中文摘要

本研究以智慧型穿戴式手環裝置為主體，搭配穿戴式健康管理系統之

手機應用程式，提供完整的生理訊號量測平台，可長時間進行生理訊

號監控，包含心跳變化、步伐分析和睡眠品質分析，以及中端資料介

接應用程式軟體做記錄，以圖形化的介面顯示，讓使用者能完整且有

系統的瞭解自己的身體狀況。本研究建置出：(1)前端的智慧型手環裝

置、(2)中端的穿戴式健康管理系統手機應用程式和(3)後端雲端社群

平台的互動應用，經由前端的智慧型手環裝置針對使用者每日的步伐、

睡眠和心跳訊號做記錄和監控，再透過中端的穿戴式健康管理系統手

機應用程式進行每日運動量和睡眠品質的分析，並提供心臟健康照護

資訊。最後可利用後端雲端社群平台和朋友進行每日分析結果的記錄

與分享，能有效的讓使用者了解自己的運動量、睡眠品質和心臟功能，

降低罹患心臟疾病的風險。

針對本研究所提出的方法與服務模式，為驗證其可行性、信效度以及

手環裝置之生理訊號量測的準確度，共設計了三項實驗：(1) PPG (Photoplethysmogram, PPG)和 ECG (Electrocardiogram, ECG)相關性實驗，共 12 名受測者，實驗相關性平均為 0.841，但透過本研究所設計的移動平均演算法處理流程，能有效的將實驗中量測到之雜訊干擾排除，平均相關性可提高至 0.896，顯示本研究所使用 PPG 訊號量測心跳變化具有高度的可靠度。(2)步伐分析實驗，共蒐集 5 位自願者，針對不同走路型態進行誤差值計算，結果顯示，使用市售 Fitbit 手環進行步伐偵測實驗，平均誤差為 3.71%，而使用本研究之智慧手環平均誤差則為 1.43%，證明透過本研究所使用之 SVM (Sum of Vector Magnitudes, SVM)訊號處理和步伐偵測狀態機可針對不同走路類型的受測者，得到較高的步伐偵測準確度。(3)睡眠翻身偵測實驗之翻身偵測敏感度平均為 73.44%，陽性預測值平均為 90.08%，顯示當智慧手環偵測出翻身動作時，有著較高的準確度，未翻身而偵測為翻身的機率較低。

由實驗結果證明本研究之方法信效度皆具備一定水準以上，透過本研究之生理訊號監控，能有效的讓使用者了解自己每日的運動量、睡眠品質和心臟功能，降低罹患心臟疾病的風險。

關鍵字－智慧型穿戴式裝置、光體積變化訊號、心跳感測、加速度訊號、步伐分析

Abstract

The purpose of this study is to establish a physiological measurement system that provided users to measure physical condition regularly in a non-invasive manner and to maintain good physical health. We measure the physiological signal with a smart wristband device, which can monitor the heart rate by a light sensor modules and record the posture signal by a motion tracking sensor modules. The smart wristband device is composed of three units: Signal control unit, Signal sensing unit and Wireless connection unit. The signal control unit is responsible to control and memorize the status of the device by an ultra-low power MCU and an EEPROM memory chip. The signal sensing unit combines two physiological signal acquisition modules: A light sensor module to monitor PPG (Photoplethysmogram, PPG) signal and a motion tracking sensor module to capture the accelerometer signal. The physiological signals captured by the two physiological signal acquisition modules are sent bythe wireless connection unit to a smart mobile device which we developed an application on both Android and iOS devices.

In order to validate the performance and accuracy of the physiological measurement system we proposed, we designed three experiments including (1) PPG and ECG (Electrocardiogram, ECG) correlation experiment: The average correlation between PPG and ECG

amount 12 subjects is 0.841. However, after processing the moving average algorithm designed in this study, the average correlation can be increased to 0.896. (2) Step detection experiment: There were 5 subjects in this experiment and the average error rate is 1.43% of a normal walking test, which is much lower than the fitbit wristband with the 3.71% average error rate. (3) Rollover detection experiment: The sensitivity and positive prediction of the rollover detection is 73.44% and 90.08%, respectively. It proof that the reliability and validity of this study is statistically significant.