A Model Research of Basketball Teaching and Training Aided System in Colleges and Universities Based on Video Image Processing Technology

Yongfei Lv, Bin Li, Bin Niu

Yanching Institute of Technology, Langfang 065201, China

Abstract

Basketball is highly competitive and entertaining, which meets the needs of people for sport and entertainment. As a result, in recent years, basketball is well developed in China. Stadiums, schools and communities have built professional basketball venues which have played an important role in promoting the development of sports for all. In college basketball training, slam-dunk, free throw, and dribble, as the foundation for scoring in basketball games, are the most important parts. They are skills based on basic technical actions. Only through continuous training and practice, can students find out a set of shooting and dribbling for themselves and can basketball training and teaching in colleges and universities be improved. Traditional shooting and dribbling training are generally based on training videos which rely heavily on experience and lacks scientific theoretical basis. This method also pays no attention to the differences between students so that it is not effective. In this regard, based on the video image processing technology, this study constructs an aided training system of basketball teaching in colleges and universities, which gives guidance to the training according to the students’ technical actions and related parameters, effectively solves the defects of the traditional mode and helps to improve basketball education.

Keywords: Video Image Processing, Basketball Aided Teaching, Shooting Training.

1. INTRODUCTION

1.1 Research background

Basketball was created by James Naismith, a physical education professor and instructor at the International Young Men’s Christian Association Training School in 1891 in Massachusetts, the United States. Then in 1936, basketball was officially included in the Olympic Games. It includes confrontation, teamwork, bodybuilding, appreciation and interesting elements so that it is favored by the majority of sports fans and has become one of the hottest sports events. Shooting means that basketball players have to shoot the basketball into opponent’s basket through a variety of technical moves under the rules of the sport. It is the way to score in the game. With the continuous development of basketball, training becomes professional which improves athletes’ physical fitness and skills. Many new shooting skills have been developed which become the focus and difficulty of college basketball teaching. If students develop bad habits in shooting, it will greatly influence the accuracy of shooting. Therefore, it is particularly important to cultivate students' shooting skills and shooting rhythm in college basketball training.

1.2 Literature review

Basketball has the following characteristics: Firstly, confrontation. The site of basketball competition is comparatively small while the duration is short so that players have to move, jump and shoot according to the situation. Secondly, teamwork. Basketball is played by a team so that victory is based on teamwork. Thirdly, it deserves appreciation. In a game, players take turns to offense and defense where the situation keeps changing. Meanwhile, the passing, shooting, stealing and dunking worth appreciation. Fourthly, it is interesting. The rules are simple while the restriction of site is small. Due to reality, the way to play basketball can be adjusted so that it is full of fun. Fifthly, it is constructive to fitness. The game is good for the physical condition, teamwork spirit and the overall health of the players (Liu, 2016). The shooting training aided system based on video image processing technology can obtain the coordinate changing track of student so as to get related parameters. With
the summary of these parameters, the characteristics of shooting teaching can be obtained so as to standardize students’ action and improve the teaching. In addition, together with the accuracy analysis, parameters for higher accuracy can be got, which is of great significance to improve their shooting (Zhang and Wang, 2016). In traditional teaching, teachers will show the skill and instruct students respectively. But this method relies on experience and is subjective. At the same time, students are different in habits so the same instruction will limit the diversity of basketball among students. Therefore, the construction of basketball training aided system and the analysis of shooting parameters together can provide reference to the best training method for students, which are important to the improvement of students’ basketball skills (Chen et al., 2014).

2. ANALYSIS OF SHOOTING TECHNIQUE

2.1 Basic technical moving of shooting

Shooting is a process of exerting one’s strength and shooting through the coordination of the moving of different parts of the body. Its process is shown in Figure 1:

![Figure 1. Theoretical Analysis Process Chart of Shooting Technique](image)

First, the player prepares to shoot when he enters the standard shooting preparation position. Then his lower limbs take the lead in stretching the body toward the direction of the shooting. The inertia of the spine extension provides strength to the coordination of the limbs and body, accumulates the muscle strength in the arm and wrist and directly transforms it into the power of shooting. The player stretches and does the shooting when he finishes a set of actions including wrist turning, shaking, bending, and finger shooting and pushing with the fastest correction of force and angle which matters for the improvement of the shooting accuracy (Tan and Zhang, 2015).

Shooting is divided into two phrases for analysis:

The first stage is about body coordination and power exerting. In this phase, strength is gained through the power exerting of lower limbs and then the inertia provides the necessary strength to arms and legs for shooting. The stage lasts until the basketball reached its highest point before getting off one’s hands. This stage can be called the power generation stage, which is an important preparatory stage for shooting. There are mainly four key actions, namely preparation, arm raising, squatting and stretching (Luo et al., 2012).
In the second stage, the basketball gets off player’s hands through wrist and fingers action. In the first stage of preparation, the player has accumulated enough power to shoot the ball stately through wrist turning, shaking, bending, and finger shooting and pushing. In order to ensure the accuracy of shooting, much attention is paid to the key - adjustment of strength and angle. However, in reality, there is not enough time for the adjustment except for penalty shot. Therefore, it is the key task for this stage to complete the adjustment quickly (Liu et al., 2012).

2.2 Player model of basketball shooting

In order to construct a basketball teaching and training aided system in colleges and universities, the knuckle points of the arm can be marked by image processing technology so as to analyze the player’s movement tracks, restore the technical actions of the player, and obtain the required parameters. Therefore, the player model includes the above two stages. In the first stage, it focuses on shooting preparation, arms raising, squatting and stretching. In the second stage, the speed and angle of shooting are marked. Through calculation, the best shooting data can be obtained so that the player can be continuously trained with the same shooting data to form a muscle memory, which can effectively improve the shooting accuracy (Yu, 2010). The general player model is shown in Figure 2.

![Figure 2. Sketch Map of Shooting Arm Marker](image)

A, B and C represents the shoulder joint, the elbow joint, and the wrist joint respectively. A human’s arm can be considered as two rigid bodies and three joints so that a coordinate system is built to clarify the position of A, B and C, and then the movement tracks of A, B and C are determined. In this case, the movement of player can be obtained.

3. STUDY OF THE COMPUTING METHOD OF THE AIDED SYSTEM

3.1 Video image preprocessing computing method

In order to improve the effectiveness, there should be foreground extraction in the video image preprocessing and the foreground pixels extracted which meet the mark color range are set as 255 while the other pixels are set as 0. So, the feature binary map containing the marker points can be obtained. Many unrelated feature points are included in the image, which reduce the accuracy of the calculation. Therefore, it is the key to eliminate these irrelevant features. In order to solve this problem, corresponding corrosion and expansion can be obtained to get the binary image containing the marked points. After the contour extraction of the binary image obtained, the desired contour containing the marked points can be obtained (Ou et al., 2010). Finally, the pixel coordinates of the contour block should be statistically analyzed to obtain the actual joint coordinates. The geometric relationship constructed by three markers A, B and C and the distinction between them can lead to the two-dimensional coordinates of the three key points in the video image and build a complete mathematical feature model of shooting movement. The basic process is shown in Figure 3:
The first step is video input. The video of student shooting is captured by camera. Each student has a fixed number of shoots, which is also a basic video analysis unit.

The second step is foreground extraction. Gaussian background modeling applies in foreground extraction. Before extraction, Gaussian filtering is used to process each frame of the image provided in the video input, which can effectively enhance the foreground extraction and reduce interference caused by external factors such as noise (Xing and Song, 2010).

The third step is marked feature segmentation, which means to choose appropriate points through comparison of the pixel RGB values and basic requirements of basketball shooting video image processing. Prior to selection, average filtering is conducted so as to get the coordinates in advance through marker color. After the selection, expansion and erosion computing have to be done with the obtained picture so as to minimize the interference of the irrelevant factors to the video image processing (Han, 2014).

The fourth step is to extract extraction coordinates through the contour feature. Feature contours are acquired mainly by pixel blocks. Through statistical analysis, the coordinates of the marker points can be obtained. Since the colors of the markers are consistent, it is necessary to distinguish the acquired coordinates.

The fifth step is to distinguish the coordinates. In the image stored in a computer, the origin is located in the upper left corner while the positive direction of the x-axis to the right. The positive y-axis is downward. So A representing the shoulder joint is the nearest point from the origin. On the basis of shoulder joint A, elbow joint B and wrist joint C are respectively shown.

The sixth step is coordinate storage. According to the above steps, the coordinates of the three points in shooting are obtained and stored in the basketball aided training system database, which plays a fundamental role for data analysis (Zhuo et al., 2017).

### 3.2 Mathematical model of shooting frame

It is assumed that the shoulder joint A, the elbow joint B and the wrist joint C are represented by $M_i (i=1,2,3)$. Each marked pixel area is represented by $G_i (i=1,2,3)$ while the number of pixel points of the corresponding pixel block is $L_i (i=1,2,3)$. Then the pixel block $G_i$ is as follows:

\[
G_i = \{(x_1,y_1),(x_2,y_2),...,(x_n,y_n)\}
\]
In the above formula, \( x_i \) and \( y_i \) represent the marked pixel coordinates in the video image respectively (Li, 2014). The center-of-mass coordinate of each pixel block can be taken as the coordinate of the three joint points during shooting and its formula is as follows:

\[
P_M(x, y) = C(x_c, y_c)
\]

\[
x_c = \frac{1}{n_i} \sum_{i=1}^{n_i} x_i
\]

\[
y_c = \frac{1}{n_i} \sum_{i=1}^{n_i} y_i
\]

\( y_c \) changes as time pass with the following track:

\[
y_c = f(t)
\]

According to the above formula, the objective function is as follows:

\[
\arg \max \|y_0\|_2, s.t. \|y_c - y_0\|_2 < \varepsilon
\]

\( \varepsilon \) represents the residual error while \( \| \| \) represents the norm. \( y_0 \) can be obtained through the differential equation, matching pursuit and so on. The time taking from preparation to shooting can be expressed by:

\[
t_0 = f^{-1}(y_0)
\]

\( f^{-1} \) means the inverse function. In the training aided system, time frame should be integer. The largest frame \( T \) on the \( y \)-axis of coordinate system is represented by \( t \).

\[
T = g(t_0) + 1
\]

3.3 Basketball position detection

The purpose of the basketball training aided system is to enable students to choose a shooting method that suits their needs and enhances accuracy and to improve their basketball skills by muscle memory due to continuous training. Shooting, as the only way to score, is of great importance to students. The shooting accuracy is influenced by a variety of subjective or objective factors among which the most evident ones are strength and angle. Therefore, the detection of the movement and track of basketball when it is shot becomes one of the key problems of the basketball training aided system. However, under the existing conditions, the traditional track acquisition is not effective and fails to obtain the basketball track and contour. Therefore, due to the special need of the video, the basic computing needs to be optimized and improved so as to improve the ability to data collection of basketball (Ren, 2012).

Hough transform algorithm is a parameter aggregation algorithm for voting away by the point-to-line duality of image space and the Hough parameter space, which turns the image detection into parameter calculation problems and thus turns the problems more intuitive and more accurate. Huff transform algorithm has been widely used in video image processing. After years of research, its application is wider. It not only plays an important role in video image processing but also in access control system, industrial inspection and even military activities. It can effectively reduce the impact of external factors such as noise and solve the problems of incompleteness and interruption of video (Wei and Li, 2013). The equation of the circle is as follows:

\[
(x - a)^2 + (y - b)^2 = r^2
\]

\( a \) and \( b \) are the centers of a circle while \( r \) is the radius. In the coordinate system of the training aided system, due to the coexistence in the same image space, point \( (x, y) \) is unknown while \( (a, b) \) and the radius \( r \) are input, then:
\[(a-x)^2 + (b-y)^2 = r^2 \] (10)

In the above formula, there is an exchange between \((x,y)\) and \((a,b)\) while \((a,b)\) and \(r\) is unknown but \((x,y)\) is converted into a known number. Through calculation, it is known that in the whole image space, when there is a valid feature point \((x,y)\), there is a circular cone with corresponding threshold. Each valid feature point \((x, y)\) in image space corresponds to a cone in the parameter space (Lin et al., 2016). In image space, the difference at the same point corresponds to the cone in the parameter space, and the two of them will inevitably intersect at the same point. This process records variables of repeated points with the same parameters by initializing a three-dimensional accumulator in the parameter space. Its formula is shown as follows:

\[A(a,b,r) = A(a,b,r) + 1\] (11)

REFERENCES


Han S.S. (2014). Analysis of the influence of core strength training on jump shot technique -- taking college basketball special students as an example, Contemporary Sports Science and Technology, 4(04), 32-33.


