中文摘要

本研究以婦產科母親與嬰兒安全監控為出發點，設計了各種應用服務協助有其需求的使用者。包含了即時性的室內定位、危險區域偵測警報與護理站、護理師與母親的監視介面軟體，透過藍芽作為來源協助在院內的人員或家屬可以掌控新生兒的位置與狀態，避免發生嬰兒遭人抱走的家庭悲劇。因此本研究建置出(1)前端穿戴式藍芽手環裝置，(2)中端中繼器做穿戴式手環資訊匯集站，(3)後臺透過演算法歸納事件後，以圖形化的介面顯示，讓醫院內使用者能完整且有系統的瞭解嬰兒的安全狀況。

針對本研究所提出的方法與服務模式，為驗證其可靠性與準確度，共設計了三項實驗。本研究以(1)驗證藍芽訊號強度與距離具關聯性，將所發開的藍芽手環於不同位置進行強度的採集和平均，建立訊號強度衰減模型與強度距離區間，得到在10公尺以內訊號強度具有規律性的遞減。(2)個數與速率變化偵測率之危險區域中繼器壓力測試，實驗結果以個數分析在發報器增加的條件變化下遺漏機率會增加，在最多個數的情況下遺漏率最高。以速率分析可以得出在速率增快的情況下，遺漏的機率會上升，最高遺漏率在行走模式為衝刺的情況下。在單一中繼器的偵測下，遺漏率最高為14.61%和18.46%，但透過兩個中繼器互補可將遺漏率降低至4.61%，可得出兩個中繼器在速率和個數因素

下具有彌補作用，可有效降低僅一個中繼器下之遺漏率。(3)傳統靜態與本研究提出動態決策定位演算法門閥值，透過更新門閥頻率不同來測試其演算法之定位錯誤率。在靜置的定位錯誤率靜態決策為5.19%、半靜態3.92%和動態決策為3.77%，可表示靜態、半靜態與動態決策定位門閥定位演算法具有相當不錯的可靠性，並且驗證出動態決策環境區域門閥具有最佳的定位錯誤率。

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，透過本研究之藍芽訊號監控與開發系統，能有效的掌握嬰兒位置且降低嬰兒被竊的風險和提供醫護人員便利的介面系統。

關鍵字－智慧型穿戴式裝置、低功耗藍芽、無線網路、室內定位、信標、孕婦、嬰兒

Abstract

Design a low energy Bluetooth (BLE) device including reference-tag-based indoor position algorithm to solve different situations including location determining, route guideline and tracking in this study. It can not only help the visitor or patient to understand the position but also provide a system for medical staff to monitor the safety of patients and new born babies in hospital. This device is tiny enough to be embedded into visitor's wristband, baby's foot band and patient's clothes. It is composed of 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 is a motion tracking sensor module to capture the accelerometer signal. The wireless connection unit combined of beacon and Bluetooth module to send data package as a BLE sender. The indoor location-based services (LBS) system is combined with smart beacon and Wi-Fi gateway. Beacon plays the role of client and Wi-Fi gateway is server. The RSSI (Received Signal Strength Indicator) of BLE signal to determine whether the beacon owner is in a particular area.

In order to validate the performance and accuracy of the safety monitor system we proposed, we designed three experiments including (1) The Relevance of Distance and signal strength: we build the attenuation module of signal strength. We defined that BLE device sense distance is 10 meters. (2) The number of device and moving speed test: we found that it's got higher lost rate if the number of device and moving speed is increased. But we reduce the lost rate by using two gateway, we got a great lost rate 4.61%

when using two gateway is better than just a gateway is 14.61% by number and 18.46% by speed. (3) Positioning error rate: we got error rate is 5.19% by static threshold. Got error rate is 3.92% by half static threshold. Another method by dynamic threshold we got the best error rate is 3.77%.

Keywords－Smart Wearable Device；Bluetooth Low Energy；Indoor Positioning；Wireless；Beacon；Pregnant Woman；Infant