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Application Group

非接觸式生理與活動訊號偵測系統於長期照護之應用

Contactless Physiological and Physical Signal Detection System for Long-Term Care

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研究領域：嵌入式系統設計、生醫電子工程、FPGA 系統設計與應用、智慧型手持裝置在醫學工程上的應用、穿戴式裝置設計、生理訊號處理。

作品摘要

隨著人口結構高齡化與疾病型態的改變，長期照護已成為現代社會中重要的課題。目前的長期照護方式主要是仰賴人力照護，但是由於人口結構改變以及勞動人口的減少，如何以有限的人力資源並維持照護品質是個急需解決的問題。

傳統心率訊號量測可以使用一般的 ECG（心電圖 Electrocardiography）量測儀器，使用時必須將沾有導電膠的電極貼片黏貼在身上或是穿著心率帶。然而長時間使用這些電極貼片與心率帶卻容易對皮膚產生刺激或不舒適感。若是使用 PPG （光體積變化描記圖 Photoplethysmogram）量測儀器則大多是要利用夾具包覆手指末梢或耳垂來進行量測，對使用者來說依然是不舒服的，尤其對於這些部位有傷口的病患來說，更容易造成疼痛或感染等問題。

由於這些缺點，這些量測方式應用於長期照護中會對使用者造成身體上的負擔，而且使用者的活動範圍也會因為儀器線材而受到限制。加上若是發生非預期的狀況時，比如：患者下床行走而無告知相關人員或生理訊號突發性異常等，照護人員無法在第一時間掌握資訊並控制情況，也會造成醫護人員的負擔與資源浪費。

然而，隨著科技的進步，目前市面上有許多穿戴式裝置可以進行心率的量測（例如：智慧型手錶、手環），雖然這些裝置在進行量測時不需要黏貼電極片，但是必須要綁緊才可以量的準確，長期下來也會對使用者造成不適，且必須經常進行充電，無法適用於長時間的監控。

因此，為了提高量測的便利性與增加量測時的舒適度，近幾年有學者提出了利用非接觸式無感測量技術能夠有效地改善上述的問題。現今的非接觸式量測心率訊號方式難以即時處理，而且除了生理監測外並無其他相關應用。所以我們提出一個透過嵌入式 FPGA（場效可程式邏輯閘陣列 Field Programmable Gate Array）平台開發系統來發展一套多人同時量測的非接觸式的心率與活動監控系統。運用 FPGA 的硬體加速的優點達到資料即時處理和提高系統穩定度與便利性。除此之外，本系統也結合了藍牙無線傳輸技術，當量測生理訊號發生異常時、使用者不在量測區域、使用者移動幅度過於激烈等，即便是照護人員臨時不在現場，也能透過手機 APP 在第一時間內顯示藍牙所傳來的通知，掌握所有來自各個量測裝置的資訊。最後，我們也搭配資料庫，將所有重要的資訊上傳雲端。可提供後續專業醫師進行生理資訊的回顧與分析。

如此一來，不僅可以減少人力資源的開銷，提升照護環境的安全性與有效性，也擴展了非接觸式技術的應用範圍。

圖 1. 利用這套系統，可以在不接觸人體的情況下，偵測人體心率與活動程度。並搭配手機 App，將所偵測得資訊即時通知給相關照護人員，達到舒適與長期照護的目的

圖 2. 系統應用於長期照護中心示意圖

Abstract

Like the rest of the world, Taiwan is an ageing society. This will place substantial additional pressure on health and long-term care services. Current long-term care is mainly relying on human care. However, due to changes in population structure and the reduction of labor force, liming the human resources and equally maintaining the quality of care becomes an urgent problem to concern.

Traditional heart rate measurement approaches required contact electrodes and conductive gel to evaluate people's cardiac activity. However, longtime having adhesive gel attached to the skin will cause irritation and allergic reaction easily. Although smart wearable devices like heart rate sensor strap or smart jackets has gradually replaced the traditional Electrocardiography (ECG) measurement, continually wearing the tight strap may lead to discomforts and rashes for general people. Nowadays, the common adopted method to monitor patient's cardiac condition is to use the PPG digit clips. Although the relative discomforts reduced, enduringly having contact probes attached to the fingertips or earlobes may increase the risk of infection and pain if the measurement parts are wounded.

As mentioned, the side effects of traditional measurement may cause extra pains for patients, especially for generics or infants with sensitive and fragile skins. Furthermore, multiple cables and wires can bring the inconveniences and disabilities for patient activity. Based on sensor-based measurement, nursing aides may not be aware of patient's ambulation or unexpected emergencies.

With the rapid growth in technology, most of wearable devices like smart bands or watches are able to detect human's instant pulse rate. While no conducting adhesive pads are necessary for measurement, the devices need to be tied on the wrist for accurate detection. The discomforts and the battery endurance will also become the potential problems for long-term monitoring eventually.

To reduce the ineffectiveness and to improve the comforts and convenience for longtime health monitoring, we proposed a novel system to perform both physiological and physical signal assessment by using camera. The system was designed based on a Field Programmable Gate Array (FPGA) experiment board development. With hardware structure employment, the stability, computation ability can be facilitated.

The system comprised the instant heart rate monitoring, physical activity and ambulation detection for multiple patens' measurement simultaneously. All the accessed information is displayed on the corresponding smartphone application through Bluetooth transmission for achieving remote monitoring prospect. Caregivers are able to manage and investigate each patient's health and physical conditions through their handheld device without physically around.

Through this contest, we suggested a system to perform future remote health caring prospect which can be ubiquitously utilized in general health care services including hospitals, healthcare centers, baby surveillance and personal health care. In response to the low labor force and increasing in older individuals, the system provides new intelligence, perspectives and analysis on trends affecting health related industries.