



A25-154

大型語言模型連接過動症資料庫之注意力訓練系統

Attention Training System Integrating Attention-Deficit/Hyperactivity Disorder Databases with Large Language Models

隊伍名稱 | 與神同行 Along with NELab

隊長 | 黃子濤 / 陽明交通大學電控工程研究所

隊員 | 林若璋 / 陽明交通大學跨領域神經科學博士學位學程
楊翔壬 / 陽明交通大學電控工程研究所
李翰霖 / 陽明交通大學藥學系



指導教授

柯立偉 | 陽明交通大學電控工程研究所

交通大學電機與控制工程博士，現為陽明交通大學電控工程研究所教授兼副學務長、數位醫學暨智慧醫療推動中心副主任、IEEE Transactions on Fuzzy Systems、Associate Editor。

研究領域

神經工程、腦機介面系統、人工智慧與機械學習於臨床資料探勘、人工智慧與機械學習於生醫訊號處理、計算神經科學、神經網路與模糊類神經網路、智慧型照護系統。

作品摘要

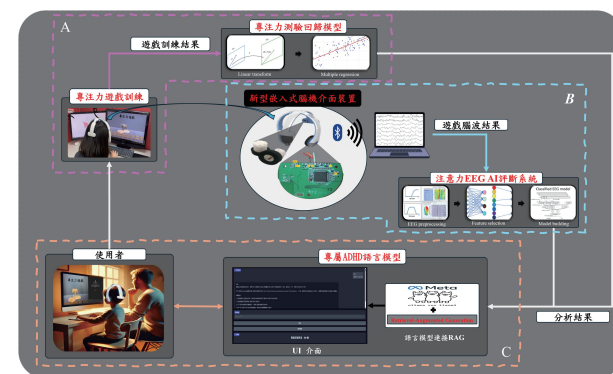
注意力不足過動症 (ADHD) 為常見神經發展疾病，影響兒童學習、行為控制及日常生活表現。傳統診斷多仰賴醫師主觀評估與問卷，缺乏即時性與科學依據，亦缺乏可持續追蹤之訓練機制。針對此痛點，本團隊設計開發結合嵌入式腦機介面、遊戲化專注力測驗、AI分析模型與語言生成技術之「ADHD專屬大型語言模型連接過動症資料庫之注意力訓練系統」，協助兒童於居家進行個別化訓練，並獲即時、具解釋性的回饋資訊。

系統包含三大核心模組 (圖一)。A模組為自主開發專注力遊戲「Sigma COG」，設計參考臨床CPT測驗，具備隨機刺激間隔與完整行為指標，並建構回歸模型，透過CPT常模與ΣCOG九大行為指標建立T-score轉換與多元回歸，實現遊戲數據與臨床標準化接軌，提升訓練數據分析的解釋性與可應用性。

B模組為新型八通道無線腦機介面，採半乾式電極設計，擷取兒童於「靜息狀態」與「執行遊戲任務」兩階段腦波，兼具良好訊號品質與配戴舒適性。團隊依循研究辦法建置EEG AI評估系統，主要以O2 β功率及腦區功能連結度為關鍵特徵，進行多層次模型建構與訓練成效分析，目前已完成100筆EEG建模，可即時呈現腦波變化與訓練改善趨勢，進一步提升AI分析結果之臨床解釋性與可靠性。

C模組為「ADHD專屬大型語言模型」搭配檢索增強生成技術 (RAG) (圖二)，整合EEG及行為特徵，建構ADHD診斷分類器與行為回歸模型，並串聯ADHD知識庫 (涵蓋DSM-5、SNAP-IV、行為數據、與EEG特徵)，用於生成個人化訓練回饋、知識問答與解釋性輔助，進一步擴展於遠距診療、家庭訓練及醫療教育等場景，提升互動性與應用價值。

目前團隊已於北中南三區收錄近250筆兒童腦波數據，累積多樣化資料，為系統優化與臨床驗證奠定基礎。系統具低成本、居家可用、回饋即時與擴展性高之優勢，除ADHD診斷與訓練，亦可應用於偏頭痛、睡眠監測與神經認知疾病等智慧健康領域。未來將與廣達電腦QOCA AIR智慧醫療平台，打造智慧化、人性化之ADHD訓練模式，實現家庭照護與臨床應用之整合落地，並朝向長期跨疾病、多場域智能輔助照護目標邁進。



圖一 系統架構圖。

Abstract

Attention-deficit/hyperactivity disorder (ADHD) is a prevalent neurodevelopmental condition that impairs children's learning, self-regulation, and daily functioning. Traditional diagnosis depends on clinicians' subjective judgment and questionnaires, offering neither scientific immediacy nor a sustained training mechanism. To address these gaps, we created the Attention Training System Integrating Attention-Deficit/Hyperactivity Disorder Databases with Large Language Models (Fig. 1), a home-based platform that combines an embedded brain-computer interface (BCI), gamified attention testing, AI analytics, and natural-language generation to deliver personalized training with real-time, explainable feedback.

Module A – Sigma COG gamified assessment. Sigma COG, our proprietary attention game modeled on the clinical Continuous Performance Test, features randomized stimulus intervals and comprehensive behavioral metrics. Using CPT norms, it maps nine key indicators to standardized T-scores through multivariate regression, aligning in-game data with clinical standards and enhancing interpretability and applicability.

Module B – Wireless eight-channel BCI and EEG analytics. A novel semi-dry, eight-channel wireless BCI captures high-quality EEG during both resting and gameplay phases, balancing pediatric comfort with signal fidelity. Following established research protocols, we built an AI-driven EEG evaluation pipeline that emphasizes O2 beta power and functional connectivity. Multi-level models track training efficacy and visualize longitudinal brain-wave trends; over 100 EEG datasets have already informed robust model development and clinically interpretable insights.

Module C – ADHD-specific large language model with Retrieval-Augmented Generation (RAG). This component fuses EEG-derived and behavioral features to train ADHD diagnostic classifiers and behavioral regression models. A RAG pipeline (Fig. 2) continuously builds and refreshes an ADHD knowledge base—aggregating DSM-5 criteria, SNAP-IV scores, curated behavioral datasets, and EEG feature libraries—so that the model can retrieve the most

relevant facts before generating output. Leveraging this RAG-powered database, the system produces personalized training feedback, conducts knowledge-centric Q&A, and supplies transparent explanations. These functions extend seamlessly to tele-health consultations, home-based coaching, and clinician-education settings, markedly boosting user interaction and real-world applicability.

To date, we have compiled nearly 250 pediatric EEG records from northern, central, and southern Taiwan, providing diverse data for system optimization and clinical validation. The platform is low-cost, easy to deploy at home, offers immediate feedback, and scales readily. Beyond ADHD diagnosis and training, its architecture can be adapted to smart-health applications such as migraine management, sleep monitoring, and neurocognitive disorder care. Future integration with Quanta Computer's QOCA AIR smart-health ecosystem will further merge cloud analytics with home interventions, advancing human-centric ADHD care and paving the way toward multi-condition, multi-scenario intelligent healthcare.

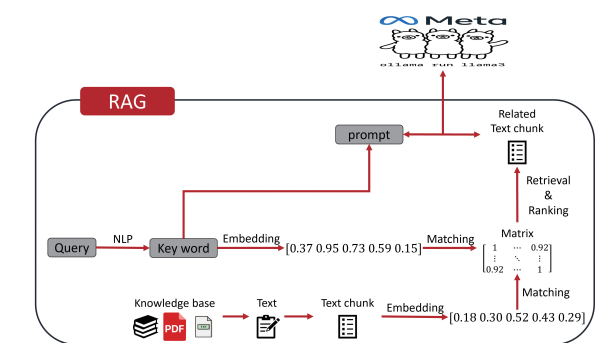


Fig. 2 Architecture overview of RAG-based ADHD knowledge integration with LLMs.