

HEALTHY LONGEVITY GLOBAL COMPETITION

2022 Catalyst Awardees

Sponsor: Academia Sinica

Additive Nano-Manufacturing of Multi-Functional Materials for Smart Stents Sensing

Principal Investigator	Yu-Sheng Lin
PI Primary Affiliation	Southern Taiwan University of Science and technology
Co-Investigator(s)	Ying-Lung Daniel Ho; Chung-Che Kevin Huang; Shuangyi Yan

PROJECT DESCRIPTION

Cardiovascular disease is one of the most threat to life, and the cause by stroke has been increasing significantly in the longevity era. According to the statistics, the average population of increased amount is about 10,000 people. For the early prevention, installing stents is a method and has become regularly used. However, it is still not able to tell the diseases immediately without a heavily examination equipment in the hospitals. This idea aims to develop smart stents which can be able to transfer the signals to outside devices by means of wifi and 5G in order to monitor the heart condition and blood flow at any time. The proposed methodology to create the smart stents is using the additive nano-manufacturing (ANM) of multi-functional components for smart sensing and monitoring and to explore vital signals by incorporating Artificial Intelligence based data analytics. The planning system mainly encompasses two parts. The first part has three tasks: (1) to create 2D/3D nanostructured polymer-based self-charging piezoelectric components via ANM (e.g., two-photon lithography based 3D direct laser fabrication); (2) to develop novel normal and shear force sensing techniques based on 2D/3D photonic nanostructures.; (3) to prototype a battery-free wireless pressure sensing networks for biomedical applications by incorporating mini-radio frequency identification (mini-RFID) chips. The second part is to establish a platform of smart biomedical sensors applied on artificial tactile sense and microfluidic chips aided by the information from the first part.

Analyzing strategies against health misinformation in Taiwan: A data mining approach

Principal Investigator	Hsin-Yu Kuo
PI Primary Affiliation	National Tsing Hua University
Co-Investigator(s)	Su-Yen Chen; Yu-Ting Lai

PROJECT DESCRIPTION

Our main mission is to determine profound and practical ways to counter health misinformation. The rate of misinformation in societies has increased and has severely affected public health. Especially, during the coronavirus pandemic, misinformation has caused social disruption, such as irrational stockpiling of materials and refusal to comply with the prevention rules. Moreover, the wrong knowledge about the coronavirus directly influences an individual's physical and mental health. Thus, it is essential to confront and rebut misinformation crises in multiple ways. Corrective information, as a crisis communication strategy, is one of the countermeasures to reduce misperceptions and misbeliefs. Some current tools and platforms inform the public whether the information they read is correct, thereby accumulating false information and its corrective information content data and providing feedback from the audience. To gain insights from data to rebut misinformation, we

analyze the features and effects of corrective information against misinformation using data science and psychological approaches to provide innovative research methods and perspectives on public information health. In brief, this project explores potential new technologies and social strategies that could help health and function during extended longevity. To understand and deal with the misinformation problem in Taiwan, we first focus on understanding Taiwan's misinformation content development. Then, by extracting features of misinformation and corrective information, we classify the types and characteristics of the content on the corrective information platforms. Finally, we evaluate the acceptability among different corrective information features by supplying feedback data corresponding to the corrective information.

Combination of Ear-EEG and Masking in Earphone for tinnitus improvement

Principal Investigator	Yi-Chun Du
PI Primary Affiliation	Department of Biomedical Engineering
Co-Investigator(s)	Ching-Feng Liu, Yi-Lu Li

PROJECT DESCRIPTION

To improve patients' tinnitus situation, our team is honored to introduce our project with the ear-EEG to automatically generate suitable masking sound for tinnitus treatment. In the meanwhile, using Artificial Intelligence (AI) method to analysis the type of the tinnitus (pulsatile or non-pulsatile). Our research has highlighted the potential of the measured ear-EEG signal through the earphone and the AI method to identify tinnitus type. This device is promised to be used in daily life, especially for the elder with the high accuracy for detecting tinnitus and giving the patient suitable and direct treatment to overcome the bad impact from tinnitus bring to. This project will contribute with high-quality evidence on the effectiveness of assistive technology in supporting people with tinnitus to help them overcome a discomfort feeling, gain concentration, and have a balanced performance in daily life. Also could avoid the potential risk from pulsatile tinnitus. This study will establish the clinical trial focus groups in Taiwan with 50 participants to use ear-EEG devices and get tinnitus masker treatment. Our product will illustrate improved tinnitus state and the patient's mood which means that it could reduce patients' anxiety and stress for homecare. At the same time, we are towards a wearable device with a small size so the patient could bring it along whenever. We do hope it will be an essential assistant for tinnitus patients.

Deep Kidney Aging Clock: From Platform Services to AI-Empowered Guarding and Intelligent System (AEGIS)-Kidney Aging Ecosystems

Principal Investigator	Yu-Ting Lin
PI Primary Affiliation	Big Data Center, China Medical University Hospital
Co-Investigator(s)	Chin-Chi Kuo; Hsiu-Yin Chiang; Hung-Lin Chen

PROJECT DESCRIPTION

Population aging is a global phenomenon that leads to the increasing prevalence of chronic diseases globally. Except for natural aging (biological), premature aging (pathological) is another serious issue, for instance, for patients with end-stage renal disease (ESRD). Taiwan has the highest prevalence of ESRD globally and ESRD remains to be the No. 1 single-cause health expenditure and has contributed to 56.2 billion in Taiwan's National Health Insurance. The accelerated aging process characteristics were found in ESRD patients, compared with age-matched controls, including telomere loss and increased susceptibility to disease and mortality. Maintaining and monitoring the kidney health of patients with chronic kidney disease (CKD) is important because CKD can rapidly progress to ESRD if not under controlled. The high-quality and multi-dimensional data is the key to provide insights to address knowledge gaps and to drive artificial intelligence (AI), and an platform that can

integrate data and AI tools and provide real-time risk prediction would be a promising solution for digital therapeutics.

The Big Data Center (BDC) of China Medical University Hospital manages the most powerful phenome-genome-environmental data platform in Asia, encompassing 20-year medical records and environmental exposure data from 3 million patients and genetic information from 230 thousand patients. In our Healthy Longevity project, we will establish the AI-Empowered Guarding and Intelligence System (AEGIS) for precision kidney aging care and validate AEGIS in the multi-center real-world setting. We expect by integrating AEGIS in the clinical flow of CKD patients, we will be able to improve the quality of care, prolong the healthy life, reduce medical costs, and toward to sustainable healthcare system.

Envisioning Future Community Mobility, Together: Co-Designing Mixed Reality for the Elderly to Explore Autonomous Vehicles

Principal Investigator	Jack Shen-Kuen Chang
PI Primary Affiliation	National Cheng Kung University
Co-Investigator(s)	Ling-Hui Chang; Chien-Ju Lin; Hsiao-Feng Chieh; Chen-Hsun Weng; Kuan-Yuan Wang

PROJECT DESCRIPTION

Community mobility is an important factor for older adults to sustain an independent yet connected life (which is an even more vital topic since the pandemic started). This factor is correlated to the mental and physical wellbeing of older people. One facet of community mobility is transportation. However, many existing transportation systems are designed in the decades-long past, barely serving well for the elderly in the present, and not likely to fulfill the needs for the future aging society.

As envisioned by many countries and companies, Autonomous Vehicles (AVs) will be advanced and available in the near future to support and transform the transportation system. While such future may happen, the current transportation system, and its upcoming integration with AVs, lack careful and systematic considerations for the elderly, a growing part of the population with special needs (e.g., deteriorated vision/hearing/driving skills). Therefore, we need to design for this AV-integrated future with the elderly in mind, now.

We propose to use iterative and participatory methods to design, develop, and evaluate mixed reality (MR) with, and for, older adults. We plan to engage the community elderlies with co-design activities to solicit stakeholder input. Then, using the input, we will develop a MR system that can provide a safe, low-cost, and flexible environment for the elderly to experience/explore AVs. We envision the outcome of this research to benefit the academia, policymaking, and the community.

Next Generation Hemodynamic Monitoring for Assessing Vascular Aging - Taking Energy into Consideration

Principal Investigator	Hao-Min Cheng
PI Primary Affiliation	School of Medicine
Co-Investigator(s)	Shao-Yuan Chuan; Geng-Shi Jeng; Jiun-Jr Wang; Chen-Hua Lin; Chi-Jung Huang

PROJECT DESCRIPTION

Population ageing has stepped much faster than before and become an unprecedented global health issue. Cerebrovascular diseases require tremendous medical expenditures and have been the major burden of health care system worldwide. Carotid hemodynamics provide low-cost and non-invasive evaluation for early detection of cerebrovascular disease and artery stiffness. In our previous studies, we have comprehensively investigated

the pulsatile hemodynamics in the carotid artery. We found that carotid energy pulsatility index is the single most important index for predicting cognitive function, more effective than all other aortic and carotid hemodynamic parameters, including blood pressure and arterial blood flow. Currently, the impacts of blood pressure or carotid flow on cognitive function are separately assessed. However, arterial flow is seldom measured unless occlusion of arteries is suspected. Despite the concept of energy, integrating both pressure and flow, has been acknowledged in the circulatory system, it is rarely utilized in clinical practice. In this project, we will develop an innovative device that can conveniently measure arterial flow and blood pressure to estimate energy pulsatility index. This proposed device will be equipped with a firmware for calculating the carotid pulsatility index derived from mean energy (steady energy) and pulsatile energy (energy that can be detrimental to end-organs). This device will be used to assess vascular aging and the impacts of various interventions including dietary, lifestyle or pharmacological intervention on cognitive function by assessing the pulsatile hemodynamics of the circulatory system, which will allow us to assess the circulatory impacts quickly and efficiently on brain aging.

Panoramic Intra-oral Diagnostic and Health Informatics System

Principal Investigator	Jerry Li-Chia Tai
PI Primary Affiliation	Academia Sinica
Co-Investigator(s)	Ammar Amjad; Getaneh Berie Tarekegn; Sue-Yuan Fan; Sucharita Khuntia; Ci-Ruei Liou; Po-Hsiang Juan; Yi-Pin Huang; Chien-Hung Fan

PROJECT DESCRIPTION

Oral health has been an indicator of longevity in the modern world. In an article by the Lancet Healthy Longevity in 2021, it notes that oral conditions are typically preventable or treatable, but are often neglected. Across the world, untreated dental cavities in permanent teeth affect about 2.5 billion people worldwide. Within that population, approximately 30% of adults in the 65-74 years old range are edentulous, or lacking teeth. Ultimately, tooth loss has significant consequences on the health of an aging population in terms of disability for nutrition intake and quality of life. In this regard, we propose a novel platform that seamlessly integrates mini-cameras with an impression tray, which is commonly used in dental practices to facilitate the insertion and removal of impression materials, to provide a convenient approach to monitor the oral health of an individual. The impression tray is selected because of its biocompatibility, affordability and portability. The integrated device possesses the potential to provide early alerts for cavities. We aim to achieve several milestones: (1) Ergonomic integration of cameras with an impression tray for unhindered insertion into mouth. (2) The distance from the camera to its imaging area varies depending on its location. To avoid blurry images, we'll optimize the focal length and coverage area of each camera. (3) After the images are captured, our algorithm will need to distinguish cavities versus color stains or other artifacts. With improved oral health for the general population, we hope to improve the health and longevity of humankind.

Smart insole for 3 D force measurement

Principal Investigator	Chao-Ching Ho
PI Primary Affiliation	National Taipei University of Technology
Co-Investigator(s)	Jung-Tang Huang; Chuan-Yu Lo, Che-Yu Chang, Yi-Ming Li, Wei-Ting Zheng

PROJECT DESCRIPTION

In this project, a magnetic sensing IC array will be integrated into a flexible circuit board to develop a smart insole for measuring the normal pressure and shear stress of the sole of the foot. At present, most plantar pressure sensing insoles can only measure and analyze the normal pressure, but the actual action of the foot usually includes the shear stress. Bearing force from different directions, if the force of three axes can be measured, it

will be possible to further analyze the force on the foot, and it can also help patients to protect their feet or help athletes to know how to make use of their feet optimally.

It will develop machine learning models between the applied 3D forces and the 3D magnetic field readouts of the magnetic sensing IC based on our home-made automatic calibration platform of 3D force load-cell. In summary, the following benefits are expected: 1) all-in-one insole: provide three-axis force and 3D trajectory of the foot based on 9-axis IMU measurement and calculation; 2) Multi-point detection: detect multi-point force at the same time; 3) Easy calibration: (A) The production of magnet silicone gaskets is standardized, and the gaskets are standardized through high-precision molds and calibration methods. (B) Various models are pre-designed, and the models are self-adjusted when the sensor is replaced. (C) Adjust the rigidity of the magnet silicone gasket, which will be attached on the top of the magnetic field sensor, so as to be used for foot patients.

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