Artificial Intelligence Assisted Early Diagnosis Mechanism for Alzheimer’s Disease

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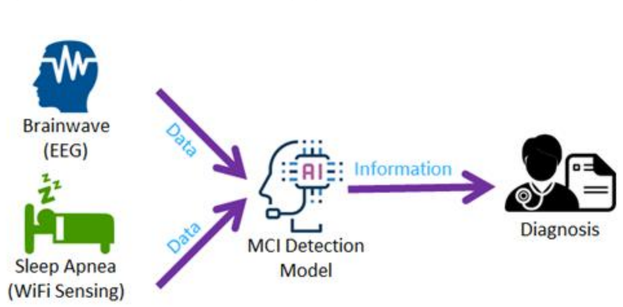
Background

The number of people suffering from Alzheimer's Disease (AD) currently accounts for two-thirds of all demented people. AD is a degenerative and irreversible dementia. AD diagnosis is not difficult. The difficulty is to diagnose the Mild Cognitive Impairment (MCI) stage before AD. People with MCI are at high-risk to later develop into AD. The differences between MCI and Normal Cognition (NC) are very inconspicuous and difficult to be accurately distinguished by physicians. This proposal plans to diagnose AD early, and the goal is to identify the MCI stage before it evolves into AD. Early diagnosis and delaying the onset of symptoms will reduce social costs.

Overview

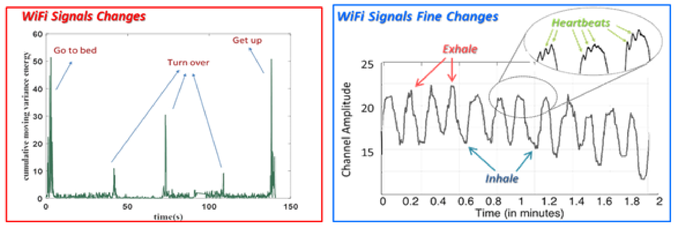
This project innovatively applies a composite approach of using non-contact long-term tracking technology for Sleep Apnea and Artificial Intelligence (AI) and machine learning algorithms to detect variations in brainwaves to build a MCI stage detection model. This model can help doctors accurately determine the MCI stage to achieve early treatment and delayed onset of symptoms.



MCI Detection Model

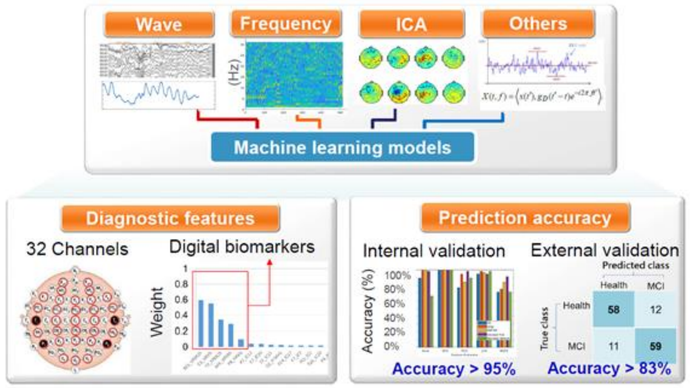
Innovation

1) Non-contact long-term Sleep Apnea tracking technology: This project proposed a device for long-term detection and tracking of sleep apnea at home, which can instantly detect apnea events during sleep. Using AI algorithms to analyze over 500 reflected multi-path WiFi radio waves, subtle differences in human breathing and apnea can be detected.



Human Breathing Detection using WiFi Signal

2) AI and machine learning based detection of brainwave variations: We work with a neurologist to analyze a large number of brainwave data from high-risk patients with MCI. This training algorithm allows AI machine learning to analyze brainwaves, and to distinguish brainwaves between MCI and healthy groups.



Machine Learning for Brainwave Data

Impact

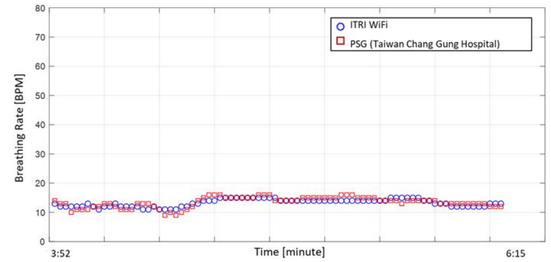
It is predicted that by 2050, there will be new AD patients every 33 seconds, which would result in 800,000 patients in Taiwan, 14 million in the United States, and more than 100 million people worldwide who would suffer from this disease. This proposal plans to diagnose AD early, and the goal is to identify the MCI stage before it evolves into AD. Early diagnosis and delaying the onset of symptoms will reduce the number of severe AD patients.

Scope

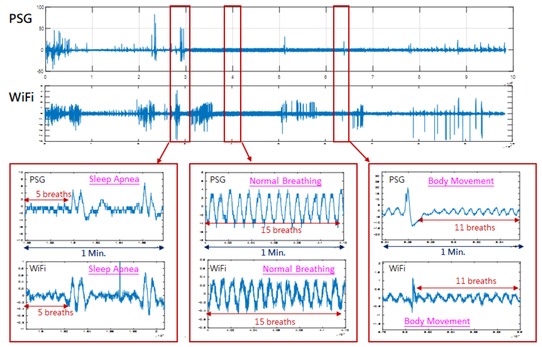
There are currently more than 5.5 million people with AD in the United States, new AD patients occur approximately every 66 seconds, and the related medical expenses exceed $ 259 billion. Because the survival period is generally 5-10 years or more after the patient is diagnosed, the related social and medical care costs are very considerable. This proposal hopes to find the treatment for the MCI stage as early as possible, slow down the onset of symptoms, and save a tremendous amount of costs for patients and the medical system. These include reducing the cost of medical care, social costs, and the burden of caring.

Project Updates & Status

WiFi is compared with PSG (Polysomnography), including normal breathing, breathing pauses, and body movements. The changes in the chest cavity measured by WiFi are consistent with the changes in PSG. So far, 10 person-time comparisons have been completed, and a total of 4338 minutes of sleep data have been received. The average sleep time per person is 7.23 hours. Sleep apnea is calculated by AHI (Apnea Hypopnea Index). PSG calculates the average AHI of 10 people is 23.06, WiFi detection average AHI is 26.78. The verification is ongoing, and it is expected to receive more data from the subjects.



Breathing Rate between PSG and WiFi



Comparison of Various Respiratory Pattern

In addition, this project constructs an AI module training platform for brain wave data, and completes brain wave data feature extraction for MCI patients and healthy people. So far, the brainwave data of 7 NCs and the brainwave data of 5 MCI patients diagnosed by neurologists have been completed. The total measurement time for each subject is 15 minutes. The brain wave data contains 32 channels of brain wave sampling data, the sampling rate is 500 Hz. Experimental results show that the accuracy of MCI detection is 83%.

Potential Challenges

Affected by the COVID-19 epidemic, the data collection in hospitals and sleep centers is not as expected. The amount of sleep data and brain wave data collected so far is not enough. In the early stage of this project, technology development will be carried out using publicly available online sleep data and brainwave database, and testing will be conducted with a small amount of data from actual subjects. It is expected that more clinical data will be validated and optimized in the future.

Next Steps & Future Directions

We expects to cooperate with medical device manufacturers or medical providers with WiFi physiological detection technology, and apply WiFi detector for TFDA (Taiwan Food and Drug Administration) medical device certification. Applying for TFDA class 2 medical devices based on the correctness of clinical test results allows our WiFi detector to increase product competitiveness and uniqueness in the home sleep monitoring market, and innovate non-contact physiological detection methods. Sleep monitoring is performed under conditions that do not affect the user's original sleep habits, and the monitoring results can be used for initial medical diagnosis or self-examination to provide users with home medical solutions.