作品名稱
互動式羽球訓練系統
Interactive Badminton Training System

隊伍名稱
BEST Black Tea

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作品摘要

隨著戴資穎、周天成等人在國際上嶄露頭角，羽球運動在臺灣不僅受到更多人的關注，同時如何更有效率的培養一位優秀的選手也成為一項重要的議題。因傳統的羽球訓練步驟繁雜且費力，為了提升訓練效率，本創作研發了一套完整的羽球訓練系統，提供教練和選手一個科學化、圖形化且多元化的訓練工具。

本創作為一「互動式羽球訓練系統」系統架構如圖 1 所示。本系統包括感測器、手機 APP 和物聯網發球機。球拍感測器會將球拍的三軸慣性感測器資料透過藍牙傳送至手機 APP 進行分析。手機 APP 透過球種辨識演算法可辨識七種球種包含：長球、切球、平球、挑球、撲球、小球和殺球，同時也會記錄速度、力道以及擊球次數，此外手機 APP 也負責發球機參數的設定、指定落點與排程的規劃。物聯網發球機則是接收手機 APP 的指令並解碼，再依照不同的指令完成出球角度與速度的調整並發球。

硬體方面，利用 STM32F746 微控制器自行開發主控板來控制發球機，球拍感測器的部分則是使用 nRF52832 系統晶片結合三軸加速計及陀螺儀來實現。軟體方面，本系統針對發球機，開發了多台發球機連線的功能，增加了發球球種的多樣性及球場的涵蓋範圍，以彌補單台發球機位置與角度的侷限性，除此之外也解決了單台發球機出球頻率太慢的問題。同時開發手機 APP 提供「指定落點模組」和「人機互動模組」，前者讓選手在進行訓練的時候可以自行選擇所需加強的落點或球種；後者透過與發球機互動的訓練，讓選手可以有對打的感覺，且在訓練結束時可以檢視手機 APP 了解自己的訓練狀況。

實驗驗證方面，我們針對羽球場上九個點進行指定落點實測，發球機發到指定落點之 30 公分半徑範圍內的準確率為 100%。球種辨識的部分，平均正確率為 94.133%。透過我們的系統，除了大幅提升選手的訓練品質，更重要的是我們以圖像化的方式呈現各個功能和資料數據，讓使用者體驗達到最佳化的效果，期望以科技帶給選手一個精準化的運動訓練。
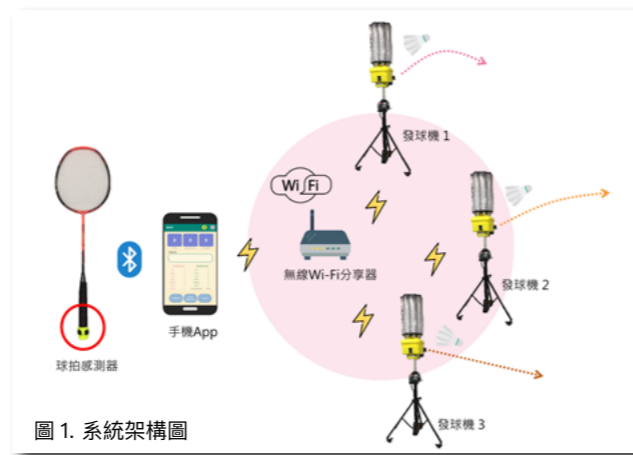

圖 1. 系統架構圖

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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、穿戴式裝置設計、物聯網應用、基於影像的生理和活動信號偵測技術、健康照護、機器學習

Abstract

With the outstanding performance of Tai Tzu Ying, Chou Tien Chen and others in the world, badminton attracts more attention in Taiwan.

At the same time, how to train a good player more efficiently has also become an important issue. Compare to the complicated and laborious traditional training procedure, our team has developed a complete badminton training system for coaches and players with scientific, graphical and diverse training tools to improve the training efficiency.

This is an "Interactive Badminton Training System", which is consisting of a smart racket sensor, a smartphone APP, and the Internet of Things (IoT) based badminton serving machines. The system architecture is shown in Figure 1. The racket sensor transmits the three-axis inertial data of the racket to the mobile phone APP via Bluetooth for analysis. On the smartphone APP, we have developed a set of ball species recognition algorithms for the most commonly played shots, such as Clear, Cut, Drive, Lob, Rush, Netplay and Smash, Besides, this APP also records the speed, strength, and number of hits, On the other hands, this APP is also responsible for setting the parameters of the badminton serving machine, planning the designated landing point and scheduling. The IoT-based badminton serving machine receives and decodes the instructions of the smartphone APP, and then completes the adjustment of the angle and speed of the ball according to different instructions and serves.

For the hardware design, the STM32F746 is used as the microcontroller on the control board in the badminton serving machine. The racket sensor is implemented using the nRF52832 chip combined with a three-axis accelerometer and gyroscope. In terms of software, this system has the feature of connecting multiple badminton serving machines for increasing the diversity of shots and angle to make up for the limitations of position and angle of a single badminton serving machine. Besides, it also solves the problem that the serving frequency of a single badminton serving machine is too slow. Simultaneously, the function of smartphone APP provides "Designated Landing Point Module" and "Human-Machine Interaction Module". The former allows players to choose the landing points or ball types they need to strengthen when training. The latter through the interactive training with the serving machine, so that players can have a feeling of playing with a real human. At the end of the training, they can check the smartphone APP to understand their training status.

In terms of verification, we measured the designated landing points for nine points on the badminton court. The accuracy of the badminton serving machine within a radius of 30 cm from the designated landing point is 100%. For the ball species recognition, the average accuracy is 94.133%. We hope that through our system, we can greatly improve the training quality of players. Furthermore, we present the various functions and data in a graphical way, so that the user experience can be optimized, and we hope that technology can bring players a precise training in badminton.