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Automatic Racket-Based Ball Dropping Point Analysis System

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Abstract. This paper introduces depth-slicing technique (DST) to detect and analyse dropping points of the ball for racket-based sports. Conventionally, dropping points of the ball is detected and recorded manually either on the spot or through sport video. As such, those approaches are very tedious and time-consuming. Furthermore, the detection of the dropping point is very subjective to human's judgement. There are different methods to obtain information for ball dropping points, but our major emphasis is on DST, which represents the object surface as points of cloud and are analysed based on a distribution map. In our research, sliced depth map sequences where the depth interval, also known as "interval of interest" which is just above the ground is captured using cost-effective RGB-D sensor, namely Microsoft Kinect sensor. With such implementation, the dropping points of the ball can be easily detected and stored. The racket based sport dataset that collected in this research is tennis. The data is statistically analysed by performing different experiments and results are obtained by a graph plotting. Conclusions are drawn from these results in order to enhance athlete's performance.

Keywords: Depth Slicing Technique; Distributional Data; Kinect.

INTRODUCTION

In the last two decades, the sport analysis was mostly qualitative in nature. However, with the recent advancement of technology related to input acquisition sensor and computer hardware, computerized motion recognition and analysis for athlete are becoming more prevalent. Computer vision technology becomes import aspect in sports analysis where the technology is utilized to gather and analyze statistical data for a match of sport game in the last two decades. In sport sciences, a common method for analyzing performance of athletes is to film the athletes and annotate the footage offline manually using a video digitization system. It is a popular method in many sports but requires expertise from the system operator to annotate the videos to highlight important components of the video contents.

Different techniques were adopted to analyse the performance of athlete quantitatively. Recently, several studies have been conducted to analyze the movement of racket-based sport, such as badminton *smashing* [1-4], *service* [5-6], and *swing* [7]. Most of the literatures above, however, only analyze the player's movement. To our very best of knowledge, there is no computerized analysis on ball dropping point so far.

Due to the emergence of inexpensive, reliable, and robust algorithms to capture the depth information, human motion tracking using Microsoft Kinect sensor is becoming more prevailing. Microsoft Kinect sensor was originally released with the intention to improve human computer interaction in gaming for the Xbox 360 game console. Despite being targeted mainly for the entertainment market, the sensor has gained enormous interests within the vision and robotics research community for its broad application [8].

Therefore, automatic racket-based ball dropping point analysis system using Microsoft Kinect sensor is proposed in this paper. Besides, the sport of interest in this research is tennis. The proposed system is believed to be beneficial to the coaches and potentially useful in enhancing the performance of athletes.

PROPOSED METHOD

By leveraging the low-cost Microsoft Kinect sensor, tennis ball is located or detected using depth slicing technique (DST). This technique is adopted because of efficient and accurate results and less pre-processing is needed. Basically, DST is to determine the maximum and minimum range of detection of the depth signal, as define by D_{max} and D_{min}, respectively. The range of interest is therefore denote as:

$$R = D_{max} - D_{min} \quad (1)$$

Then, the blob of the shuttlecock in the depth sequences is extracted and the centroid, *C* of the blob in terms of *x*, *y*, and *z* coordinates are determined and collected subsequently.

Furthermore, the distance of the ball between each frame is calculated by:

$$Dist(C_i, C_j) = \sqrt{(X_{ci} - X_{cj})^2 + (Y_{ci} - Y_{cj})^2 + (Z_{ci} - Z_{cj})^2} \quad (2)$$

where X, Y, and Z indicate the 3-dimensional (3D) coordinates for the detected centroid. After that, the speed is computed using:

$$S = \frac{Dist}{(t_2 - t_1) / FPS} \quad (2)$$

where t_1 and t_2 are the instances of time and *FPS* is frame per second which is equal to 30 in our research.

EXPERIMENTAL RESULTS AND DISCUSSIONS

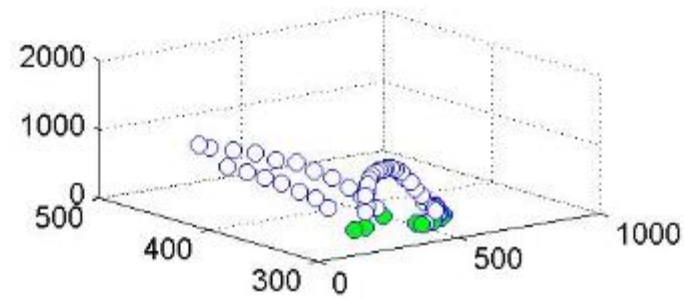
Tennis ball dropping dataset was collected by capturing different movements or actions of player in order to allocate the positions of the dropping point at different points. The main attributes of the dataset are frames, 3D coordinates and occurrences. Table 1 shows the partial of the collected data.

TABLE (1). Partial data of the collected data for tennis ball dropping points.

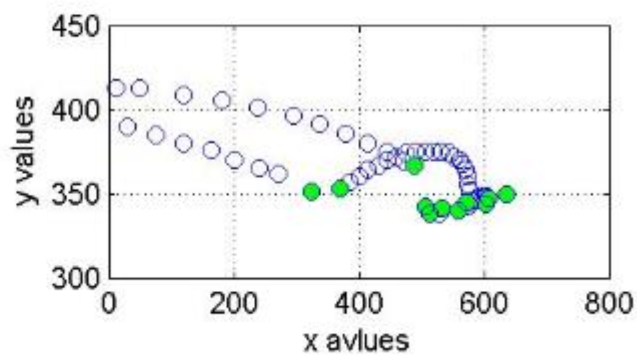
Frame	X-Coordinate	Y-Coordinate	Z-Coordinate	Occurrence
935	488	367	13	1
936	472	369	141	1
937	446	375	283	1
938	414	380	421	1

939	380	386	552	1

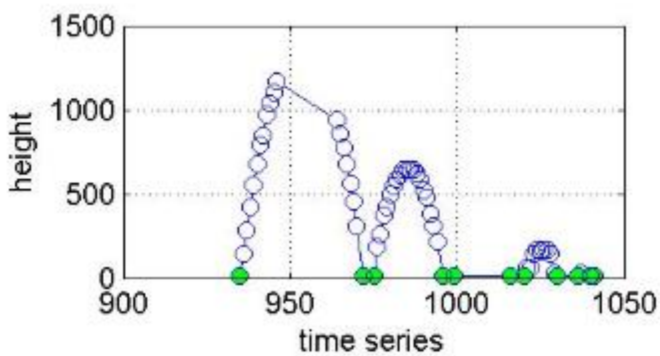
Figure 1 shows the trajectory of the tennis ball in different projections. Generally, the trajectory shows the tennis ball was hit by the player and bounced. Figure 1(a), 1(b), and 1(c) demonstrate the trajectory of the tennis ball in 3D, X-Y plane, and depth plane respectively.



(a)



(b)



(c)

FIGURE 1. Trajectory of the tennis ball in different projections. (a) 3D, (b) X-Y plane, and (c) depth plane.

In addition, the speed of the ball can be visualized and analyzed from Figure 2. Basically, the tennis ball travels with higher speed when the ball is bouncing.

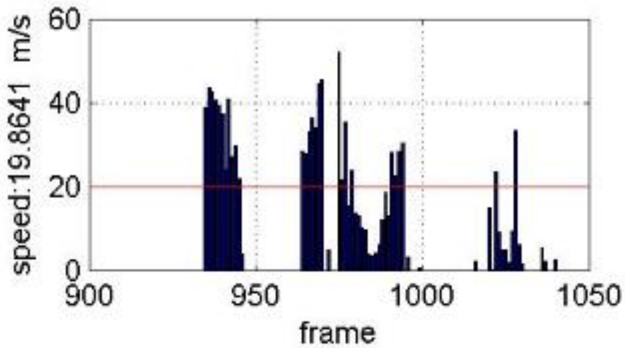


FIGURE 2 Speed graph of the tennis ball.

CONCLUSIONS

In this paper, we have presented the tennis ball dropping analysis using cost-friendly Microsoft Kinect sensor. Depth slicing technique is employed in order to detect and locate the dropping point of tennis ball. Then, the centroid point in terms of 3D coordinates is determined. From the collected data, analyses such as trajectory and speed can be examined by graph-plotting method. Therefore, the proposed system is believed to be helpful to the sport coaches, and enhance the performance of players.

REFERENCES

1. Nagasawa, M., Hatori, Y., Kakuta, M., Hayashi, T., & Sekine, Y. (2012), Smash motion analysis for badminton from image. *In Proceeding IIEEJ 3rd Image Electronics and Visual Computing Workshop*.
2. Ni. B, Wang, G. & Moulin, P. (2011), RGB-D-HuDaAct: A color-depth video database for human daily activity recognition. *In Proceeding of IEEE International Conference on Computer Vision Workshops*, 1147-1153.
3. Ning, Y. (2013), Research of badminton forehand smash technology based on biomechanical analysis. *Journal of Chemical and Pharmaceutical Research*, *5*(11), 172-177.
4. Salim, M. S., Lim, H. N., Salim, M. S. M., & Baharuddin, M. Y. (2010), Motion analysis of arm movement during badminton smash. *In Proceeding of Biomedical Engineering and Sciences*, 111-114.
5. Hussain, I., Ahmed, S., Bari, M. A., Ahmad, A., Mohammad, A., & Khan, A. (2011), Analysis of arm movement in badminton of forehand long and short service. *Innovative Systems Design and Engineering*, *2*(3).
6. Yoshikawa, F., Kobayashi, T., Watanabe, K., & Otsu, N. (2010), Automated service scene detection for badminton game analysis using CHLAC and MRA. *World Academy of Science, Engineering and Technology*, *4*, 841-844.
7. Liu, G., Zhang, D. & Li, H. (2014), Research on action recognition of player in broadcast sports video. *International Journal of Multimedia and Ubiquitous Engineering*, *9*(10), 297-306.

8. Goles, J. (2010), Inside the race to hack the Kinect. *New Scientist, 208*(2789), 22.