

HEALTHY LONGEVITY GLOBAL COMPETITION

2023 Catalyst Awardees

Sponsor: Academia Sinica

A novel wireless deep brain stimulation approach for treating Parkinson's disease

Principal Investigator	Po-Han Chiang
PI Primary Affiliation	National Yang Ming Chiao Tung University
Co-Investigator(s)	None

PROJECT DESCRIPTION

Parkinson's disease (PD) is one of the most prevalent neurodegenerative disorders worldwide. Conventional deep brain stimulation (DBS) with electrode implantation is clinically used for severe PD patients. However, the electrode implants are invasive and carry the risk of side effects. Therefore, developing a novel, minimally invasive technology for wireless DBS in neurological disorders is an urgent health longevity problem that needs to be addressed. Magnetic stimulation is an ideal neuromodulation approach that can penetrate tissues and skull without interference, thus eliminating the need for electrodes or fiber implants. In the last decade, wireless DBS approaches based on magnetic nanoparticles have seen rapid development. Among them, nano-mechanotransducer-based wireless DBS only requires low-intensity and low-frequency alternative magnetic field, which allows for the scalable application of the magnetic platform to larger volumes. In this study, we aim to investigate the translational potential of nano-mechanotransducer-based wireless DBS in PD. We hypothesize that abnormal motor function in a PD mouse model can be rescued by wirelessly stimulating a specific deep brain region with this approach. Overall, this study will provide a potential strategy of treatment for PD and other neurological disorders with minimal invasiveness.

Build elders on-line community for regular rehabilitation and daily muscle training

Principal Investigator	Kuan-Chun Sun
PI Primary Affiliation	FREE Bionics
Co-Investigator(s)	Cheng-Hua Wu, Founder/CEO Ming-Chang Teng, CTO Yi-Jeng Tsai, PhD Chia-En Huang, PhD

PROJECT DESCRIPTION

This project is based on a portable and home-used robot, called NimBO, which could provide single joint muscle evaluation, training (ex: isokinetic, isotonic, isometric, passive/assist-active range of motion), and bilateral tele-operated control system for doctor to review user's status and renew training program remotely. An APP will be developed as a key role between controller of robot, interaction with doctor, and connection to on-line community.

Developing Brainwave-Based Audiometric Systems to Evaluate Speech Quality and Listening Fatigue for Users of Speech Enhancement Technology

Principal Investigator	Yu Tsao
PI Primary Affiliation	Research Center for Information Technology Innovation, Academia Sinica
Co-Investigator(s)	Cheng-Hung Hsin, PhD

PROJECT DESCRIPTION

This research project aims to advance the field of audiology by developing a novel approach for evaluating speech quality and assessing listening fatigue in users of speech enhancement (SE) technology. Utilizing brainwave-based audiometry techniques and leveraging advancements in machine learning, this project seeks to provide personalized and objective assessments of SE system effectiveness.

The initial phase of the project entails recruiting a sizable cohort of healthy young adults to participate in electroencephalogram (EEG) experiments. These experiments will capture brainwave patterns during speech perception tasks, encompassing various listening conditions such as clear speech, noisy speech, and speech processed by SE systems. By establishing a normative model of brainwave activity in a healthy population, the project aims to quantify the impact of SE technology on speech comprehension.

The subsequent phase focuses on developing neural network models that extract pertinent features from the EEG data. These models will enable the objective evaluation of speech quality and the detection of listening fatigue in SE users. The primary objective is to optimize SE systems to enhance individual user experiences and communication outcomes.

By merging state-of-the-art technology with insights from neuroscience, this project strives to revolutionize audiological evaluation paradigms. Our ultimate goal is to make substantial contributions to audiology, advancing personalized solutions that empower individuals with hearing loss to actively participate in the auditory world and enhance their life quality.

Early detection of Age-related Hearing Loss in Artificial Intelligence

Principal Investigator	Chung-Yen Lin
PI Primary Affiliation	Institute of Information Science, Academia Sinica
Co-Investigator(s)	Taso Yu, PhD.

PROJECT DESCRIPTION

The World Health Organization predicts that 1.2 billion adults over 60 will have age-related hearing loss by 2025, associated with frailty and dementia. To combat such a dilemma about age-related hearing loss (presbycusis), we develop an AI model which can detect hearing loss early using data from the Taiwanese population's genetic background, lifestyle, medical treatment, and environment based on the dataset from Taiwan Biobank. The AI model aims to detect hearing loss early by analyzing genetic variance (SNPs), lifestyle, medical treatment, and environmental factors as input and hearing loss/tinnitus as output. The study uses the Taiwanese population dataset from Taiwan Biobank, making it the first in the country. This modeling approach can be applied globally to detect hearing loss and other age-related diseases such as osteoporosis, sarcopenia, disability, cognitive decline, and dementia. Further analysis of the AI models may uncover more biomarkers related to hearing loss and lead to new therapies and drug candidates. This approach could ultimately improve our quality of life as we age.

Lab-on-a-chip for cardiovascular disease

Principal Investigator	Jung-Tang Huang
PI Primary Affiliation	National Taipei University of Technology
Co-Investigator(s)	Jakkrapatr O.Baiyokvichit, MS

PROJECT DESCRIPTION

This project is a lab-on-a-chip (LOC) for detecting cardiovascular disease. It is going to change the CVD biomarkers measurement from a time-consuming technique into a practically simple screen test regarding point of care testing (POCT).

This LOC will detect different biomarkers, including Cardiac Troponin I (cTnI), Creatine Kinase Myocardial Band (CK-MB), and Cardiac Natriuretic Peptides (NPs), through the different aptamer and redox probes which enable it to detect each biomarker simultaneously.

The chip in the LOC platform will be made of a reliable silicon base chip with gold electrodes. Polydimethylsiloxane (PDMS) and polymethyl methacrylate (PMMA) will be used to create the microfluidic channels and microfluidic vacuum pump for filtering and preparing the blood sample. Furthermore, gold nanoparticles will be deposited into the magnetic beads before they are conjugated with the aptamer. This will result in a stronger link between the aptamer and magnetic beads.

A change in conformation of the aptamer, after it is bonded to the target, results in a variation in the conductivity and distance between the redox probe on an aptamer and the electrode surface. The conversion of the chemical reaction from the redox probe into an electrical signal will be measured from the reader circuit and sent to the user's smartphone.

The entire procedure will take no more than 10 minutes, and this LOC is anticipated to cost no more than 100 NT\$ to make it affordable and feasible for anyone with the risk of CVD.

Neck patch carotid artery stenosis and stiffness sensor for early warning of life-threatening stroke

Principal Investigator	Ting-Wei Wang
PI Primary Affiliation	National Tsing Hua University / Department of Biomedical Engineering and Environmental Sciences
Co-Investigator(s)	NA

PROJECT DESCRIPTION

Carotid artery stenosis and stiffness represent one of the most hazardous forms of vascular hemodynamic issues, capable of triggering life-threatening strokes. Due to the fact that carotid artery stenosis and stiffness are chronic vascular diseases that may not necessarily exhibit symptoms in the early phase, routine monitoring and assessment of these conditions through carotid ultrasonography are widely adopted in clinical practice to achieve early diagnosis and prevention. However, carotid ultrasonography is a large and intricately operated medical device, and it lacks the capability for continuous real-time monitoring of carotid artery health. Late detection of severe carotid artery stenosis or hardening could result in strokes and endanger patient safety. To this end, we aim to develop a neck patch carotid sensor utilizing electromagnetic induction-based technology to measure variations in electrical parameters across multiple sites along the carotid artery, thus distinguishing the lesion severity and location of stenosis and stiffness. The key innovation lies in the introduction of electrodeless electromagnetic induction-based sensing technology, enabling the penetration of magnetic fields into the deeper layers beneath the skin to extract accurate physiological signals. In contrast to conventional carotid ultrasound, the proposed neck patch electromagnetic induction-based sensor eliminates the need for electrode preparation,

gel application, and specialized operation, offering a solution for real-time monitoring of carotid stenosis and stiffness for stroke prevention. This transformative proposition holds the potential to significantly advance the realms of intelligent wearable technology, personalized medicine, and preventive care within the domain of cardiovascular and cerebrovascular healthcare.

Using Sound Technology to Detect Abnormalities in the Daily Life of Elderly Living Alone

Principal Investigator	Huang, Kuang-Chiu
PI Primary Affiliation	Aurismart Technology Corporation
Co-Investigator(s)	Huang, Ching-wei MS, RN

PROJECT DESCRIPTION

Health Longevity often entails the challenges of living alone. Immediate dangers of accidental falls and chronic conditions of Elderly Living Alone (ELA) are often worse than those who live in groups, so here we aim to alleviate the problem.

Detection of sounds of ELA's daily activities at home allows us to infer whether there is abnormality in ELA's life from the differences to the norm. From just using sounds we can promptly tell the relevant parties if the user is in trouble or inform the user to be aware of deteriorating health.

The system is designed to encompass as many aspects of life with as little invasiveness as possible. It is a passive response system that reduces the risk of living alone and lightens their worries about being one fall away from death.