

Data and Process Simulation of Recognition Rystem for Descent Point Trajectory of Badminton

Shuwen Liu^{1,a}, Yawei Song^{2,*}, Jiang Li^{3,c}

¹Nanjing Sport Institute, Nanjing, Jiangsu, China

² Sport Institute, Nanjing, Jiangsu, China

³Nanjing Sport Institute, Nanjing, Jiangsu, China

^ae-mail:1846139300@qq.com, ^be-mail:syw0008@163.com, ^ce-mail:14358242872@qq.com

Article Info

Volume 83

Page Number: 574 - 585

Publication Issue:

July-August 2020

Article History

Article Received: 06 June 2020

Revised: 29 June 2020

Accepted: 14 July 2020

Publication: 25 July 2020

Abstract

In recent years, with the increasing attention to badminton in competitive sports and the upcoming Tokyo Olympic Games in 2020, whether our badminton team can continue to break through and achieve good results has become a major focus. Each badminton team has a high requirement for its athletes' movement skills, so it is crucial to provide timely and effective feedback of the flight parameters of badminton to the coach after the players hit the ball during training and competition. In this study, the landing point and trajectory of badminton were captured and analyzed, and a data and process simulation system with technical and tactical guiding significance was designed to improve the training of badminton.

Keywords: Badminton, Data and Process Simulation System ,Descent Point trajectory,Software; Statistics

1. Introduction

Badminton has been enjoying popularity and extensive participation for a long time among sports events. As a highly competitive ball game, it is characterized by high intensity, high skill and fierce competition, and the key to success in the game for athletes is the effective use of techniques and timely coaching. In the regular large-scale competition court, the coach can only provide guidance when the score is 11 points in the middle. How to find action laws of different athletes through scientific detection technology during the game or training, and then improve their skills and tactical abilities through targeted scientific training is one of the key technologies to improve skills and tactics of ball sports. At present, during the course of a badminton game, the tracking and recognition of the badminton can be achieved mainly by capturing the video and

image through the camera, followed by manual identification and analysis. As well as the development of information, image recognition and communication technologies, it is possible to process simulation and analyze the trajectory, speed, and technical and tactical levels of ball sports.

2. Design objectives

After the game, the singles game video of the badminton shot on the spot is imported, and an algorithm is automatically used to calculate the technical parameters, such as landing point, over-net pace, badminton flight trajectory, etc., and areas of technical actions and positions of the attack and defense (strike point and landing point are the positions of the badminton) are manually annotated. Statistics of actions, route, pace, landing point and other related technical indicators of attack and defense in the game can be obtained, and the

statistical results can be used to simulation the athlete's technical and tactical levels and characteristics. In the singles final between Lin Dan and Li Zongwei at the 2012 *London Olympics*, Lin used the lift more in front of the net, and the badminton had a low arc and fast speed, which interrupted the opponent's rhythm and footwork in front of the net^[1]. Sometimes, the athlete uses the method of deception to confuse the opponent and get a point. Therefore, the intervention of multimedia

technology will enable the coach to conduct more comprehensive on-site guidance. By recording these data, the performance of the opponent can be observed in the video to analyze the data and summarize the problems in the usual training and correct them in time^[2].

Note: All interface images in the present study are design sketches, which have some differences with actual effects of the software.

3. System Introduction

Table 1. Trajectory recognition system of descent point of badminton

	Components	Performance or functions of parameters
Hardware part	Frame rate	2048×2048@400fps
Software part	Image part	Conversion, import, storage, extraction and compression
	Landing point of badminton	Tracking and delineation of over-net image and position, trajectory
	Pace of badminton	Calculation and statistical analysis
	Court marking	Probability statistics for position and area of landing point
	Privilege management	

4. Algorithms introduction

4.1 Flying trajectory of badminton

The optical camera parameters are precisely selected to ensure high-speed and clear image capture of the badminton in the air. Additionally, based on computer vision technology in the field of artificial intelligence and according to the game scene and image features, sub-modules of algorithm are designed and implemented, including badminton detection and identification, trajectory tracking simulation, etc. Finally, the final synthesis is conducted to obtain flight simulation information of the badminton.

4.2 Over-net pace

Based on the badminton's flight trajectory acquired

by the high-speed camera, the badminton's net trajectory is automatically intercepted and its displacement is calculated. Finally, the corrected reference objects of the court are used to obtain the actual over-net pace.

4.3 Automatic identification of landing point

Through many analyses of the landing point under different flight trajectories of badminton, the characteristics of trajectory direction, pace attenuation and bounce are proposed to design an expert system for the judgment and accurate identification of landing point for the badminton.

4.4 Detection algorithm flow chart

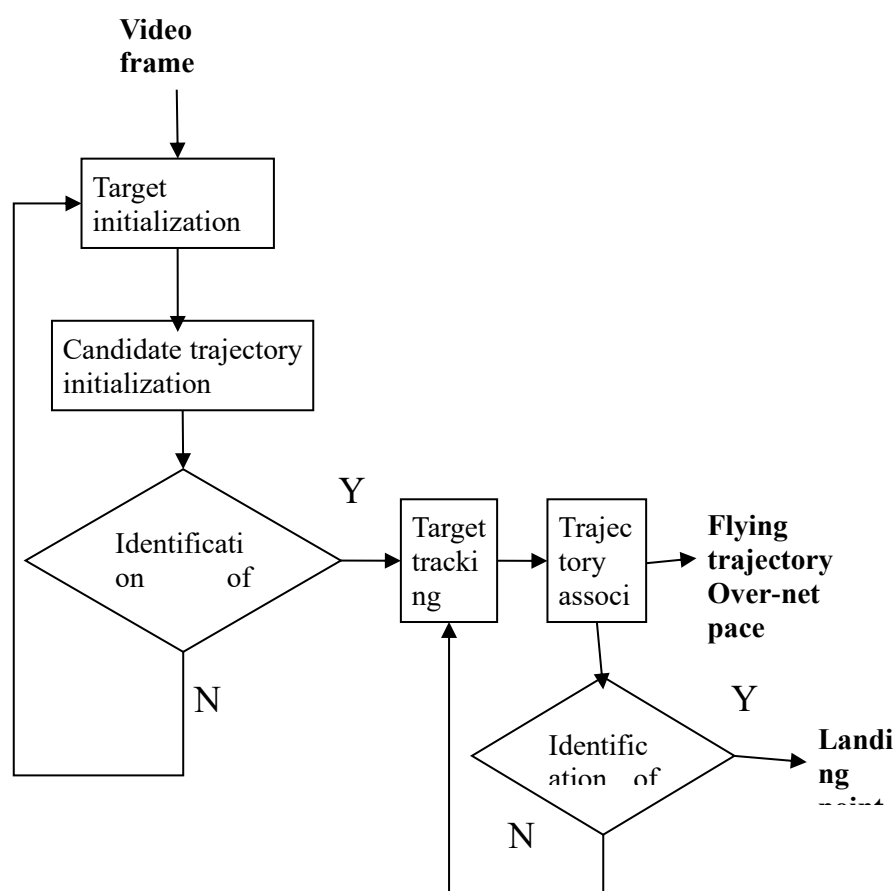


Figure 1. Detection algorithm flow chart.

5. Software usage procedure

The offline analysis method is used in the software, and the video is imported for analysis and processing after the match. The analysis and processing include an algorithm to automatically identify the landing point, over-net pace, flight trajectory of badminton, manually annotated landing point area, striking position area of athletes, techniques and actions of attack and defense for athletes. For example, the common forecourt cross-court drop technique involves hitting the badminton at forecourt in a slightly hooked manner over to the other corner of the opponent's court [3]. It is usually used by athletes as a technique to mobilize the opponents. The sudden strike will force the opponent to change the original technical action. The strike can be either a high point or a low point [4]. At this moment, we can focus on analyzing the parameters of the forecourt to obtain the corresponding data.

There is also a classic tactic in the court—deception, which has no clear definition. As long as the flight trajectory of the badminton is changed or the strike leads to misjudgment by the opponent, it can be called deception [5]. The deception activity can be divided into three aspects: changing direction and speed, using body movement and eye-gazing direction, which depends on the basic consciousness of athletes [6,7]. Therefore, this action can be divided into two or more basic strokes for subsequent analysis, and the specific operation is presented as follows:

5.1 Startup interface

A game video is selected to perform manual annotation, game replay, data statistics, and other operations. New game videos can be imported via the “Import Video” button. If the imported video file is manually deleted, the system will automatically delete the corresponding video information from the list.

5.2 Court labeling

The offline analysis method is used in the software, and the video is imported for analysis and processing after the match. manually annotated landing point area, striking position area of athletes,

techniques and actions of attack and defense. According to the characteristics of attacking route for the badminton, the two half-courts are divided into nine areas, as shown below.

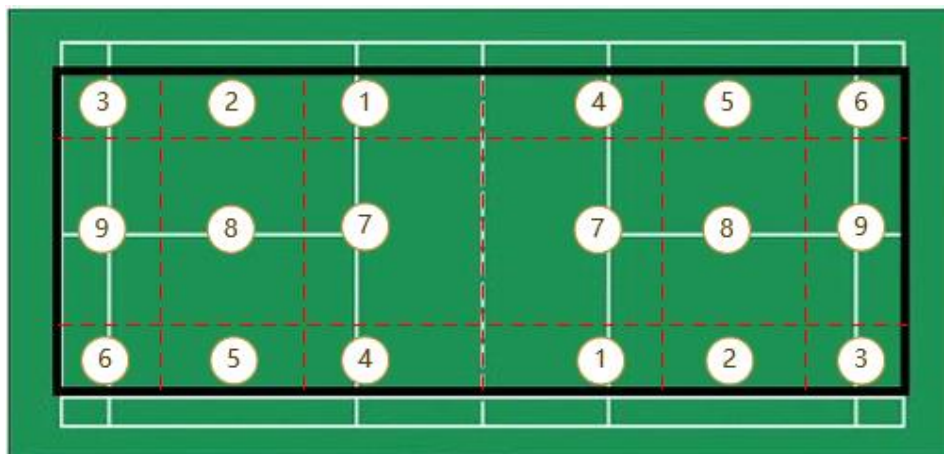


Figure 2. Schematic diagram of partition of the badminton court.

5.3 File Import

First, the video file is copied to the software-specified directory, then the “Import Video” button is clicked at the main interface, the video file to be imported is selected, the relevant information is entered, and the “Confirm Import” button is clicked. Video information is automatically added to the video list.

5.4 Manual annotations

At present, the algorithm can simulation the badminton from the video screen and analyze its landing point, flight trajectory, over-net pace and other information. The basic procedure of manual annotations is as follows.

If the conversion of attack and defense is fast, or the operator is not sufficiently skilled, the video playback speed can be decreased, thus ensuring input of relevant information in a timely and accurate manner.

5.5 Function interface

Users can play, pause, and stop playing the game video at any time using the “playback control” button. The “playback speed control” button can reduce or increase the playback speed. The playback

progress bar can be adjusted at will, and the video playback can be automatically synchronized.

Based on actions of the athletes in the video, when the athlete strikes with the racket, users click the area where the strike position is located (No need to click on the precise area), then the action name of attack and defense on the right side is clicked or the corresponding shortcut key is pressed, the system automatically generates an action record, which is added to the record of actions. If an operational error occurs, users can click on the previous action record in the left action record, and the video will automatically start playing from the attack and defense action; re-annotation can correct the previous mistakes.

Below the video, according to the information set when the video was imported, the names of athletes and half-courts for both sides are displayed. In the game, after the two sides change courts, users should click the “change courts” button or the corresponding shortcut key to change the position of athletes on both sides. All the action information by the manual annotations automatically matches the corresponding athlete.

5.6 Game replay

The comparison between manual annotations and results of algorithm analysis can be checked in the left list for the review.

The real-time location, action, route, landing point, flight trajectory, over-net pace and other information of the badminton can be automatically superimposed on the video, and the corresponding information can be switched at the bottom left to synchronously display in the video. In the replay process, the manual counting method can also be used to calculate the number of points lost, especially those due to active fault. Meanwhile, it is necessary to conduct statistical analysis of the opponent's fault points and create related records for subsequent analysis^[8,9]. Previous studies have suggested that by

replaying game actions using multimedia technology, more badminton players can learn skills and paces from these excellent athletes. It can stimulate their interest in learning. Hence, they can correct their mistakes in time, and also make the learning process clear, thereby contributing to their concentrations^[10,11].

5.7 Data simulation

The technical and tactical statistics for both sides of the badminton game, including landing point analysis, over-net pace analysis, and action statistics undergo automatic simulation by the expert system after the processing of algorithm, and the above-mentioned key technical and tactical data are extracted as follows.

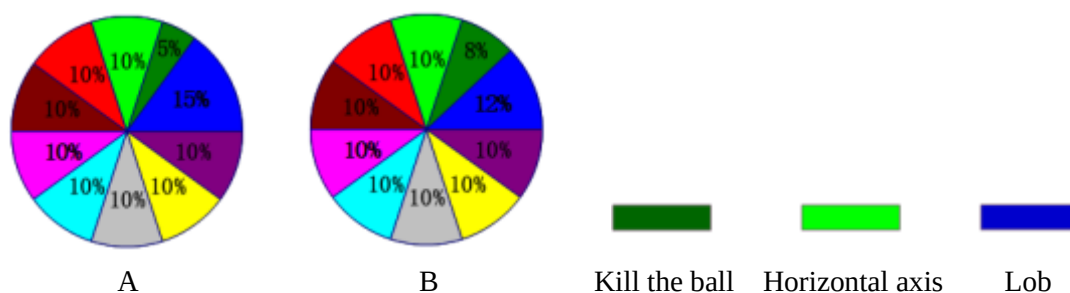


Figure3. Data statistics for the frequency and proportion of strike.

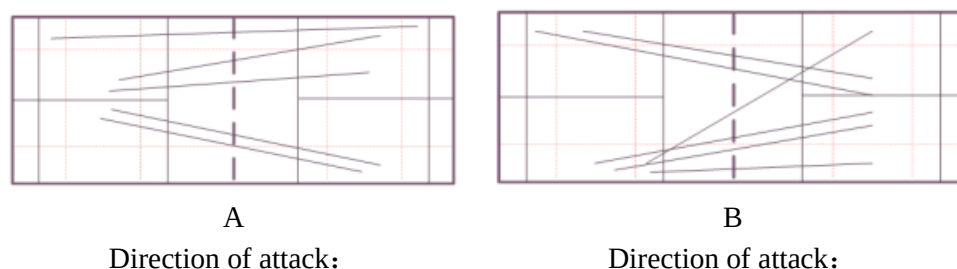


Figure 4. Cartogram of attacking route.

6. Summary

Based on the test results of recent major international badminton competitions, this system has functional advantages especially in the badminton over-net pace, attacking route and strike technology. This system partially compensates for the errors of the coach's subjective judgments in the field, and it can also provide effective information

for preparations during pre-match training and post-match adjustment. The present study contributes to the research and development, helps to tackle problems in the Olympics, and jointly offers advice to the Chinese badminton team.

Acknowledgement

This work was support by Science and Technology Service Project of Science and Education

Department of the State Sports General Administration.

References

1. Adrian Gheorghe. Conversion of Churches into Mosques in the Early Ottoman Historiography (XVth Century). A Selective Evaluation of Sources[J]. Review of Ecumenical Studies Sibiu, 2016, 8(2): 271-307.
2. Jerome Jie Jen Lee, Wei Ping Loh. A state-of-the-art review on badminton lunge attributes[J]. Computers in Biology and Medicine, 2019, 108: 213-222.
3. Pei Ganghui. Technical analysis of forecourt actions for the badminton. Contemporary Sports Technology 2014; (4): 42-44.
4. Dai Jin, Zhong Jianping. Comparison and analysis of forecourt tactical characteristics of top-ranking athletes in men's singles of the badminton. Sports 2009; (2): 23-24+41.
5. Abián-Vicén, Sánchez, Abián. Performance structure analysis of the men's and women's badminton doubles matches in the Olympic Games from 2008 to 2016 during playoffs stage[J]. International Journal of Performance Analysis in Sport, 2018, 18(4): 633-644.
6. Yuan Yue. Deceptive movement analysis of badminton and the application of multimedia technology on identifying deceptive movement. Advanced Materials and Information Technology Processing, 2014(87): 673-675.
7. Christo A. Bisschoff, Ben Coetzee, Michael R. Esco. Heart rate variability and recovery as predictors of elite, African, male badminton players' performance levels[J]. International Journal of Performance Analysis in Sport, 2018, 18(1): 1-16.
8. Robertson, Pion, Mostaert, Norjali Wazir, Kramer, Faber, Vansteenkiste, Lenoir. A coaches' perspective on the contribution of anthropometry, physical performance, and motor coordination in racquet sports[J]. Journal of Sports Sciences, 2018, 36(23): 2706-2715.
9. Liu Xiufeng. Comparison and analysis of techniques for Lin Dan vs. Li Zongwei at men's singles final of the badminton in London Olympics 2012. Journal of Nanjing Sport Institute (Science Edition) 2012; (11): 78-79.
10. Hung, Shwu-Ching Young, Lin. Exploring the effects of integrating the iPad to improve students' motivation and badminton skills: a WISER model for physical education[J]. Technology, Pedagogy and Education, 2018, 27(3): 265-278.
11. João Guilherme Cren Chiminazzo, Júlia Barreira, Leandro S. M. Luz, William C. Saraiva, Josué T. Cayres. Technical and timing characteristics of badminton men's single: comparison between groups and play-offs stages in 2016 Rio Olympic Games[J]. International Journal of Performance Analysis in Sport, 2018, 18(2): 245-254.