and rapidly search for key targets(vehicles/pedestrians) and provide short clips of the targets' moving path simultaneously, and as a result fulfill the quick search application service of technological surveillance and Investigation.

Scientific Breakthrough

1. Provide a comprehensive solution for video analyzing and retrieving, which can rapidly analyze considerable image data and effectively extract crucial information from the video.
2. Quickly build object associated databases through AI attribute analyzing and recognizing mode, providing a platform to rapidly search for crucial information and data.
3. Using the video synopsis technique, video clips of the moving path of the key target can be provided effectively, which shortens the period of inspecting huge amounts of videos.
4. Supports offline video analysis, online video streaming, and multiple-camera surveillance structure.

Industrial Applicability

1. Security Industry: Provide multiple camera intelligent safety surveillance systems for buildings such as apartments or factories.
2. Police Industry: Provide the application service of crucial figure surveillance and reconnaissance in public areas for law enforcement crews.
3. Catering and Service Industry: Provide the vendor with an all-weather all-field video surveillance environment, improving the tourists' safety protection.

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National Applied Research Laboratories

Blowing type of Ketone gas sensor applied in healthy care

National Applied Research Laboratories / Taiwan Semiconductor Research Institute |
Han-Ding Syue, Jhih-Hong Lin

Technical Introduction

This technology is used micro-electro-mechanical systems combined nanomaterials and micro-heater systems, because the interdisciplinary integrated manufacturing technologies are used to make miniaturized sensor elements, which are equipped with bluetooth functions of algorithms and detection devices to monitor the ketones gas concentration during patient breathing applied in healthy care.

Scientific Breakthrough

The gas sensor has the function of monitoring abnormal fuctionanl metabolis. This non-invasive home detection instrument can avoid the pain of traditional needle sticks. Moreover, the device is simple operation and rapid detection. Portable sensor makes home care much convenient, because non-intrusive detection is not common in recent commercial sensors. Also, the MEMS manufacturing technology can miniaturize the dimension of sensing devices, and thus, it is much suitable for the application of consumer electronic products.

Industrial Applicability

This non-invasive detection method can more conveniently monitor the diabetic patients metabolic status, because the ketone gas is a biological symbol for the breathing of diabetic patients. In addition, used micro-electromechanical manufacturing technology, the sensor devices can be applied healthy care of home care detection instrument to facilitate patient numerical monitoring .

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National Synchrotron
Radiation Research
Center

The Future Light Source - Ultrafast Molecular Imaging: Free Electron Laser

National Synchrotron Radiation Research Center | An-ping Lee Assistant Scientist

Technical Introduction

The fourth-generation light sources – free electron lasers (FEL) are able to generate electromagnetic waves with much higher brightness than the third-generation synchrotron radiation sources in the wavelength range from microwave to X-ray. It produces ultra-short light pulses with duration as short as a few femtoseconds(10^{-15} seconds). In NSRRC, a superradiant free electron laser in terahertz frequency range was set up by employing an in-house developed laser-driven photocathode radio frequency electron gun system and a technology called radio frequency electron bunch compression. It is currently the terahertz radiation source with the highest peak power in Taiwan. In addition, we also designed an extreme ultraviolet free electron laser test facility that is based on similar technology.

Scientific Breakthrough

The superradiant free electron laser in terahertz (10^{12} Hz or THz) region built in NSRRC can produce coherent THz sources with central frequency of 0.6 THz and pulse energy of 20 mJ. NSRRC is currently building an extreme ultraviolet free electron laser test facility with peak power of about 300 MW. The shortest harmonic radiation output can be as short as 6 nm. The photon beam has high peak brightness, ultra-short time scale and better time coherence.

Industrial Applicability

The technologies of high-brightness ultrafast electron beam, linear accelerator, terahertz and extreme ultraviolet free electron lasers being developed in this research are expected to be applied significantly to the fields of ultrafast electron microscopy, non-destructive inspection, material processing, and advanced semiconductor manufacturing.

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Fast Cancer Screening and Prognosis Assessment and Prediction of Treatment Response in Chronic Kidney Disease by Using Synchrotron Infrared Microscopy

National Synchrotron Radiation Research Center | Yao-Chang Lee Associate Scientist
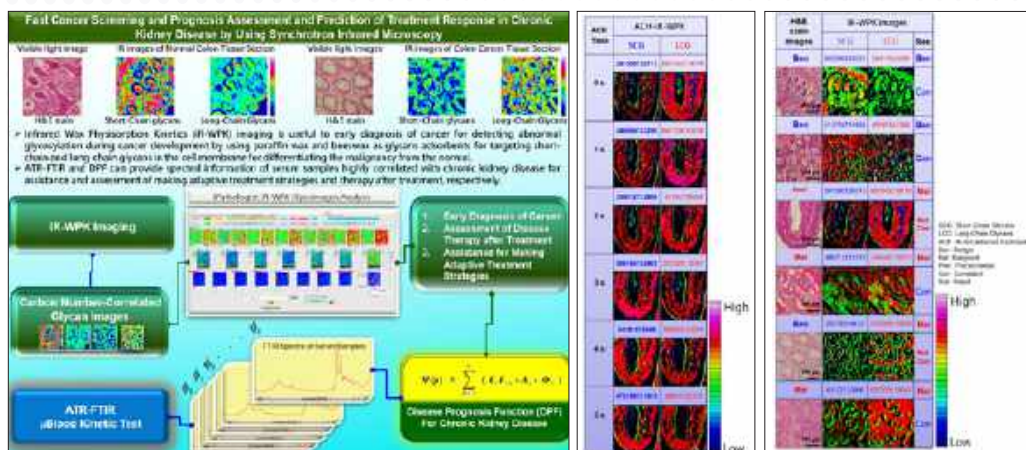
Technical Introduction

1. Infrared wax physisorption kinetics (iR-WPK) provides a glyco-histopathological imaging analysis for examining tissue sections, which utilizes n-alkanes ($n\text{-}C_nH_{2n+2}$) with carbon number (CN) from 20 to 34 and beeswax as glycan adsorbents for targeting similar longitudinal length of glycans of glycoconjugates anchoring in the cell surface.
2. It is an in-situ non-destructive method of examining tissue sections for cancer screening and prognosis prediction for chronic kidney disease by profiling aberrant glycans covalently-attached to both glycoconjugates anchored in tissue sections.
3. It can screen ten cancers including colon cancer, breast cancer, ovary cancer, cervical cancer, oral cavity cancer, gastric cancer, skin cancer, prostate cancer, intestinal neuroendocrine tumor and brain cancer.

Scientific Breakthrough

1. Infrared wax physisorption kinetics (iR-WPK) can provide an in-situ non-destructive glyco-histopathological imaging analysis at the spatial resolution of $10 \times 10\ um^2$ for cancer screening and prognosis prediction of chronic kidney disease by detecting the distribution of the population ratio of aberrant to regular glycans attached to glycoconjugates anchored in the cell surface and immune complex deposited onto glomerulus, respectively.
2. The method of iR-WPK has been successfully proved to in vitro diagnose ten cancers at least, including colon cancer, breast cancer, ovary cancer, cervical cancer, oral cavity cancer, gastric cancer, skin cancer, prostate cancer, intestinal neuroendocrine tumor and brain cancer. Single detection for cancer screening can be done for 6~15 minutes by using iR-WPK imaging at room temperature (28°C).

Industrial Applicability

1. The technological package of Infrared wax physisorption kinetics (iR-WPK) imaging and iPathologist is useful to disease screening. The patents for the method of iR-WPK has already licensed (non-exclusive license) to iCometrue company, and the product vanderWaals produced by iCometrue for fast cancer screening has been commissioning since 2019.
2. The combination of ATR-FTIR spectroscopy and disease prognosis function (DPF) can provide spectral information of serum samples highly correlated with chronic kidney disease for the assistance and assessment of making adaptive treatment strategies and therapy after treatment, respectively.

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Highly Efficient Fabrication and Applications of Bioinspired Flexible Photonic Crystals by Trapping of Structural Coloration

National Synchrotron Radiation Research Center | Wei-Tsung Chuang Associate Scientist
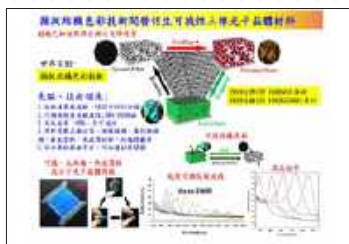
Technical Introduction

Rapid fabrication of network-structured amphiphilic block copolymer photonic crystal films could be accomplished by the facile spin-casting process. By immersing into alcohols, the swollen network could give rise to the visible structural coloration. Unlike the disappearance of the visible reflection in the lamellar film, the network structure could trap the visible structural coloration by vitrification of the network after drying, namely, trapping of structural coloration (TOSC). With further control of diffusive distance and diffusivity, full-visible-wavelength structural colorations are obtained. This TOSC is reversible and responsive with heat. By TOSC, we firstly fabricate the flexible copolymer photonic crystal featuring tunable and reversible structural colorations in solid state.

Scientific Breakthrough

Unlike extremely hard and low efficient chemical way to synthesize various samples with millions of molecular weights, we developed a unique technique—trapping of structural coloration (TOSC)—through which a single-molecular-weight copolymer sample could make full-visible-wavelength gyroid photonic crystal films in solid-state within 10 minutes through a simple process of immersion into ethanol and control of film thickness. After 2002, this is the first investigation to overcome the limitation of molecular weight and may largely accelerate the mass production of the visible photonic crystals for applications.

Industrial Applicability

By trapping of structural coloration (TOSC), the visible photonic crystal films could be utilized in reflected-mode photonic crystal displays without the need of backlight. Owing to flexibility, lightweight and low cost, various optical devices for communication applications can be fabricated. Because of reversibility, the TOSC-featured photonic crystal films be made as stimuli-sensitive detectors of social security for volatile-organic compounds and alcohol-detectable stickers. Showing aesthetical artworks with shining colorations only observed in natural creatures, these portable detectors could be applied in anti-counterfeiting field, energy-saving paint and cultural and creative industries.

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Small- and Wide-angle X-ray Scattering on Biological Structures

National Synchrotron Radiation Research Center | U-Ser Jeng Researcher/Professor

Technical Introduction

(1) High flux mode for integrated measurements of SAXS/WAXS/UV-Vis-absorption/Refractive-index/Multi-angle-light-scattering (MALS) with an online high-performance liquid chromatography (HPLC) instrument, suitable for exploring biomacromolecular solution structures of a wide length scale and structural kinetics down to microsecond time scale.
(2) Ultra SAXS (USAXS) mode for resolving hierarchical structures of bio-machinery assembly up to a few micrometer length scale.
(3) Anomalous SAXS mode for metal or mineral distributions (including calcium) in bio organelle or drug carriers.
(4) Microbeam SAXS/WAXS mode for structural mapping of the textures or specific infected cells in natural/synthetic bio-tissues, organelles, or biomaterials.

Scientific Breakthrough

This TPS BioSAXS beamline outperforms many worldwide SAXS beamline in biostructural research. There are three major breakthroughs of the new beamline, including
(1) High flux mode for integrated measurements of SAXS/WAXS/UV-Vis-absorption/Refractive-index/Multi-angle-light-scattering (MALS) with an online high-performance liquid chromatography (HPLC) instrument, suitable for exploring biomacromolecular solution structures of a wide length scale and structural kinetics down to microsecond time scale.
(2) Ultra SAXS mode for resolving hierarchical structures of bio-machinery assembly up to a few micormeters.
(3) Microbeam SAXS/WAXS mode for structural mapping of the textures or specific infected cells in natural/synthetic bio-tissues, organelles, or biomaterials.

Industrial Applicability

· Fast structural screening process for biomolecules with molecular mass from 1 kD to 10000 kD.
· Allergen and allergic-reaction-induced structural changes.
· Interaction between metallic nanoparticles and lipid molecules and its connection to inflammation inhibition.
· Protein misfolding and aggregation in Alzheimer's and other RAN/DNA related diseases.
· Structural and compositional analysis of combined antiretroviral (ARV) drugs used in ARV therapy.
· Other cancer-related studies like solution-based structural analysis of phosphatases and glycoprotein.
· Diary products in solution, gel, or solid forms.

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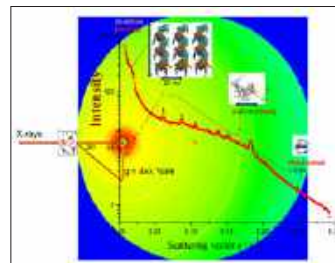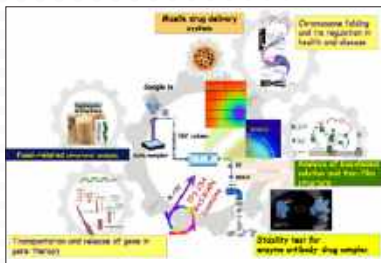
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National Science and
Technology Center for
Disaster Reduction

Climate Traveler

National Science and Technology Center for Disaster Reduction | Yung-Ming Chen Research Fellow

Technical Introduction

The Climate Change Division will set up a system that allows the users to select his/her area of residence. By reading the inputted location, the system will then automatically access the climate change database and transfigure the projected data of the year 2050 to readable climate conditions of the location chosen by the user. Such information will be presented in a form of a postcard; users can take a profile photo on the spot to customize it into a personal "Postcard from the Future," allowing the user to feel closer to the climate change reality that we are now facing.

Scientific Breakthrough

To homogenize and grid the data from more than 1,900 observation stations across Taiwan for nearly 60 years data set, and recieve the global climate models data which have resolution over 100 kilometers, through numerical and statistical simulation and calculations, establish 4,800 grids across Taiwan with a resolution of 5 kilometers data. These can not only present the climate change information of Taiwan's villages and towns from the past 60 years to the end of the century, but also provide various fields with the use of this data for impact assessment and application of climate change in detail spatial.

Industrial Applicability

Private sectors can use the projected climate change data in evaluating the potential impact of climate change to different industries, therefore constructing a more thorough adaptation strategy in avoiding future loss.

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Rain Alert APP

National Science and Technology Center for Disaster Reduction | Yi-Chiang Yu Research Fellow

Technical Introduction

The purpose of this software is to implement real-time radar monitoring technique in meteorological service through industry-academia cooperation. The design transforms professional weather webpage into APP software, which is available for mobile devices, it also provides notification service by using GPS positioning system. This is an experimental product which integrates radar observational data in Taiwan with the latest observation data from FORMOSAT-7. By using data assimilation method and radar reflectivity extrapolation method, it develops real-time early warning technique and provides probability of precipitation information in future 1 hour.

*This product is only for the research exhibition, the actual weather forecast information will be based on CWB official announcement.

Scientific Breakthrough

This APP integrates 9 weather radar observation data, including CWB, CAA, Air Force and disaster prevention radar, to develop real-time early warning technique. The design transforms professional weather webpage into APP software, which is available for mobile devices, it also provides notification service by using GPS positioning system.

1. It integrates radar observation data in Taiwan with the latest observation data from FORMOSAT-7. By using data assimilation method and radar reflectivity extrapolation method, it develops real-time early warning technique through radar reflectivity.
2. Through 10-minute update frequency, it provides probability of precipitation information in future 1 hour.

Industrial Applicability

Rain alert APP let users get the latest precipitation information before going out or get off work. The service is available for various industries.
The related disaster prevention data and open data aid enterprises and citizens in technology cooperation in order to create more industrial opportunities.

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Application of Internet of Things(IoT) in Flood Monitoring

National Science and Technology Center for Disaster Reduction | Wen-Ray Su Research Fellow

Technical Introduction

Combining automatic real-time flood sensing technology from Civil IoT with real-time precipitation data from CWB to reduce the incidence of false alert. By merging technology with Google Street View, terrain data and real-time observation image from MOI, users can easily get information about flooded area through Disaster Response Decision Support System (DRDSS)

Scientific Breakthrough

The Intellectual real-time Push Notification technology on disaster prevention, combining flooding sensor and precipitation data from CWB with CCTV and Google Street View, can be used to simulate disaster projection through traffic-network analysis.

Importing 3D visualization techniques, along with big data integrated by NCDR, be able to improve precision of meta image and data simulation, aiding citizens and local government in decision-making and resources allocation stage, also can be used by local government in programming stage of disaster prevention.

Industrial Applicability

The technology can combine flood, precipitation and real-time image data by using data networking. For flood monitoring, it can be practically used in disaster prevention, providing commanders the precision of the events. This technique had achieved early warning during Typhoon Hagupit in 2020.

National Science and Technology Center for Disaster Reduction

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