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智慧型中風上肢復健機械手臂

An Intelligent Rehabilitation Robotic Arm for Stroke Patients

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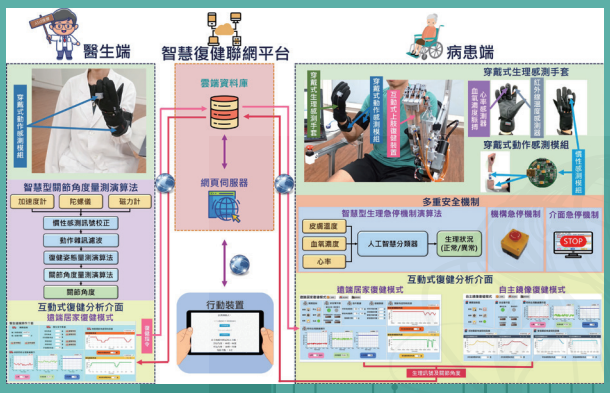
作品摘要

世界衛生組織（WHO）統計資料顯示，2019年來腦中風已是全球的第二大死因，導致每年將近610萬人死亡。台灣衛生福利部統計顯示，2017年腦血管疾病已位居國人十大死因之一。腦中風病患因為腦部中樞神經受損，造成記憶減退及肢體控制障礙，經常會產生下列症狀：關節僵硬、變形、肌腱收縮及肌肉無力。其中約30%腦中風病患發生肌肉痙攣的損傷，主要發生在上肢的手指、手腕及手肘等部位；導致日常生活功能性動作失能，造成生活品質下降和家庭問題。

居家診療復健是社會進步的重要象徵，但是目前病患使用單關節的復健機構，重複執行枯燥的復健動作，讓居家復健病患時常半途而廢，失去較佳的康復時機。傳統的居家復健裝置，無法完整的自動收集病患復健過程的動作及生理資訊，使得照護者難以協助完整的復健過程，醫生也無法快速評估病患居家復健的療效。因此，我們發展智慧型中風病患上肢復健機械手臂，具低成本、多功能、高效率及高安全性的等優良特性，期望推廣現代化智慧復健設備與應用。

本系統整合了下列智慧機構：互動式上肢復健裝置、含智慧生理感測模組的穿戴式智慧型手套、計算量測關節角度的智慧演算法、安全生理參數監控之智慧機制、互動式的復健分析介面、以及智慧聯網平台。本作品工作模式可以提供中風病患執行遠端居家復健和自主鏡像復健療程。醫生可透過本智慧型關節角度量測分析，規劃關節復健的較佳動作。經由智慧聯網平台，可以提供遠端復健指引，協助病患在家執行高效率的復健療程。並透過互動式復健分析介面，醫生可以即時監測病患的關節復健動作。病患可以在居家環境使用自主鏡像復健療程模式，用自己的健側手動作帶動患側手進行復健。病患復健療程的動態角度及生理訊號等紀錄，儲存於智慧聯網平台，完整建置病患的復健歷程，提供醫生評估復健成效之參考。此外，本系統設計多重可控安全機制，於復健響應或生理訊號異常時，能夠即時快速的停止機構作動，以確保使用者安全。

本智慧型中風病患上肢復健機械手臂已經完成穿戴式多功能感測裝置、智慧復健輔具及智慧聯網平台，具現場與遠端應用功能，記錄並提供完整的醫病互動式復健資訊。可以執行高效能現場診療、居家復健及遠距照護等應用。



▲圖一 本智慧型中風上肢復健機械手臂之系統設計架構

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研究領域

穿戴式智慧技術、人工智慧與深度學習、智慧型控制與系統識別、智慧復健輔具

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研究領域

微機電系統、半導體微製程、感測與量測自動化、工程科技教育

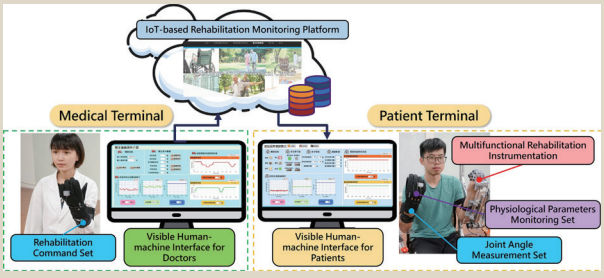
Abstract

The World Health Organization (WHO) shows that stroke patients have been the second leading cause of death in the world since 2019, resulting in nearly 6.1 million deaths each year. The cerebrovascular disease was one of the top ten causes of death in Taiwan in 2017. Stroke patients often suffer from memory loss and impaired limb control because of damage to the brain central nervous system to leave symptoms of joint stiffness, deformation, tendon contraction, and muscle weakness. About 30% of stroke patients suffer from muscle spasm injuries, which mainly occur in the fingers, wrists, and elbows of the upper limbs, leading to functional disability in daily life, resulting in a decline in quality of life.

Home therapy and rehabilitation is an important symbol of social progress. However, patients currently use single-joint rehabilitation institutions to do boring rehabilitation exercises that makes home rehabilitation patients give up halfway to lose opportunities for recovery. Traditional rehabilitation equipment cannot fully collect patient's information, so that doctors cannot quickly diagnose the patient's recovery status. Therefore, we have developed an intelligent upper limb rehabilitation robotic arm for stroke patients with excellent features such as low cost, multi-function, high efficiency, and high safety. We look forward to improving the intelligent rehabilitation equipment.

The system integrates many smart mechanisms including interactive rehabilitation device, wearable gloves with smart physiological sensing modules, smart computing algorithms, automatic safety mechanisms, interactive analysis interface, and network platform. The project operation provides remote home rehabilitation and independent mirror rehabilitation which can assist doctors in better joint rehabilitation diagnosis. Remote rehabilitation guidelines can be provided by the network platform to assist patients in performing home rehabilitation procedures efficiently. Doctors can monitor the patient's rehabilitation status in real time using the interactive interface. The self-mirroring rehabilitation function can guide patient rehabilitation of the affected hand by healthy hand movements. The rehabilitation records are stored on the smart network platform to build the patient's rehabilitation history as references for doctors to evaluate the effectiveness of rehabilitation. In addition, the system is designed with multiple automatic safety mechanisms to protect user safety.

The smart equipment that can perform stroke rehabilitation locally or remotely have been developed by integration of wearable multifunctional sensing devices, rehabilitation structures and smart network platforms. The medical-patient interactive information can be provided for on-site treatment, home rehabilitation, or remote care.



▲ Fig. 2 Developed IoT-based rehabilitation monitoring platform with the connection of medical-patient information