13th GOLDEN SILICON AWARDS

# A13-245

## Wireless Inertial Sensors and Shoulder Motion Applications

## 無肩戴：無線體感慣性儀與肩部動作量測


**隊伍名稱**

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## 作品摘要


由於無線感測網（WSN）的多點感測、低功耗與無線傳輸等特性，使得WSN逐漸被應用於行動健康照護（mobile healthcare，m-health）或隨意健康照護（ubiquitous healthcare，UHC）等領域。長時間的監測應用中，比較常見的有讀取包含心跳、ECG與血壓等非侵入式人體生理訊號量測為主；另一方面，短時間的監測則有復健動作的施行、氣喘尖峰流量觀察、血氧與血糖量測等項目。其中，居家進行復健的效果往往低於在醫院的復健效果，主要因為在醫院有復健醫療師在旁觀察並給予適時的修正，如能實現遠端復健動作的監測、分析、並適時給予患者動作的修正回饋，將可以大量減低患者前往醫院的需求與復健師的工作量。

所以本作品建構可配戴於人體的無線慣性感測節點與參數顯示系統。硬體方面主要於40mm×37mm×2mm的四層印刷電路板（PCB）上，整合微處理器、ZigBee射頻晶片、三軸加速規、兩軸陀螺儀、單軸陀螺儀、與印刷式倒F型天線。軟體部分則包含節點上的韌體與後端的接收顯示軟體；其中，慣性節點與接收節點的軟體使用開放原始碼的TinyOS開發，接收站電腦則使用Matlab撰寫序列埠資料讀取、封包解譯與轉換、與off-line類神經網路辨識程式。

實際應用上，已將所開發的兩個慣性節點使用於五十肩復健動作的運動參數量測，初步使用配戴於手腕的慣性節點所回傳的三軸加速度與推導出的向量夾角，進行六個復健動作的辨識，結果除轉盤動作低於60%辨識率外，其他五個動作的辨識率都超過85%。初步成果說明所開發的無線慣性節點在復健動作的辨識有相當可行性，預期將能為行動健康照護領域有所貢獻。


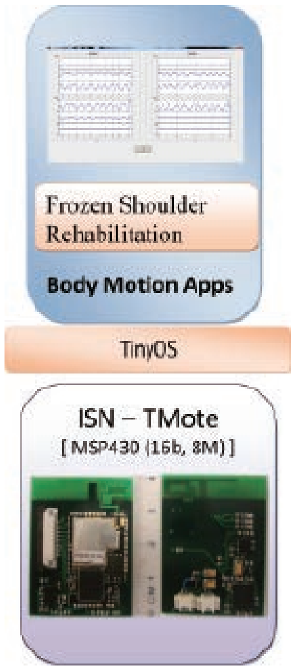


圖1 > 系統架構圖

圖2 > 節點一配戴位置

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**研究領域**

無線感測網路暨應用、數值電磁學。

## Abstract

Wireless sensor networks (WSN) emerge as an important technology in mobile or ubiquitous health care (m- or u-health) with the multiple hops, low power consumption, and wireless transmission. Several physiological signals including the heart beat rate, breath rate, ECG, blood pressure, etc., have been reported utilizing the WSN technology. Physical therapy monitoring is another good candidate for WSN deployment since it typically involves a continual and repetitive process of rehabilitation for geriatric guidance or stroke patients to achieve complete recovery. Clinical records are necessary references for physiatrists to prescribe associative programs. Therefore, it is important for the successful treatment to ensure that patients are continuously complying with their therapeutic assignments. Also, the applying of WSN sensors will levitate the loading of the physical therapist significantly.

This study establishes wireless sensor network (WSN) inertial sensors that comprise micro control unit, ZigBee-compatible radio frequency chip, tri-axial accelerometer, biaxial gyroscope, single-axial gyroscope, and a planar inverted-F type antenna on a four-layer printable circuit board with size of 40mm x 37mm x 2mm. Firmware on the sensors are developed using the open-source TinyOS, and the receiving and display program are written using the Matlab program. To distinct those activities of the shoulder motion, the artificial neural network (ANN) algorithm is employed to classify the input signals.

Two self-developed inertial sensors are attached on arm and wrist for measuring six rehabilitation exercise of frozen shoulder. The measured data are sent wirelessly to a base node where a Matlab-based program is developed for retrieving packet, parsing packets, and recognizing motion data based on. Accelerations in three axes and the derived angle form a 4-tuple vector as the motor feature of employed recognition algorithm. As results, five of six exercises are successfully recognized with 85-90% of accuracy rates but the complex one (i.e. the spiral rotation exercise) reached only around 60%. The pilot study approves good feasibility of self-developed WSN ISNs to recognize rehabilitation exercises as well as contribute advanced applications for mobile or ubiquitous health care in the future.

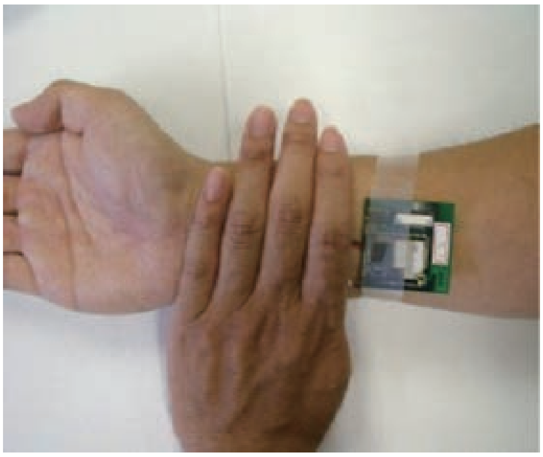

Fig.3 > 節點二配戴位置

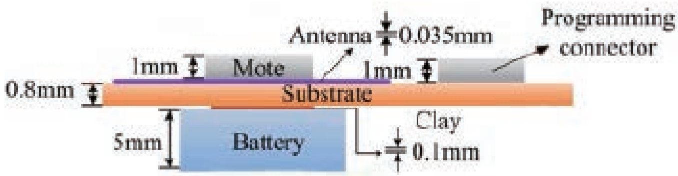


Fig.4 > 慣性儀示意圖