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腦神經動態學習機制之雲端ADHD輔助診斷系統

Neurological Dynamic Learning Mechanism Cloud ADHD Auxiliary Diagnosis System

隊伍名稱｜神「金」工程
Neugold

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研究領域

神經工程、腦機介面、智慧醫療、人工智慧、機器學習，計算神經科學、生醫訊號處理

作品摘要

注意力不足過動症 (ADHD) 是一種早發型的神經發展疾病，其主要症狀為不專心或過動、衝動，影響全球3~10%兒童，其中台灣兒童及青少年達診斷標準比例高達8.7%，約22萬人口，明顯造成學業、人際和家庭生活障礙，因此即早精準診斷並予以適當的治療，可以有效降低症狀對患者造成長期的影響。現今臨床診斷主要是依據主要照顧者所填寫的量表以及醫師根據精神疾病診斷準則手冊對兒童的行為觀察，但可能會因個案特質或照顧者對行為發展誤判不瞭解等因素造成量表結果不太可靠，所以客觀測量對醫師診斷是很重要的。為解決現今較為主觀的診斷方式，本團隊開發並設計出此「腦神經動態學習機制之雲端ADHD輔助診斷系統」，系統涵蓋三個部份，分別為：

1. **新型嵌入式腦機介面系統**：為解決傳統腦波量測儀配戴耗時、打膠式電極和攜帶不便等劣勢，因此本創作研發出無線8通道嵌入式腦機介面系統，採用ADS1299高精度腦波訊號放大器晶片，通道遍布於額葉、頂葉和枕葉區，系統搭配半乾式海綿電極，根據實驗結果顯示電極阻抗約為120kΩ，表現優於市面上現有之乾式電極，與傳統濕式電極收錄到之訊號比較也具高度相關性。
2. **即時生理狀態顯示平台**：此平台包含五個生理狀態指標，分別是注意力、壓力、疲勞和左右腦活化，透過腦波即時傳輸，觀察受測者的各項指標動態變化。
3. **雲端AI輔助診斷系統**：透過預先訓練並儲存在系統的模型進行類別概率預測和關鍵腦波特徵分析，產生一份腦波評估報表供臨床醫師參考，以達到客觀輔助診斷ADHD之目的。

以本團隊收錄來自四大醫療院所共約100名ADHD及正常兒童之腦波資料庫為例，收錄受測者靜息狀態和執行任務之腦波資料的同時，搭配生理狀態顯示平台能讓醫師即時觀察其生理指標的變化，實驗結束後可以將腦波數據上傳至雲端AI輔助診斷系統，基於事先訓練好之穩健模型，能快速的預測該名新受測者患病概率並計算關鍵的腦波特徵數值，提供給醫師更多客觀診斷依據。

圖一 系統架構圖。

Abstract

Attention Deficit Hyperactivity Disorder (ADHD) is an early-onset neurodevelopmental disease. Its main symptoms are inattention, hyperactivity, and impulsiveness. It affects 3-10% of children worldwide, and 8.7% of children and adolescents in Taiwan meet the diagnostic criteria with a population of about 220,000. It has obviously caused obstacles to academic, interpersonal, and family life. Therefore, early and accurate diagnosis and appropriate treatment can effectively reduce the long-term impact of symptoms on patients. Nowadays, clinical diagnosis is mainly based on the scale filled out by the primary parents/guardians and the physician's observation of the child's behavior according to the Diagnostic and Statistical Manual of Mental Disorders (DSM). To overcome the limitation of the current clinical subjective evaluation, our team developed and designed the "Neurological dynamic learning mechanism cloud ADHD auxiliary diagnosis system". This system consists of three components as follows:

1. **Novel embedded brain-computer interface device:** To solve the disadvantages of traditional EEG measuring instruments such as time-consuming wearing, gel electrodes, and inconvenience in carrying, we developed a wireless 8-channel embedded brain-computer interface device. The device is equipped with semi-dry sponge electrodes. According to the experimental results, the electrode impedance is about 120 kΩ, which is better than the existing dry electrodes on the market. It is also highly correlated with the signals collected by traditional wet electrodes.
2. **Real-time physiological state display platform:** This platform includes five physiological state indicators, which are attention, stress, fatigue, and left and right brain activation. Through the real-time transmission of EEG, the dynamic changes of various indicators of the subject can be observed.
3. **Cloud AI-aided diagnosis system:** Through pre-trained and stored models in the system, class probability prediction and key EEG feature analysis are performed, and an EEG evaluation report is generated for clinicians to refer to, so as to achieve the purpose of objective auxiliary diagnosis of ADHD.

In the clinical trials, we recruited about 100 ADHD and normal children from four major medical institutions, while collecting the EEG data of the subjects' resting state and performing tasks, the physiological state display platform can enable physicians to observe the changes in their physiological indicators in real-time. After the experiment, the EEG data can be uploaded to the cloud AI-assisted diagnosis system. Based on the robust model trained in advance, it can quickly predict the disease probability of the new subject and calculate the key value of EEG features. Provide doctors with a more objective diagnosis basis.

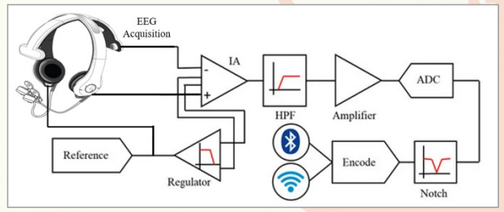

Fig.2 Flowchart of signal preprocessing in the embedded Brain-Computer Interface system.