觀心自在：全功能無線心臟智能照護物聯網

文／林珮雯

由本校資工系趙禧綠教授及電機系教授伍紹勳教授組成「觀心自在」研究團隊，開發創新的全功能無線心臟智能照護物聯網，以提供友善、便利、全方位心臟照護服務。研究團隊不僅囊括 2018 年經濟部智慧聯網創新應用競賽總冠軍，還榮獲第十七屆經濟部國家產業創新獎，為臺灣產學研多元創新典範。

一百歲的心電圖儀還缺什麼？研究團隊改良傳統的心電圖儀器設備太笨重、昂貴及不方便移動使用等缺點，讓病患貼上三個有如 OK 繃的貼片，運用 3 導程差動電壓結合 AI 演算法可產生如醫療等級 12 導程的心電訊號，以利心臟即時監測，具技術優勢。為申請美國 FDA 認證，我們進一步使用傳統 V1~V6 的導程貼位，兩兩相減，取得三個差動導程訊號合成 12 導程的心電訊號 (如圖一系統架構圖所示)。

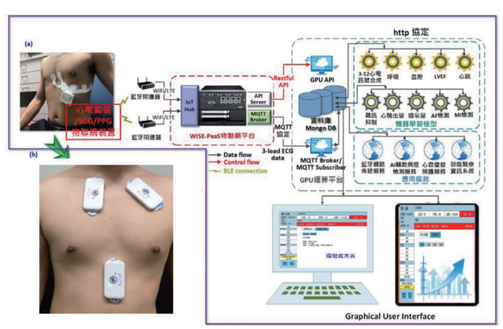
著眼於臨床上困境，心電圖監測多樣但缺少有效率的整合服務。研究團隊致力於以資通訊科技、人工智慧與創意服務模式，來逐步克服目前心臟病診斷與照護上常遇到的「症狀確認不易」、「長時完整觀測難」、「即時診斷難」、「危險預警難」，與「全時照護難」等技術、人力、與價格瓶頸。

全功能無線心臟智能照護物聯網，包含心房顫動、心肌梗塞、心臟衰竭嚴重程度等人工智慧病症檢測、心臟衰竭復健、心臟動力學參數估計、生理訊號即時監測、藍牙定位、姿態分析、深度學習模型自動更新、智能醫療資訊系統。「觀心自在」最大特色是基於開源醫療資訊系統做進一步功能開發，對每一位監控的病患，提供客製化預警 / 警示設定服務。進一步地，將病患臨床心電圖檢查結果饋入機器學習病症檢測網路模型，提供即時與非即時機器學習病症檢測服務。

觀心自在的技術與服務漸趨成熟，心電圖訊號與心房顫震檢測正確率並已達到 95%，而人工智慧心肌梗塞與心臟衰竭嚴重程度檢測雖然目前判斷準確度約 80%，但與各醫院仍持續進行人體實驗，未來更多臨床收案資料，必定能提高人工智慧檢測精準度。

觀心自在系統是結合產學研能量，研究團隊與國內多家廠商合作，包括工業電腦龍頭廠研華等 8 家協力產研機構。至於在實驗場域部分，則與台大醫院、台北榮總、台中榮總、成大醫院、新光醫院等合作。從醫院，醫生及病人的實際需求及意見回饋中，不斷修改產品及服務。

發展心臟智能照護物聯網，透過微型監測穿戴裝置可應用於心臟診斷、復健照護、急診救護及遠距醫療用途，具市場潛力。目前臨床部分已申請上市前審查，遠距照護部分亦有商品雛型，朝商業化方向發展。



Vipasyana: A Full–Functional Wireless ECG for Healthcare AIoT System

Professor Hsi-Lu Chao from the Department of Computer Science and Professor Sau-Hsuan Wu from the Department of Electrical and Computer Engineering formed a research team, “Vipasyana”, to develop a full-functional wireless ECG for healthcare AIoT system to provide user-friendly, convenient and comprehensive heart and vascular care services. The research team won not only first place in the 2018 Smart Networking Innovation Application Competition of the Ministry of Economic Affairs, but also the 17th National Industry Innovation Award of the Ministry of Economic Affairs, which brought out an innovation paradigm of diversified industry-academia research in Taiwan.

How could you improve a 100-year-old electrocardiograph? The traditional electrocardiograph is too bulky, too expensive, and inconvenient to carry, so the research team proposed a portable method: three band-aid-like patches are attached to a patient to proceed real-time 12-lead ECG digital signals by consuming 3-lead differential voltage with AI algorithm.

The massive variety and lack of integration services in ECG monitoring systems are the clinical difficulties for a long time. Using information and communication technology, artificial intelligence and innovative service models, the research team overcome step by step challenges of heart diagnosis and care in clinical scenarios, such as technology, manpower, and price bottlenecks, which comprise "the difficulty of confirming symptoms", "the difficulty of Long-term clinical observation", "the difficulty of real-time diagnosis", “the difficulty of warning signs of diseases”, and “the difficulty of full-time care”.

The full-functional wireless ECG for healthcare AIoT system is composed of heart failure rehabilitation system, cardiac dynamic parameter estimation, real-time physiological signal monitoring, Bluetooth positioning, posture analysis, automatic update of deep learning models, and intelligent medical information system. The most significant characteristic of “Vipasyana” is that it extends system functions based on an open-source healthcare information system. The enhanced system provides personalized and customized early warning/warning setting and feeds the patient-specific ECG result into a disease detection model trained by machine learning technology to provide real-time and non-real-time disease detection services.

As the technology and services of “Vipasyana” is getting mature, the accuracy of ECG signal and atrial fibrillation detection has reached 95%. Although the accuracy of the diagnosis of myocardial infarction and heart failure powered by artificial intelligence is currently about 80%, the team confidently expects to improve the system accuracy by more feedback in clinical practice in the future.

The system of "Vipasyana" is an achievement of industry and academia collaboration. The research team cooperates with many domestic manufacturers, including eight industry-research institutions such as Advantech, the leading industrial computer manufacturer. Regarding the experimental field, the team collaborates with National Taiwan University Hospital, Taipei Veterans General Hospital, Taichung Veterans General Hospital National Cheng Kung University Hospital, and Shin Kong Wu Ho-Su Memorial Hospital. They will continuously enhance products and services according to the actual needs and feedback of hospitals, doctors and patients.

Through wearable devices, the full-functional wireless ECG for healthcare AIoT system can be applied to cardiac diagnosis, rehabilitation care, emergency care, and telemedicine market; hence it is expected to witness future growth. At present, the system has been applied for the review of a premarket approval with clinical trials. In addition, a commercial prototype of the remote monitoring system has been implemented and a business plan is put on track.