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Swing gesture recognition with wearable sensors for playing a table tennis game

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Abstract. Recently, a fitness tracker has been developed to monitor various kinds of exercise. However, most of the trekkers still provide the function to monitor exercise time, distance, and type of exercise. However, the technique of analyzing the activities of the ballgame is not developed yet. In this paper, we propose an algorithm to distinguish the behavior of table tennis games in order to monitor the movement of ball games. In a controlled environment, the analytical accuracy was found to be about 100%, 95%, and 90% accurate for the forehead, backhand, and none swing activity respectively.

Keywords; Activity recognition; accelerometer; gyroscope; wearable sensors

1. Introduction

Recently, motion tracking using smart watches or wearable devices is getting attention. Typically, Apple Watch, Samsung Gear, LG Watch, and Garmin are basically tracking the number of steps and running activities. It tracks not only walking and running but also various kinds of exercise. Samsung gear Fit Pro2 has partnered with Speedo, a swimming company, to track swimming activities and analyze swimming time and swimming stroke types. It also recognizes actions such as stretching. In this way, studies are being conducted to understand various exercise activities using sensor data measured in a wearable device.

Studies have been carried out to measure swing motion in various ways from various athletic activities [1-3]. In previous works, researchers calculate the average

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vector of the discrete wavelet transform (DWT) based on the accelerometer value built in the smartphone, thereby calculating the tennis swing forehand stroke, Backhand stroke, forehand volley, and backhand volley [2]. Hu and his colleagues analyzed the table tennis movement using Kinect [3]. The joint information transformed into spherical coordinates is extracted by LDA dimension reduction and k-means clustering, and feature points for motion classification are extracted and HMM is used. In this paper, we propose a method to distinguish the swing type from the forehand, backhand, and no swing by using the acceleration sensor and the gravity sensor of the smart watch.

2. Methods

Basic procedure of this work is as shown in Fig. 1. We used an acceleration sensor and a gravity sensor on the smart watch to analyze the swing activity. Acceleration sensors were used to identify yaw, pitch, and roll using x, y, and z values and to classify the type of swing as a forehand and backhand using the change in gravity value that varies with the direction of the wrist. The acceleration sensor value was analyzed to determine whether or not to play a table tennis swing.

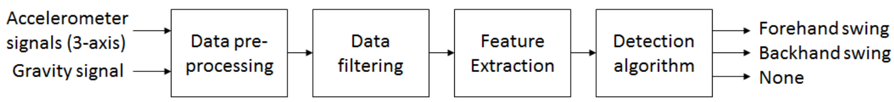
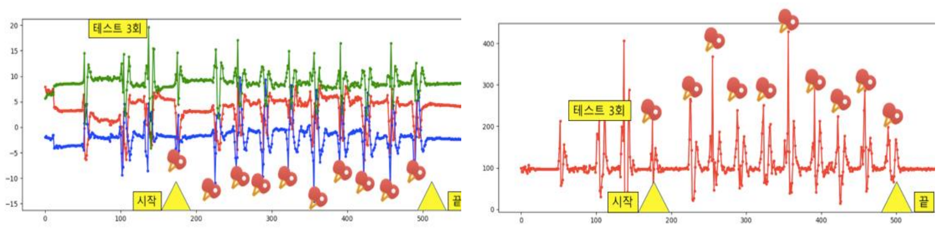
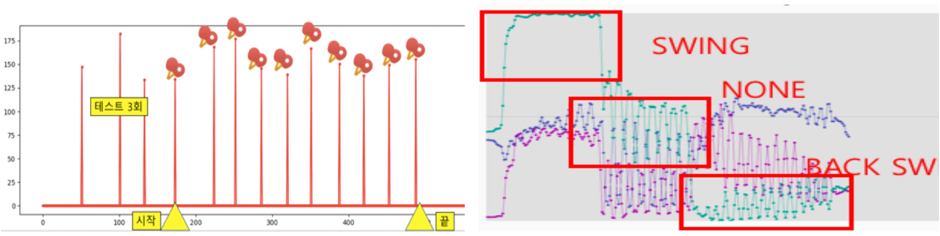


Fig. 1. Overall data processing procedure

For data preprocessing step, we collected pilot data to see the data ranges, features, and patterns, then we applied basic band pass filter by assuming swing activity frequency during a game (0.5 Hz to 3 Hz). Then we computed Signal Vector Magnitude for each axis values. In the peak detection algorithm, all values below a certain threshold are treated as 0, and peaks occurring within a certain window size after the first peak are not regarded as peaks. The results are shown in Fig. 2.



(a) (b)



(c) (d)

Fig. 2. Processed signal result

3. Results

Smart Watch used LG Urbane and Samsung Galaxy Note 4 used for implementation. In order to measure the accuracy of the algorithm, a total of 58 swing tests were conducted on 5 adult male subjects. Each subject had 10 swings using typical table tennis rackets. We collected 383 swing data from the 58 swings that we tested and found 100% accuracy in a controlled experimental setup. Then we evaluated three types of swing activity recognition result using gravity sensors. We found the threshold to classify three activities empirically. Since the peak value of the acceleration sensor generated in the range beyond this section is not a forehand or a backhand, it is a behavior that is not a swing but it can be regarded that the acceleration sensor value is largely changed. As a result of the swing test 20 times for each section, the accuracy of the forehand was 100%, the backhand was 95% and the non-swing was 90%.

4. Conclusion

In this paper, we proposed swing activity detection method using wearable sensors in a smart watch. From the experiment we found that 100 accuracy of swing count detection, and 100%, 95%, 90% for forehand, backhand and non-swing activity classification. As a future work, we will collect more data to verify the proposed method in uncontrolled environmental situation. It is expected to develop various services related to table tennis such as swing posture correction, winning percentage analysis, and automatic table tennis game scoring system based on the proposed method.

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References

[1] E. Boyer et al., “Low-cost motion sensing of table tennis players for real time feedback,” International Journal of Table Tennis Sciences, Paris, France, pp.1-4, 2013.

[2] G. Heo et al. “Analysis of Table Tennis Swing using Action Recognition,” Journal of Institute of Control, Vo1.21, No. 1, pp40-45, 2015.

[3] L. Zhang et al., “Kinect based 3D video generation,” In proceedings of IADIS, Madeira, Portugal, pp.278-282, 2016.