A23-046

基於多光譜光源血氧影像偵測之傷口癒合分析及預測系統

Multispectral Imaging Based Tissue Oxygen Saturation Detection System for Wound Healing Analysis and Prediction

隊伍名稱｜快快好 Healing up!

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研究領域

顯示器電路設計、前瞻智慧醫療顯示技術開發、生醫電子系統

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研究領域

傷口癒合與疤痕、周邊神經再生、電刺激、幹細胞、再生醫學

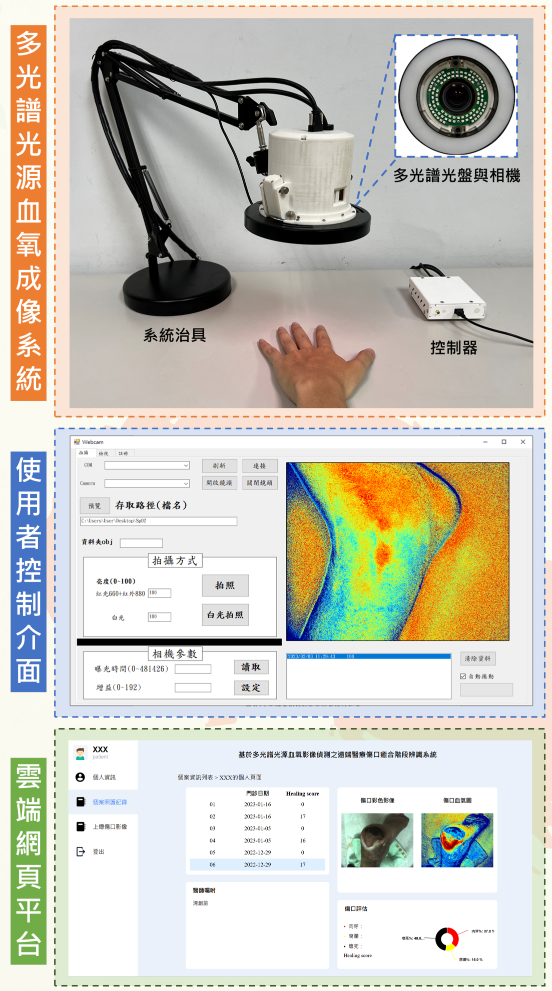
作品摘要

隨著臺灣老年人口數量的成長，高齡醫療照護的相關需求也隨之增加，其中慢性傷口是目前醫療院所中棘手的議題，此類傷口需長期監控並給予合適的治療，否則可能導致嚴重的併發症，例如截肢和敗血症。然而，傳統慢性傷口診斷方式為透過醫生視診判斷或可見光影像辨識，僅能看到傷口表面狀況，且容易受到醫師主觀的意識影響，導致不同的判斷結果。

為了解決前述的問題，我們提出了基於多光譜光源血氧影像偵測之傷口癒合分析及預測系統，其系統架構如圖一所示，包含多光譜光源成像系統、使用者控制介面與雲端網頁平台。我們的系統透過多光譜光源照射傷口組織，藉由血氧濃度演算法與人工智慧模型輔助醫師判斷傷口皮下血氧分布與癒合階段等資訊，並結合雲端顯示平台，達到遠端醫療功能。

本系統已完成多次小鼠動物實驗以觀察開放性傷口在恢復過程中的血氧值變化，同時使用市售醫療儀器-雷射都卜勒血流儀進行驗證比對，其結果顯示本系統可比雷射都卜勒更明顯觀察到傷口皮下組織血液循環的變化，有助於傷口癒合階段的分析。經由動物實驗驗證後，本系統目前已於合作醫院進行臨床病患收案，其中包含多種不同慢性傷口，如糖尿病傷口、壓力性褥瘡與靜脈鬱滯性潰瘍，收集多次回診的傷口影像以觀察傷口癒合狀況，並作為傷口癒合預測演算法的訓練資料。圖二為本系統之傷口癒合辨識演算法架構與臨床案例圖，本系統之演算法可分為三個階段，分別為傷口偵測、組織辨識與癒合分析。在傷口癒合分析的階段，本演算法導入血氧與組織辨識結果之相關特徵以判斷傷口未來是否會癒合。

本系統除了可提供醫療人員傷口皮下組織血氧濃度資訊以了解傷口處的血液循環狀況，更可透過人工智慧演算法自動辨識傷口的大小、組織以及未來癒合狀況分析，提供醫療人員更全面的傷口資訊以執行診斷，能幫助慢性傷口病患加快傷口的恢復速度與降低就診檢查的頻率，減少醫療體系與病患的負擔。



圖一 基於多光譜光源血氧影像偵測之傷口癒合分析及預測系統架構圖。

Abstract

Chronic wounds have become a challenging issue in medical institutions due to the population aging in Taiwan. Such wounds requiring long-term monitoring and appropriate treatments may lead to serious complications such as amputation and sepsis. However, the conventional diagnostic methods relying on doctors' visual examination or the identification by visible light imaging can only observe the condition of wounds' surfaces. Moreover, the methods show different judgment results due to physicians' subjective influence.

To determine the status of wound healing, we have proposed a multispectral imaging-based tissue oxygen saturation (StO_2) detection system for wound healing analysis and prediction. The system architecture is shown in Figure 1 and consists of a multispectral light source imaging system, a user control interface, and a cloud-based web platform. The system illuminates tissues by multispectral light sources and applies StO_2 algorithms and artificial intelligence algorithms to assist physicians in assessing information such as the distribution of StO_2 and wounds' healing stages. Additionally, the system integrates with a cloud platform to implement remote medical functionality.

The system has achieved multiple experiments on mouse models to observe the variations in the level of StO_2 during the wound recovery process. The results were verified and compared by a commercially available medical device, the laser Doppler flowmetry (LDF). The results showed our system is better able to observe the changes in blood circulation within the subcutaneous tissue of the wound compared to LDF, assisting the analysis of wound healing stages. After the validation of animal experiments, the system is currently being applied to various types of chronic wounds, such as diabetic ulcers, pressure ulcers, and venous ulcers, for clinical patient recruitment in a collaborative hospital. Collecting wound images by multiple visits is conducted to observe the wound healing progress and serve as training data for the wound healing prediction algorithm. Figure 2 illustrates the algorithm framework for wound healing recognition and clinical case images. The algorithm consists of three stages: wound detection, tissue recognition, and healing analysis. In the stage of healing analysis, the algorithm introduces relevant features from StO_2 and wound tissue recognition results to determine whether the wound will heal in the future.

In addition to providing healthcare professionals with the information about the StO_2 in the subcutaneous tissue of the wound, the system can automatically identify the size, tissue, and future healing trend of the wound through AI algorithms as well to accelerate the recovery of chronic wounds and reduce the frequency of medical examinations to alleviate the burden on the healthcare system and the patients.

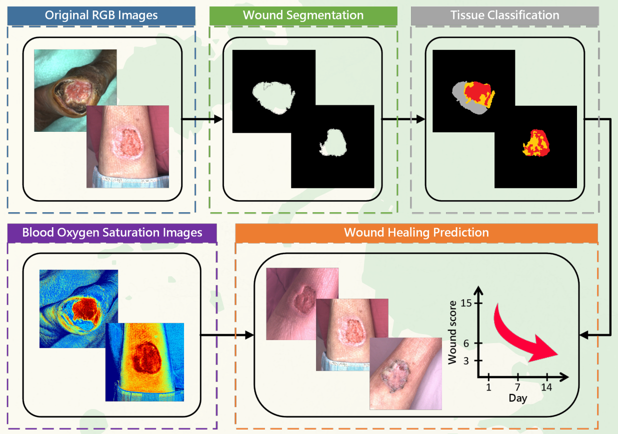


Fig.2 Multistage wound analysis and prediction results.