Research on Key Technologies of Basketball Object Segmentation and Tracking Based on Image Analysis

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Abstract. Since the 21st century, with the continuous development of society, people's living standards have been improved, and their physical qualities have been constantly improved. These factors have promoted the development rhythm of basketball, and at the same time put forward higher requirements for players' abilities. In order to improve players' basketball accomplishment quickly, many high-tech equipments are also used in basketball, which provides a lot of technical support for coaches to make training programs for players. With the rapid development of image processing technology, moving target detection technology in video has been more and more widely used. Tracking the flight trajectory in basketball shooting and analyzing the trajectory with image processing technology can improve the accuracy of basketball shooting. In this paper, a basketball tracking method based on image analysis is proposed, and an adaptive object model is further established. Then, the object model is used to improve the block matching method to track basketball. Finally, the tracking deviation is corrected, and the basketball tracking effectiveness detection mechanism is established.

Keywords: Image analysis; basketball; motion tracking

1. Introduction
With the vigorous development of basketball entertainment, more and more people are studying basketball video images. After obtaining frame images from basketball videos, the first thing to do is to segment the source image as necessary [1]. With the rapid development of modern science and technology, the relationship between sports and science and technology is getting closer, and science and technology have been widely penetrated and transplanted into the sports field [2]. Scientific training methods and effective technological monitoring aids are the most effective ways to improve athletes' performance [3]. Motion analysis methods based on video images have become the most basic scientific training conditions for major professional sports organizations and national sports teams abroad [4]. The rapid development of multimedia, Internet and wireless communication technologies has led to the explosive growth of video data. Facing the massive growth of video data, how to effectively store, index and segment it has become the focus of attention, and content-based video analysis is a key link [5]. Finding your favorite videos from the massive sports video data has also become a major demand of users, and traditional data management and retrieval methods using text identifiers are difficult to meet the needs of users, which makes the current rapid rise of content-
based. The video retrieval method and technology of "are gradually applied to the analysis and retrieval of various sports videos [6]. With the rapid development of image processing technology, the detection technology of moving objects in video has also been more and more widely used. Especially in the application of sports in recent years, the image processing technology in video includes three parts: image acquisition, processing and image secondary display [7].

The use of image processing methods for basketball flight trajectory tracking is mainly combined with computer three-dimensional visual analysis methods. The edge amplitude and contour characteristics of the image are detected through the acquisition of video sequences by imaging equipment, and the expert database is constructed for visual analysis, correcting basketball trajectory, and correcting basketball shooting actions. And comprehensive judgment [8]. Basketball is currently one of the most popular ball sports, and basketball shooting is the key to scoring. Tracking the flight trajectory in basketball shooting, combined with image processing technology for trajectory analysis, can improve the accuracy of basketball shooting [9]. Today's sports events, not only from the perspective of the appreciation of sports events and the development of sports competitions, but also the physiological and biochemical monitoring of athletes, technical and tactical analysis, and the scientific selection of athletes, are increasingly inseparable from the support of advanced computer technology [10]. Image video tracking of basketball flight trajectory can accurately analyze the basketball flight trajectory curve to guide basketball shooting training [11]. This paper proposes a basketball flight trajectory tracking method based on image and video sequence analysis, and further establishes an adaptive object model, then uses the object model to improve the block matching method to track the basketball, finally corrects the tracking deviation, and establishes a basketball tracking effectiveness detection mechanism.

2. Basketball object extraction method based on image segmentation
To realize the extraction of basketball objects, firstly, the basketball objects in video frame images are selected, and then the selected target is determined as the foreground object. After basketball detection, it is necessary to use appropriate methods to calculate some characteristic parameters of basketball in the image. Through research, it is found that the calibration algorithm of the image can obtain the size and position of the target in the image, and analyze it with the basketball goal parameters in the system to judge whether the basketball has scored. Basketball consciousness refers to the special function and ability of basketball players to correctly reflect the regularity of basketball through the positive thinking process of the brain in basketball practice. It is a reflective action of correct psychological and physiological functions accumulated by athletes during their long-term understanding of basketball practice. In order to obtain the size of the object and its corresponding position in the image from the video image, and to determine the relationship between the corresponding point in the object and the corresponding point in the image, the commonly used method is image calibration technology. Selection of Basketball Objects and Modeling of Background. By modeling the background of basketball objects in a single frame video image, assuming that the background is static, any meaningful moving object is the foreground [12]. Basketball can be used as the foreground and the corresponding game scene as the background in the basketball game video. The general ways to acquire basketball consciousness are mainly acquired by basketball players from training and actual combat experience, and accumulated slowly through other ways. As shown in Figure 1, the image path is determined for motion detection.

The traditional camera calibration method has certain requirements for the camera model, and the size and shape of the calibration object must be processed under known conditions, and the parameters inside and outside the camera model can be obtained by mathematical transformation and calculation. Background modeling methods are mainly based on single Gaussian model, background subtraction method based on statistics and image sequence initialization method. By comparing various modeling methods, it is found that the background of basketball object modeling by general methods is not very clean and clear, and Gaussian mixture model is relatively successful. The camera self-calibration method does not need a specific calibration object, but calibrates according to the positional
relationship between the surrounding images and the corresponding images taken during the camera movement. There are differences in the selection of traditional camera calibration methods and camera self-calibration methods for different occasions. For some occasions, the traditional calibration technology can be used if the precision is high and the parameters do not change frequently. However, the camera self-calibration method can be used for the occasions with low accuracy requirements such as communication and virtual reality. Students participate in activities with multiple senses in class, which can better understand and remember problems, thus greatly improving the learning efficiency in the limited classroom learning time.

![Figure 1](image1.png)

**Figure 1** Motion detection to determine the image path

Video analysis combines all the sensory factors such as images, characters, animations and sounds to stimulate students’ brain memory cells in many ways, so as to achieve the highest learning efficiency. Figure 2 is a manual detection program for image processing.

![Figure 2](image2.png)

**Figure 2** Manual detection procedure

Digital high-definition industrial webcam and wireless router are used as real-time video capture equipment, which can realize multi-channel simultaneous acquisition and recording according to bandwidth and notebook computing power. Notebooks need to have hardware compression and decompression functions, so that all collected video signals can be processed quickly. There are usually several cameras working at the basketball game scene. Therefore, during the game video recording process, the recorder only needs to switch the cameras at different positions to shoot the
video pictures of the basketball game from different perspectives. By analyzing the basketball features in the video shots, the video is divided into long-range shots and close-range shots. The gray histogram of video image reflects the frequency of gray values appearing in the image, that is, the estimation of gray probability density of the image. When the target city included in the video image, that is, the foreground and background areas are quite different, the gray histogram will show a double peak valley shape. Analysis of Main Function Modules of Basketball Video Tactics Real-time Tracking and Analysis System The system is a system integrating data collection, video editing, tactical recognition, post-production of video and interaction. It can not only meet the current collation and output of competition data, but also record the competition for later production and preservation of video, and at the same time it can interact with the terminal.

3. The design of image acquisition system for basketball

3.1. Application of digital image processing technology in basketball training

During the training or competition of players, high-speed cameras are used to record some or some guiding actions of players when they perform tactics such as pick-up and roll-off, cover, etc. The image signals are transmitted to the CPU through the image acquisition system, and then are stored in the database after a series of processing. When players do daily training, they can extract images or videos of related technical actions from the database and carry out corresponding targeted training. The system configuration parameters are the basketball goal recognition values defined in the system according to the installed camera position. When the camera installation position changes, the system parameter values will change correspondingly. System configuration parameters are also very important reference values in the process of basketball goal. Multi-objective player detection is the core research part, which has very important research value. The correct recognition of moving targets is the most important prerequisite for target tracking and tactical recognition.

![Figure 3 Basketball segmentation process for close-up shots](image-url)

In order to detect basketball goals in fixed-point shooting, we should first understand some basketball changing characteristics in the process of fixed-point shooting. First, we should know some rules of fixed-point shooting. Through these rules, we can know the position of athletes and the changes of basketball in shooting. However, there are many interference factors in the real basketball
game field. Because the foreground moving target occupies a larger space than the visual field area, it is easy for the players to be blocked. In this way, the foreground identified by the background difference method will have adhesion and other problems. The basketball segmentation process of close-range shot is shown in Figure 3.

3.2. *Workflow of digital image analysis technology*

There is a lot of background information in the video of basketball game, and basketball has strong structure. When a player is training or competing, using the characteristics of piezoresistors, when a player hits a shot at a certain position, it is recorded. By collecting the data of the player's shooting situation, the hot zone distribution of the player's shooting is obtained, and the information is stored in a large database through a data processing system. If the relative motion between the camera and the object is ignored, the background in the basketball game video will not change basically, because the basketball movement is obvious. Therefore, there will be obvious changes in basketball area within a certain inter-frame range. Aiming at the tracking result deviation caused by image noise and basketball object contour scaling, the peak characteristic of edge gradient is used to correct it [14]. Finally, an effective detection mechanism for basketball area tracking is established. If the basketball area tracking is effective, the object template will be updated with this area; if it is not effective, the basketball will be segmented, and the basketball object template will be re-established with the segmented basketball area. There is an original background picture, and a new picture is formed after the moving target enters the background picture. Then, according to these two pictures, the picture with only the moving target can be obtained, so that the moving target needed by the experiment can be eliminated from interference of other factors. Figure 4 shows the image cognitive structure system.

![Figure 4 Image recognition structure](image)

After wavelet transform and filtering optimization, the topological structure of image segmentation is greatly optimized, and the monitoring area is better. See table 1 for performance parameters of image segmentation before and after optimization. The simulation comparison of image segmentation topology reliability optimization is shown in Figure 5.

**Table 1** Performance parameters of image segmentation image structure before and after optimization

|                      | Before optimization | After optimization |
|----------------------|---------------------|--------------------|
| Number of rows       | 113                 | 145                |
| Number of columns    | 97                  | 126                |
| Monitoring points    | 10961               | 18270              |
Using sensors such as high-speed cameras or piezoresistors to obtain the information of players' shooting percentage or tactical actions during training, the target information is stored in the database through a series of screening by the data processing system for reference during training. At the same time, the machine vision technology can be used to record the players' movement state on the field in real time, and the players' information can be transmitted to the coach's electronic equipment terminal in real time, so that the coach can arrange the tactics of rotation and lineup arrangement. Among all the motion search algorithms, the full search method has the best performance, because it performs block matching calculation on every point in the whole search window, and finally obtains the best matching point according to the principle of minimum SAD [15]. Because the full search method searches point by point, its computation is also the largest. If the processing speed of the system is not enough, it is difficult to realize the real-time multimedia system by this method. In the video of basketball game, besides translational movement, basketball also has its own rotation in three-dimensional space, which leads to inconsistent movement of each pixel in basketball area, and the color change of basketball area is unpredictable.

4. Conclusions
With the massive growth of sports video data, the urgency of sports video analysis is increasing. Moving target detection technology is an important subject in the field of computer vision, and it is also the basis of related image processing research. This technology is widely used in various application fields. In order to obtain the size of the object and its corresponding position in the image from the video image, and to determine the relationship between the corresponding point in the object and the corresponding point in the image, the commonly used method is image calibration technology. In order to improve the real-time performance of the algorithm and make full use of the segmented basketball features, the improved block matching method is used to track the basketball position of the subsequent frames, and finally the contour deviation caused by image noise is corrected, and the validity of the tracking result is detected. There is an original background picture, and a new picture is formed after the moving target enters the background picture. Then, according to these two pictures, the picture with only the moving target can be obtained, so that the moving target needed by the experiment can be eliminated from interference of other factors. In the video of basketball game, besides translational movement, basketball also has its own rotation in three-dimensional space, which leads to inconsistent movement of each pixel in basketball area, and the color change of basketball area is unpredictable.

Acknowledgements
Shandong Province Social Science Planning Research Project "Analysis and Suggestions on the Development of Non-governmental Sports Organizations under the Background of Healthy Countries" has been Ratification and 19CTJ19. Project Category: General Project.
References
[1] Application of digital image analysis and processing technology in basketball in the era of big data. China New Communications, vol. 20, no. 1, pp. 209-210, 2018.
[2] Miao Jun. Video image tracking and extraction simulation of basketball arm shooting. Computer simulation, vol. 34, no. 11, pp. 224-227, 2017.
[3] Ma Mingbing, Huang Jing. Autonomous detection method of basketball image motion block difference based on optical flow method. Science Technology and Engineering, vol. 19, no. 11, pp. 229-234, 2019.
[4] Deng Jianxun. Ship remote sensing image analysis technology based on image segmentation and target extraction. Ship Science and Technology, vol. 39, no. 24, pp. 140-142, 2017.
[5] Yelin Liu. The realization of machine vision for finding basketball based on LabVIEW. Electronic production, vol. 396, no. 10, pp. 41-43, 2020.
[6] Zhang Rong, Xiao Tao. Research and analysis of shooting skills in elementary school basketball training. Contemporary Sports Science and Technology, vol. 5, no. 13, pp. 60-61, 2015.
[7] Liang Zhidong. Comparison of mean value of finger length ratio between college basketball players and ordinary college students. Journal of Physical Education, vol. 24, no. 2, pp. 135-139, 2017.
[8] Li Yilin, Tao Jing, Huo Yiwen, et al. Research on optimization of gesture feature extraction and image segmentation. Computer Applications and Software, vol. 37, no. 2, pp. 161-165+206, 2020.
[9] Li Xinwei, Ding Zhengyan, Shang Yanfeng, et al. A region segmentation method for intersection surveillance images. Computer Applications and Software, vol. 37, no. 3, pp. 236-243, 2020.
[10] Kang Wenfeng. Basketball video image adaptive monitoring technology at low bit rate. Science Technology and Engineering, vol. 19, no. 12, pp. 242-246, 2019.
[11] Han Lihua, Zhang Lulu. Research on Cross-Region Image Segmentation Method in Personnel Tracking Process. Computer Simulation, vol. 33, no. 10, pp. 330-333, 2016.
[12] He Bo. Angle intelligent visual image decomposition and judgment method in the process of basketball projection. Modern Electronic Technology, vol. 41, no. 10, pp. 175-178, 2018.
[13] Research on prediction of basketball team player behavior based on video. Microcomputer application, vol. 34, no. 11, pp. 31-33, 2018.
[14] Yan Jing, Pan Chen, Yin Haibing. Automatic image segmentation algorithm for fast online active learning. Pattern Recognition and Artificial Intelligence, vol. 29, no. 9, pp. 816-824, 2016.
[15] Wu Tao. Research on the influence of mobile phone image mutual evaluation feedback teaching on college students' basketball learning interest. Contemporary Sports Science and Technology, vol. 10, no. 5, pp. 127-128+130, 2020.