Chapter 8
Design of Assistant System for Basketball Shooting Training of Teenagers Based on Deep Learning

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Ma Mingyu and Ramir Santos Austria

Abstract At present, there are some phenomena in the development of campus basketball, such as insufficient training venues, low coaching level of coaches, imperfect competition system and unbalanced regional development, which will inevitably affect the development of campus basketball characteristic sports. Shooting is the main offensive technique of basketball and the only means to score points. Therefore, in order to meet the requirements of automatic action evaluation in basketball, this paper develops a teenagers' basketball shooting training assistant system based on deep learning, and uses YOLOv4 to classify the influence of basketball frame by frame. In order to analyze the shot information and flight trajectory of basketball, this paper realizes basketball detection by improving Hough transform. The research results show that compared with the traditional training methods, the fine movements obtained by the teenagers' basketball shooting training assistant system in this paper have certain advantages and can bring better teaching effect.

8.1 Introduction

Shooting is the main offensive technique of basketball and the only means to score points. The key to the success or failure of a basketball game is to score in the basket, so it is of great significance to better use and master shooting techniques and improve the shooting percentage [1]. Shooting is the most basic and important thing in basketball. The ultimate goal of the cooperation among players, the application of skills and tactics and the command of coaches in the game is to score points. In ordinary shooting training, one or two people are generally used to conduct antagonistic and disturbing shooting training for a shooter, but this method is easily influenced by many factors such as the personal ability, height and defensive action of the defender, and cannot achieve complete results. In a fierce competition, teenagers are

M. Mingyu · R. S. Austria (✉)
University of the Cordilleras, 2600 Baguio, Philippines
e-mail: 2023236027@qq.com

subjected to various psychological stimuli for a long time, and psychological factors are particularly important. Teenagers should be good at adjusting and controlling their psychological activities in the competition in order to exert their maximum sports potential.

Whether the rules are changed or the techniques and tactics are updated, the shooting percentage is always one of the important factors that determines the outcome of the game, especially in today's increasingly fierce basketball competition, the shooting percentage of free throws shows its position that cannot be ignored [2, 3]. If the data in basketball can be quantitatively analyzed by using sports mechanics and mathematics, and the exact solution can be obtained, targeted training can be carried out, which can quickly improve the level of basketball players. Literature [4] studies the real-time rotation of projectile, and realizes the accurate judgment of throwing action. Literature [5] uses the distance information between all joints contained in the previous image and the distance information between each joint point in the current image and the joint point corresponding to the reference action to describe the information of the athlete's deviation characteristics, posture characteristics and movement characteristics. In sports, basketball is a high-intensity, intermittent and long-lasting sport. Therefore, basketball players are required to have good physical fitness and be able to show their best state and effect in basketball matches [6, 7].

As a basketball educator, we must think about the development and future of basketball in the context of unprecedented attention and full promotion of campus football. The different treatment of football and basketball at this time has complicated practical and social factors. This is not only traced back to the influence of football in the world, the present situation and problems of football development in China, but also closely related to the present situation of basketball development [8]. Therefore, in order to meet the requirements of automatic action evaluation in basketball, this paper develops a teenager's basketball shooting training assistant system based on deep learning, and uses YOLOv4 to classify the influence of basketball frame by frame. In order to analyze the shot information and flight trajectory of basketball, this paper realizes basketball detection by improving Hough transform. By summarizing these parameters, we can get the shooting characteristics of teenagers, thus standardizing teenagers' behavior and improving teaching quality.

8.2 Research Method

8.2.1 System Overall Design

Modern basketball continues to develop in the direction of high altitude, high speed and superb technical movements, which is not only a confrontation between technology, tactics, psychology and intelligence, but also a physical confrontation. In the basketball game, athletes should not only have a certain ability of quick sprint, but

also need good endurance. When the score advantage is large, the athletes' psychological state is relatively stable, the pressure is relatively small, and they can play calmly and maintain a high shooting percentage. When athletes enter the game with emotion, it will have a serious impact on the shooting percentage, and they will become more impatient after missing the shot, leading to the loss of the game. In training, we should arrange the training content reasonably according to the age characteristics of athletes, pay attention to the training of core strength, and know the reasonable distribution of physical strength in the competition, so that the whole audience can maintain a good shooting percentage.

At present, there are some phenomena in the development of campus basketball, such as insufficient training venues, low coaching level of coaches, imperfect competition system and unbalanced regional development. These phenomena will inevitably affect the development of campus basketball characteristic sports. In order to solve the problems comprehensively and thoroughly, it is necessary to improve the implementation mechanism. Although the change of the competent department of top-level design has created a favorable space for campus basketball, the greater institutional obstacle lies in the education system itself [9]. The education system dominated by the college entrance examination makes academic work an important factor restricting the development of campus basketball. However, in basketball education itself, the idea of the supremacy of the competition has long occupied a dominant position. Instead of making basketball a popular and entertaining teenagers sport, it makes basketball confined to professional basketball players and special students.

The main factors affecting the shooting percentage are: shooting distance, air resistance, shooting speed, shooting height, basketball rotation, athletes' physical movement parameters (such as shoulder and hip angle, shoulder chain angle, foot and hip angle, knee angle, trunk angle, displacement of body center of gravity, etc.), athletes' psychological quality and technical and tactical level. How to obtain effective location cloud data is the key to human recovery and reconstruction. Traditional contact measurement and non-contact measurement point cloud data formats are different, because there are differences in the process of machine scanning object parameters. In order to build an efficient basketball teaching and training assistant system, we can use image processing technology to mark the joint points of the arm and analyze the athlete's movement trajectory, so as to restore the athlete's technical movements and obtain the required parameters. The best shooting data can be obtained by calculation, so that athletes can be trained continuously with the same shooting data to form muscle memory, and the shooting accuracy can be effectively improved [10, 11].

For a long time, the attitude of our campus in recruiting basketball talents has always been that as long as we have a talent for basketball or a skill in basketball, we have almost no requirements for the level of cultural knowledge, which objectively leads to the overwhelming majority of teenagers not paying attention to the learning of cultural knowledge at all, and even many parents and teachers think that sports students do not need to strengthen the learning of cultural knowledge. At present, the

students of high-level college basketball teams in China mostly come from professional teams, sports schools and traditional sports middle schools. However, due to the restriction of the competition system, primary and secondary schools are characterized by short-term utilitarian behavior of sports training, and only pay attention to ranking and winning the championship at their level, ignoring the selection of materials and systematic training, resulting in some promising talents "precocious", and it is impossible to improve their sports performance at the university level, or the improvement rate is very small [12].

Teenagers' basketball shooting training assistant system uses Microsoft's Kinect, magnetic tracking equipment and data gloves to obtain the speed, angle and height of the player's shot in the real scene, submit it to the system for calculation, and display the shooting situation of the virtual player on the screen. At the same time, the system gives tips such as the best shot angle and the minimum shot speed according to the athlete's shooting situation to assist the athlete's training. Teenagers' basketball shooting training auxiliary system structure as shown in Fig. 8.1.

The system is divided into four modules: sports data collection, data processing, sports data analysis and dribbling animation. Sports data collection.

Sports data collection. Including collecting basketball players' pitching and dribbling data, collecting high-level players' sports information, and establishing a standard dribbling database, which laid the foundation for auxiliary training; Sports data processing. Including shadow joint information recovery; Motion redirection data
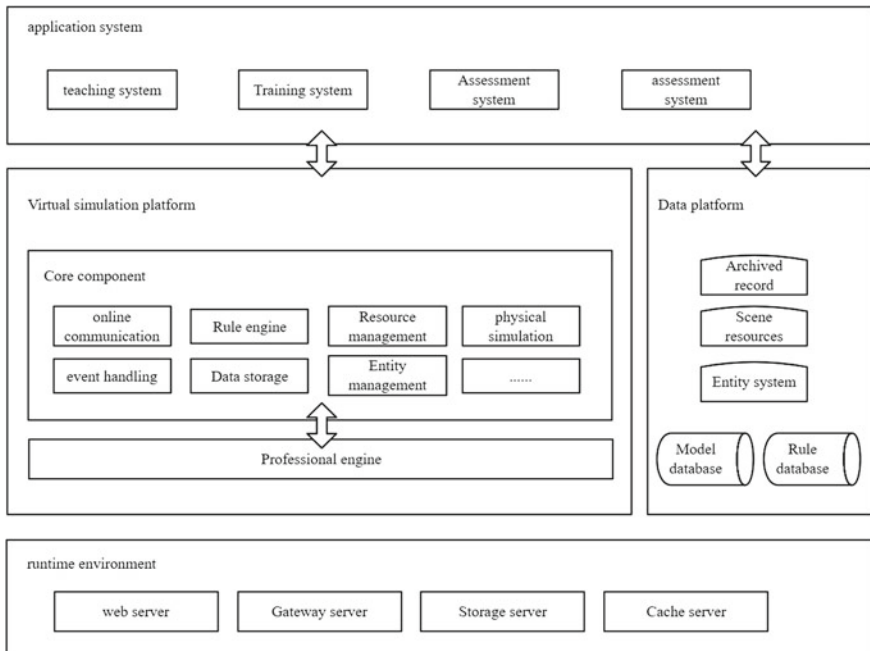

Fig. 8.1 Teenagers' basketball shooting training assistant system structure

analysis. It is to give training guidance according to the comparison results between the information movement of trainers and the movements of high-level basketball players, so as to quickly improve the level of coaches; Dribble animation. The animation is driven by capturing the motion data file, and the virtual human body is driven, which represents the dribbling motion of the body.

Using Microsoft's Kinect, the shooting speed and posture of athletes in real scenes are obtained, and the shooting situation of virtual athletes is displayed on the screen. Basketball has a physical material, and it will bounce after landing. After training, you can register online, and then send the score to a remote server to record your current score, or you can update your score and check the previous scores.

8.2.2 Key Technology Realization

From the perspective of international influence, the influence of basketball is far greater than that of football. Professional basketball is widely spread in China, and the basketball leagues of all schools have a relatively complete scale. Both the school and teenagers actively hold basketball leagues to promote sports exchanges between campuses. However, the influence and popularity of football on campus are low. Under the background of the all-round development of campus football, only by correctly facing the pressure and challenges, turning difficulties into opportunities and seeking reform breakthroughs can we help campus basketball grow stronger.

In the fierce competition field, physical contact between athletes is frequent, and referees will inevitably have some misjudgments and missed judgments. If athletes do not make mental preparations in advance, their emotions will fluctuate greatly, and they will express dissatisfaction with referees and opponents. There are many technical action methods of shooting, which can be divided into one-handed shooting and two-handed shooting according to different holding methods, such as in-situ one-handed shoulder shooting, one-handed low-handed basket shooting, in-situ jump shooting, sudden stop jump shooting, make-up basket, dunk and so on. Athletes should choose suitable shooting methods according to their own style of play and position characteristics and carry out systematic training. We should combine the actual situation, carry out targeted research and practice, strive to be targeted in teaching and training, and effectively solve the problem of shooting percentage in the game.

Image understanding technology based on deep neural network is a hot spot in machine vision in recent years. The neural network framework with excellent model can quickly understand images and extract available information, and it takes up less computational resources. It has been gradually applied to embedded devices. Therefore, combining the target detection algorithm based on deep learning with the visual ranging technology, a ranging and positioning method based on the visual algorithm with simple conditions, high precision and strong stability not only conforms to the development direction of technology, but also has very important practical significance to all aspects of production and life. Therefore, in order to meet the

requirements of automatic action evaluation in basketball, this paper develops a teenagers' basketball shooting training assistant system based on deep learning, and uses YOLOv4 to classify the influence of basketball frame by frame. In order to analyze the shot information and flight trajectory of basketball, this paper realizes basketball detection by improving Hough transform. By summarizing these parameters, we can get the shooting characteristics of teenagers, thus standardizing teenagers' behavior and improving teaching quality.

YOLOv4 model can accomplish the target detection task well, but its basic network, Darknet53, has many layers, complex structure, large parameters and high requirements for memory and computation, so it is difficult to be applied to mobile devices and embedded devices. Therefore, in this paper, the model is improved on the basis of YOLOv4 by combining with Mobilenetv3, and the feature of the image is extracted by using Mobilenetv3 as the basic network, and then the detection method of YOLOv4 is still adopted. The detection results of the same input picture are output on three different scales, and different anchors are selected on each scale to regress the bounding box of the target. The anchor size is obtained by k-means clustering. The loss function still selects the loss function in YOLOv4. The structural schematic diagram of YOLOv4 used for image classification is shown in Fig. 8.2.

Compared with YOLOv3, YOLOv4 has a big change in introducing CSPNet, which makes the skeleton network become CSPDarknet-53. Compared with Darknet-53, CSPDarknet-53 network only improves the structure of the original basic module ResUnit. Compared with Resumit, after downsampling, the CSPUnit module shunts the features in the channel dimension, and only half of the features enter the original Resumit module, and then they are directly spliced with the other half of the features in the channel dimension, and finally undergo a convolution operation.

The core idea of Hough transform is to map the image space to the parameter space by using the point-line duality between the graphic space and the parameter space, and to transform the global problems to be solved in the image space into local problems in the parameter space for solution. Based on the standard Hough transform, this paper proposes an improved method. The basic idea is to reduce the dimension of the accumulator and replace the multiple loop with a multidimensional array. It is known that in the image space, a circle can have the following parameter expressions:

$$\begin{cases} x = a + r\cos\theta \\ y = b + r\sin\theta \end{cases} \tag{8.1}$$

where (a, b) is the center of the circle, r is the radius of the circle, and θ is the included angle between the line connecting point (x, y) and the origin and the x axis.

After the corresponding points in the image space are mapped to the parameter space, the formula of the circle is:

Fig. 8.2 Schematic diagram of YOLOv4 structure for image classification
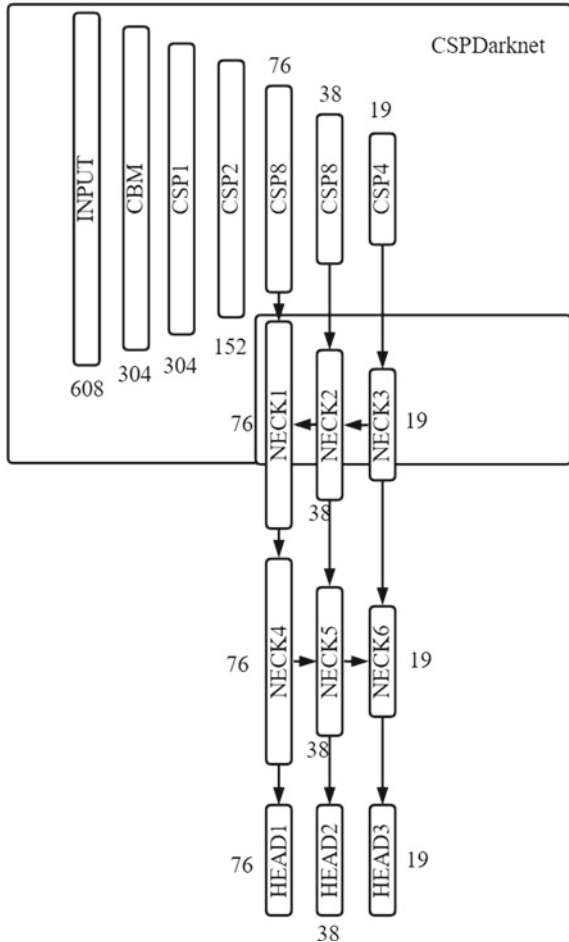
$$\begin{cases} a = x - r\cos\theta \\ b = y - r\sin\theta \end{cases} \tag{8.2}$$

The specific improvement steps are as follows:

Initialize the Hough array matrix with a pixel of 1 in the pixel space and set the initial value of the variable;

According to Formula (8.2), calculate the value of (a, b) as a non-negative integer, and record the statistical effective value to determine the index value of Hough array;

According to the Hough index value, Hough array is constructed, which is mainly realized by the accumulator. At this time, the number of array layers is $r_{min} - r_{max}$;

Find the layer with the largest cumulative value in the Hough array, which corresponds to the circle with the most pixels in the image space, and the radius corresponding to the array is the radius r of the circle;

Find the center of the positioning circle, and the average value of all (a, b) in the layer with the highest value is the center of the circle.

Compared with the circle classical Hough transform, the improved algorithm firstly extracts the basketball foreground through Gaussian background modeling, further obtains the foreground edge map, and selects the positioning circle area, thus reducing the number of useless pixels in the image, thus shortening the detection time and improving the detection efficiency.

8.3 Result Analysis

There are 10 top international basketball players' game images in the image database, and each player's basketball action data contains about 15,000 images. The size of each frame is adjusted to 64×48, and then the frames are input into the designed framework for feature extraction. In order to train the parameters of the network, the random gradient descent algorithm is used in this paper, and the initial learning rate is set to 0.1. After 20,000 iterations, the learning rate becomes 0.001 and the momentum is set to 0.8. Data fitting adopts MATLAB; The working environment of the algorithm is Dell OPTIPLEX 390 with 4.00 GB memory and Intel (R)Core(TM) i5-2400 CPU.

In this paper, the prediction results of free throw frames of one video unit of two teenagers are analyzed. As shown in Fig. 8.3, the acquisition result of a video unit of an athlete's hand frame is as follows:

Professional athletes hit more than 90% of the free throws, and this time 13 of the 15 groups of free throws were hit. Obviously, the shooting angle of professional athletes has always been near the best shooting angle, which is also consistent with the conclusion in the paper. Therefore, a good free-throw technique should ensure that it still has strong stability when the physical strength is too high during the game. The best shot speed solves this problem, and at the same time, a good shot angle makes the allowable error of basketball entering the basket larger, which further improves the stability of the free-throw basket.

The method proposed in this paper can help basketball players to better adapt to various training methods and tactical training, and quickly improve their performance. The automatic scoring of the teenagers' basketball shooting training assistant system (the algorithm proposed in this paper) and the traditional manual scoring in shooting evaluation are analyzed by linear regression to study their correlation, as shown in Fig. 8.4.

Each point represents the result of a test, the abscissa represents the evaluation score obtained by the automatic evaluation algorithm, and the ordinate represents the real value evaluated by the traditional training method. It can be seen that the
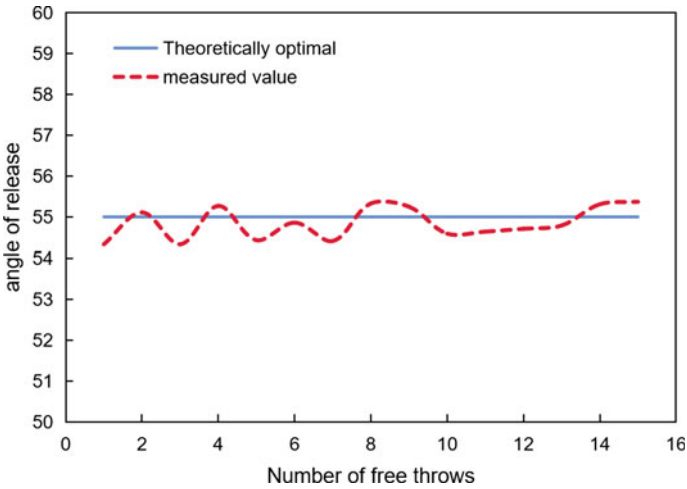
Fig. 8.3 A video unit of the athlete obtains the result map by hand frame
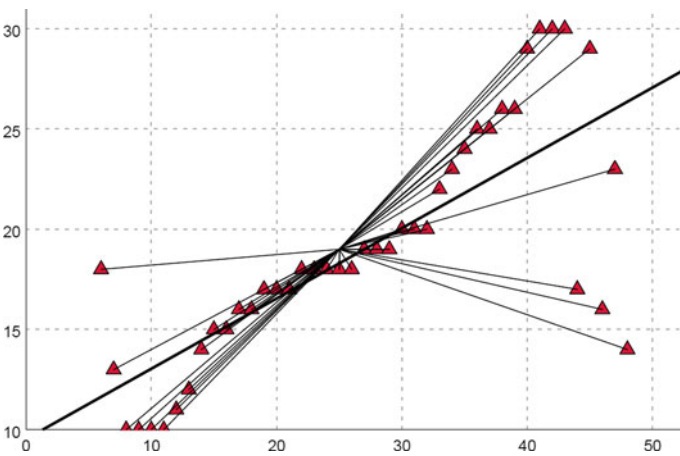

Fig. 8.4 Correlation analysis of scoring

score of automatic evaluation algorithm is linear with that of the traditional training method.

Compared with traditional training methods, the fine movements obtained by teenagers' basketball shooting training assistant system in this paper have certain advantages and can bring better teaching effect. This combination of explanation and demonstration can greatly stimulate athletes' senses, make them have a deeper memory and a deeper understanding of technology.

8.4   Conclusion

Shooting is the most basic and important thing in basketball. The ultimate goal of the cooperation among players, the application of skills and tactics and the command of coaches in the game is to score points. As a basketball educator, we must think about the development and future of basketball in the context of unprecedented attention and full promotion of campus football. In this paper, a teenagers' basketball shooting training assistant system based on deep learning is developed to meet the needs of automatic action evaluation in basketball. By summarizing these parameters, we can get the shooting characteristics of teenagers, thus standardizing teenagers' behavior and improving teaching quality. The research results show that compared with the traditional training methods, the fine movements obtained by teenagers' basketball shooting training assistant system in this paper have certain advantages and can bring better teaching effect.

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