Application Group
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巧捷萬端—上肢復健外骨骼裝置

The Exoskeleton Device for Upper-Limb Rehabilitation

隊伍名稱　巧捷萬端
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作品摘要

本作品旨在整合網路通訊、機電設計、互動式網頁與資料庫建置，設計一個穿戴式上肢復健外骨骼裝置，用以克服醫療資源分配不均及人力短缺的問題，進而提升遠距復健醫療品質及節省醫療成本。本作品具備體積小、輕量、低成本及易於操作等優勢，是一個俱市場價值的可攜式裝置；所開發的主要功能模組包含：多維度機構、感測及驅動電路、資料庫、互動式介面等。機構設計部分，為達到符合上肢復健行為之輕便裝置，部分客製化關鍵組件係自行以 3D 印表機製作完成；其他如訊號擷取 / 分析、資訊傳輸、控制器設計等，主要是建構在一個以樹莓派（Raspberry Pi）為基礎的嵌入式控制核心，可提供外骨骼的遠端參數設定、復健模式調整、患者操作力回饋、電量提醒等功能。

傳統的上肢復健裝置多僅限於單一往復式操作模式，缺少與醫師的即時互動，對復健效果研判與即時調整明顯不足。在本作品中，患者歷次復健過程可以透過資料庫完整的記錄，醫師亦可透過網頁檢視每次的復健結果，藉以判斷患者的復健進展，得以進一步規劃後續療程。除此之外，醫師可因應患者的實際恢復情形，進行遠端外骨骼操作範圍的設定，亦可得知患者是否有主動配合復健，以達最佳療程安排。本作品經由系統整合與實測，所期待之功能都得以驗證，期望未來對國內遠距復健醫療整體運作有其實質貢獻。

圖 2. 復健紀錄關聯式資料表

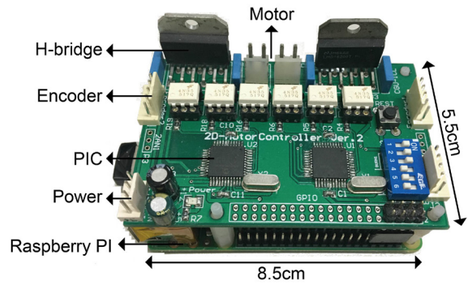

圖 1. 數位控制平台，上層 PIC 微處理器，下層樹莓派微電腦

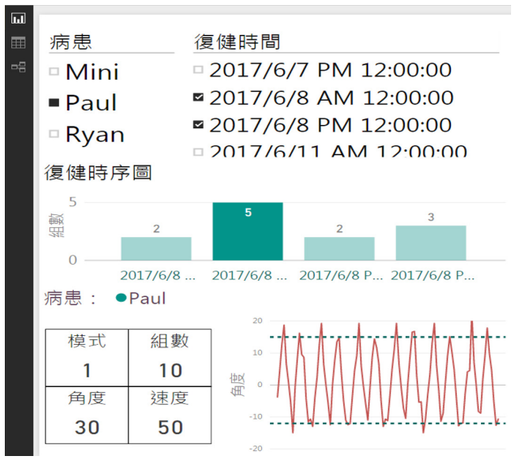

圖 3. 互動式網頁視覺化呈現

Abstract

This work is mainly on designing a wearable exoskeleton device for upper-limb rehabilitation by the integration of network communication, mechatronics design, interactive webpage, and database management. It is desired to overcome the problems such as uneven distribution of medical resources and insufficiency of manpower. Furthermore, the tele-rehabilitation quality can be improved and the medical cost can be reduced. This mobile device is with market values, having the advantages of small volume, less weight, lower cost and easy to operate. The developed function modules include a multi-dimensional mechanical structure, sensor and driver circuits, database, and interactive interface. In the design of mechanical structure, some key components are self-designed with 3D printer to fulfill the required rehabilitation operations. The signal acquisition and analysis, information transmission, and controller design are implemented in a Raspberry Pi based embedded kernel. The control kernel can provide the capabilities such as remote parameter setting, rehabilitation model adjustment, operating force feedback, and lower power indicting.

In general, traditional upper-limb rehabilitation devices are restricted to single reciprocating operations. It is lack of the interaction between patients and doctors. The judgement of rehabilitation effects and real-time adjustment are not enough. In this work, the patients' rehabilitation processes are recorded in a database. Doctors can view the rehabilitation outcomes through webpages to judge the rehabilitation progress. Moreover, the consequent treatment can be scheduled. In addition, doctors can remotely execute the range setting of exoskeleton devices. It can be also known whether the patients cooperate with the designated rehabilitation for better treatment assignments. From system integration and testing, the required functions are verified. It is expected that the proposed work can do some contributions for tele-rehabilitation medical operations.

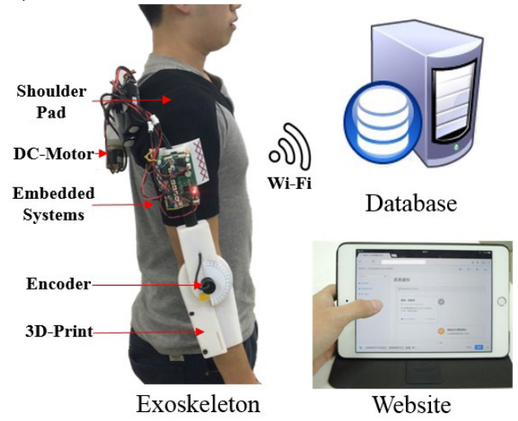

Fig 4. System diagram of the rehabilitation exoskeleton device for upper-limb

Traditional	Proposed
Site limited	Without site limited
Heavier than 10kg	Smaller and lighter to 1.5kg
Unable to record healthy history	Able to record healthy history
Rebabilitation inly for one mode	Able to choose many operation modes
Unable to support remotely health care	Able to support remotely health care

Fig 5. The comparison between the traditional rehabilitation devices and our proposed