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ORIGINAL

Framework Design of Sports Image Analysis System Based on SIFT Algorithm

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ABSTRACT

Human motion is carried out in a certain time and space dimension, and the kinematics of human motion is a quantitative description of human motion The main measurement methods of collecting kinematic parameters by camera include plane fixed-point camera method, plane fixed-point tracking camera method, plane orbit tracking camera method, three-dimensional fixed-point camera method, three-dimensional fixed-point tracking camera method, etc. In sports image analysis and processing, global features are generally used to complete rough matching, while local features have good results in strict and fine matching. In sports image analysis, high-speed local feature extraction and matching calculation are important links. This paper presents a framework design method of sports image analysis system (Abbreviation: SIAS) based on SIFT algorithm, which can greatly reduce the amount of data and improve the efficiency of image analysis. The experimental results in the actual field show that the framework design method of SIAS based on SIFT algorithm proposed in this paper is effective and efficient.

KEYWORDS: SIFT algorithm, sports, image analysis, system framework design

INTRODUCTION

Human motion is carried out in a certain dimension of time and space, and the kinematics of human motion is a quantitative description of human motion. The main measurement methods for collecting kinematic parameters by camera include plane fixed-point camera shooting, plane fixed-point tracking camera shooting, plane fixed-point tracking camera shooting, stereo fixed-point camera shooting, stereo fixed-point tracking camera shooting and so on (He et al., 2018). Human recognition of moving image analysis is a high-level semantic concept, while machine recognition of images is a low-level semantic concept. There is a huge gap between these two semantic concepts, which is called "semantic gap". With the development of sports biomechanics, obtaining kinematic parameters by 3D fixed-point camera has been widely used in physical education and scientific research. However, in order to obtain relatively accurate 3D kinematics parameters, the calibration accuracy of 3D coordinates of image analysis is the key. As we all know, there are many factors that affect the accuracy of the 3D frame. In this study, in the non-competitive state, the moving images in the 3D frame are photographed by changing the shooting angles of two cameras, and then the frame is calibrated by the same analyst, so as to obtain the error values of each marker point, and then reveal the influence of different shooting angles on the 3D frame, which is intended to provide reference for exploring the best shooting area (Xue et al., 2018; L. Zhang et al., 2019) At the end of 1970s, image analysis based on sports came into being. It analyzes images and uses text retrieval technology to search keywords to analyze (Y. Li, 2021; Luiz, Lima, Rossini, Pezza, & Pezza, 2019).

Because the objects and their structures in the image only exist in a certain scale range, the scale invariance of sift operator is suitable for local feature recognition and matching. Using the compensation technology based on SIFT feature, the dynamic image is accurately registered, and then the moving target is detected by inter frame difference technology. Compared with the simple difference method and the differential accumulation method, the differential multiplication in this paper can greatly filter out the noise points and accurately segment the moving target contour (Pluim, 2016; Ramey, McInnis, & Palmer, 2016). SIFT algorithm expands feature detection according to scale space to determine the location and scale of key points, and then takes the main direction of key point field as the direction feature of modified points, so as to complete the independence of operator to direction and scale (Adamczyk et al., 2021; Bielik et al., 2006). SIFT feature is a local feature of sports image analysis. It has good invariance to translation, rotation, scale scaling, illumination condition change, occlusion and image noise. SIFT algorithm can extract massive feature data for fast and accurate matching (H. Li & Zhang, 2021). At the same time, it can be easily combined with other forms of eigenvectors to improve scalability.

At present, the retrieval method based on the analysis of sports images is limited in its application because of its shortcomings such as difficulty in processing images with large data and high computational complexity (X. Zhang & Yang, 2021). The analysis and registration of sports images based on SIFT goes through the following steps: First, in the scale space of sports images, SIFT feature points are extracted and screened to generate feature descriptors (Kuo, Su, & Kuan, 2016; Moren & Göhringer, 2019). Secondly, within a certain scale space range, search the SIFT point pair with the smallest Euclidean distance between feature vectors to match the SIFT feature points from different images (Zadeh, Haddadnia, & Montazeri, 2016). The main feature of SIFT is that it utilizes the objective visual features contained in sports images, and the analytical similarity is reflected in the visual similarity. It doesn't need to be explained by anyone, so it doesn't need or only needs a small amount of manual intervention, so it has been applied in situations that need automation (Cao, 2021; Qi et al., 2016). In this paper, a framework design method of SIAS based on SIFT algorithm is proposed, which can greatly reduce the amount of data and improve the efficiency of image analysis. The experimental results in practical fields show that the framework design method of SIAS based on SIFT algorithm proposed in this paper is effective and efficient.

1. Related Work

Literature (Rai et al., 2017) The accuracy of sports image analysis will be relatively low. In the future work, it is worth looking forward to applying this method to image analysis, plus the probability and statistics method. In addition, because SIFT features are characteristic values based on pixel values, they are sensitive to noise, so fuzzy matching method can be considered. The research of literature (Stefanatos, Foukalas, & Tsiftsis, 2017) The experimental results show that 60 images contain a huge amount of feature information, but some of these features are useful features, while others are not very useful for image classification. Literature (Peng, Wu, Zhang, & Lin, 2021) proposed that the SIAS framework can quickly and accurately calculate various kinematic parameters of human motion, and display the results in various forms such as images, curves and data tables, which intuitively reflects the technical characteristics of human motion, so it is favored by the majority of coaches, athletes and scientific researchers. Literature (Namdar, Basgumus, Tsiftsis, & Altuncu, 2018) Aiming at the difficult problem of moving target detection in the framework design of SIAS, this paper proposes a new moving target detection method combining SIFT and differential multiplication. Image registration is completed by SIFT feature matching algorithm, and the background image under the moving camera can be accurately compensated by obtaining the rotation, scaling and translation of the moving image. The research of reference (Dou, Qin, & Tu, 2018) shows that the core of human motion image three-dimensional analysis system is the

transformation of coordinate data, that is, the two-dimensional plane coordinates of spatial points are transformed into three-dimensional spatial coordinates, and the system framework is an important tool for the transformation of image two-dimensional coordinates of motion technology into three-dimensional spatial coordinates. Literature (Geng & Pahlavan, 2015) During display, the compared images can be displayed on the same screen at the same time or cross displayed. Literature (Schillings & Stuart, 2017) Through the method of big data analysis, there are many sports image analysis items with different requirements. In addition, it involves different points and calculation models and methods. After comprehensively processing the action images of the best athletes, with explanations and instructions, we can make TV teaching materials integrating images, curves, characters, indicators and explanations. The research in literature (Hooper, Baker, Blanch, & Prausnitz, 1990) shows that the distribution of nodes in the framework of SIAS must be evenly distributed throughout the control field to ensure that there are enough evenly distributed control points for human movement in any position of the control field. Literature (Galstyan & Harutyunyan, 2016) puts forward that sports image analysis mainly includes two working procedures, one is to compress sports image data due to digital conversion equipment; Secondly, it emphasizes the working procedure of some characteristics in sports images. These works are quite important, even more important than the subsequent concrete processing work, because the accuracy of image sampling point calculation is closely related to this.

This paper studies the framework design of SIAS based on SIFT algorithm. Considering the framework design of SIAS, there must be motion overlapping regions between sports targets detected by continuous multi frame differential binary images, which have certain stability, and the noise point distribution is random, using this property, the middle overlapping regions of sports targets can be extracted by multiplying multi frame differential binary images, accurately detect the sports image analysis, and effectively eliminate the random noise points. Differential multiplication has a strong ability to resist noise interference. SIFT algorithm is used to classify 20 kinds of semantic concepts, and satisfactory results are achieved. Sampling and comprehensive display of all images. When the SIFT descriptor is too large, the search effect is not ideal. The two nearest neighbor method can be used, that is, search the nearest neighbor and next nearest neighbor points.

3. Principle and model of SIFT algorithm

This paper mainly analyzes the analysis of sports images based on SIFT algorithm, and uses Direct show technology to analyze sports images. This method makes use of the advantages of SIFT feature matching algorithm in information content, image matching ability, algorithm robustness, etc., reduces the dependence on image content, and has strong anti-noise ability.

Automatic extraction of feature data requires synchronous display with images. Such as the change of the center of gravity. When showing where the body moves, the center of gravity should be displayed synchronously, and the center of gravity display curve will not disappear. With the popularization of audio-visual teaching in schools, the demand for TV teaching materials in the teaching and training of sports events will increase continuously, and the establishment of this system will make it very easy to make sports TV teaching materials. The data curves in the database are divided into three categories: one is the pattern data curve category; Second, the comparison parameter curve class; It is the characteristic parameter curve class of the best athletes at home and abroad. In fact, when the range of movement is not very large and far away from the scene, the distortion between images can be ignored when stitching images. In addition, in the long-term follow-up diagnostic test, input all the parameters of the tracked athletes, which can make the test results more accurate. The main functional framework of the system consists of four parts, as shown in Figure 1.

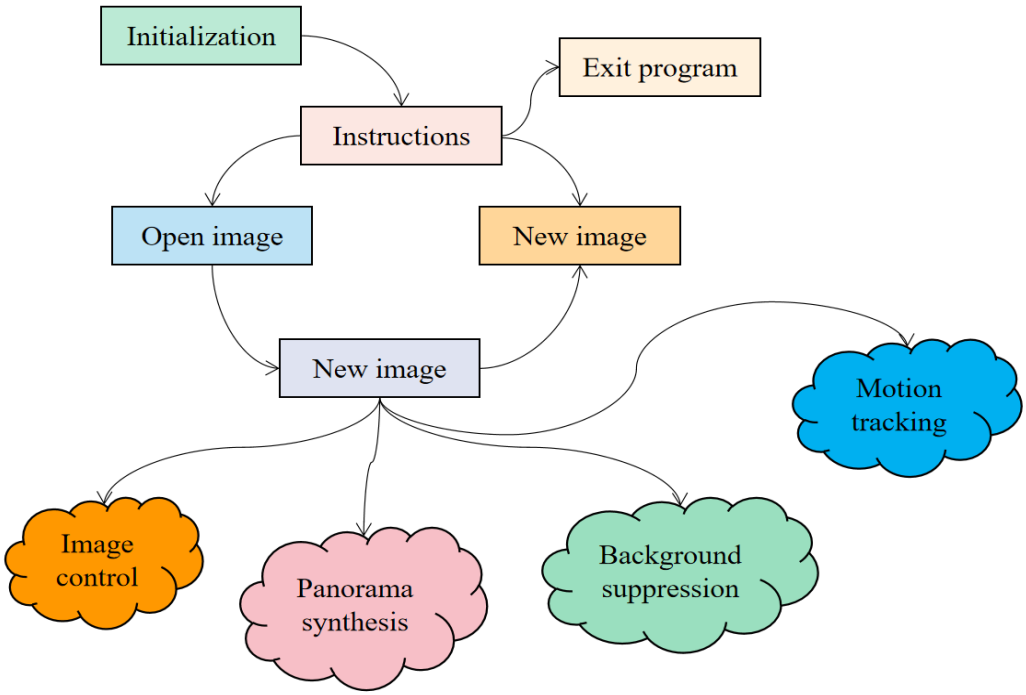

Figure 1: Functional framework of the system based on SIFT algorithm

The ascending or descending order of the distance can be used as the order of node search. When some parts of the body of a specific senior athlete are blocked in sports, such as gymnastics and diving somersault rotation, input the specific athlete's height, weight, upper and lower limbs, trunk and other link parameters, so that the three-dimensional information can be accurately inferred. When the ratio of these two distances is less than a certain value, it can be judged as a matching point pair, which can eliminate a certain amount of wrong matching points. After binarization,

the corresponding residual image obtained by difference is subjected to phase and operation, which can well extract the moving region and eliminate the influence of noise. To sum up, the flow chart of SIFT feature matching image registration is shown in Figure 2.

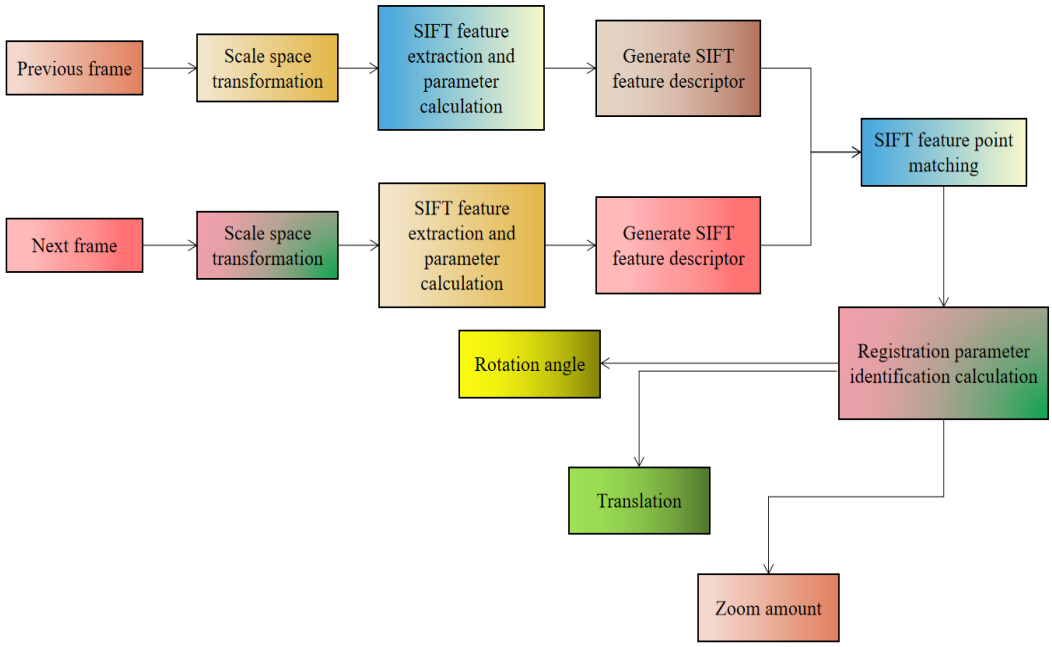

Figure 2: Flow chart of image registration

SIFT feature matching algorithm has the advantages of rich information, strong matching ability and good robustness. It can deal with the accurate matching problem between two images. In SIFT algorithm, the multi-scale features of image data are simulated by scale space. According to the scale space theory, the scale space l of two-dimensional image is defined as Gaussian scale space

$$L(x,y,\delta)=G(x,y,\delta)*I(x,y) \quad (1)$$

Where * is the convolution operator; (x,y) are spatial coordinates; σ is the scale coordinate;$G(x,y,\delta)$ is a Gaussian function with variable scale, expressed as

$$G(x,y,\delta)=\frac{1}{2\pi\delta^2}e-\frac{\left(x^2+y^2\right)}{2\delta^2} \quad (2)$$

Gaussian difference scale space is the convolution of Gaussian difference equations of different scales with images, which can be simply obtained by directly subtracting two Gaussian images of different scales.

$$D(x,y,\delta)=(G(x,y,k\delta)-G(x,y,\delta))*I(x,y)=L(x,y,k\delta)-L(x,y,\delta) \quad (3)$$

In order to extract SIFT feature points efficiently, Gaussian difference pyramid is constructed layer by layer by down-sampling method. Under the condition of ensuring the sampling accuracy, the calculation amount of SIFT feature points can be greatly reduced.

$$\hat{z}=-\frac{\partial^2 D^{-1}}{\partial z^2}\frac{\partial D}{\partial z} \quad (4)$$

In order to obtain the rotation direction information of SIFT feature points and ensure that the feature descriptor has rotation invariance, the direction parameters of feature points need to be determined by using the distribution characteristics of neighborhood pixel gradient direction θ. The gradient value and gradient direction of SIFT feature points are m (x, y) and m (x, y) respectively θ (x, y). In the neighborhood window centered on SIFT feature points, histogram is used to count the gradient direction of neighborhood pixels. The peak of histogram represents the main direction of neighborhood gradient of feature points, so it is used as the direction parameter of SIFT feature points θ.

$$m(x,y)=\sqrt{L(X+1,y)-L(x-1,y)^2+(L(x,y+1)-L(x,y-1))^2}$$
$$\theta(x,y)=\arctan\frac{L(x,y+1)-L(x,y-1)}{L(x+1,y)-L(x-1,y)} \quad (5)$$

The SIFT feature points of the image have been detected, and each SIFT feature point has three pieces of information: position (X, Y), scale δ and direction θ.

After SIFT registration, the moving object can be segmented by frame difference between the two registered images. Let $I_{k-1}(x,y)$ and $I_k(x,y)$ be the registered images of the front and back frames, and the binary image of the moving target can be obtained after the difference between frames and threshold processing.

$$d_{k-1,k}(x,y)=\begin{cases}1 & |I_k(x,y)-I_{k-1}(x,y)|>T\\ 0\end{cases} \quad (6)$$

Theoretically, in the differential binary image $d_{k-1,k}(x,y)$, only the pixel position of the area covered by the moving object is non-zero; However, in practice, due to the high-frequency noise, light variation, slight background

variation and other influencing factors in the image, and at the same time, image registration will also cause errors, so that there are still many non-zero pixels in the binary image except for moving objects, that is, there are noise points.

4. Research on Framework Design of SIAS

4.1. Framework Design of SIAS Based on SIFT Algorithm

In the practical application of sports image analysis based on SIFT algorithm, in order to obtain key images, when the background changes, it is necessary to reconstruct the background and modify the vehicle detection process. Background reconstruction can be done by comparing adjacent similar image frames. In 1970s, the technical analysis and research methods of sports images mainly used the film analysis system to analyze the films shot on the spot. That is to say, N frames of images are continuously collected in the video stream, two adjacent frames are subtracted by pixels, and the subtracted part is the background image. Finally, all the subtracted images are added together, and the total number is divided by n-1 to get the background image of the current video stream. This background sports image is used as a comparison template to analyze the sports image. Because of the large amount of video data, in general, it is not obvious to read data directly from the video data stream to realize recognition processing. Superimposed comprehensive display of individual athletes at different times. It includes the comprehensive display of the same athlete's different competition times in the same game and the comprehensive display of the same athlete's competition actions in different periods. The purpose is to facilitate comparative analysis. Multi-individual simultaneous superposition comprehensive display. It includes the comprehensive display of different athletes' actions in the same competition and the comprehensive display of different athletes' best performance actions. This kind of comprehensive display is convenient for finding problems and insufficient diagnosis.

In SIFT algorithm, a maximum leaf node tree is set to shorten the search time. At the same time, taking the sports image analysis distance as the starting point, the system framework design is established. The priority is set according to the increasing order of describing the sub nodes to be detected, which can clarify the search order and further shorten the search time. According to the queue mechanism, when searching along a branch in a certain direction, a member is added to the priority queue. The member information includes the sports image analysis distance between the node and the node to be tested. The ascending or descending order of the distance can be used as the order of node search. In this paper, firstly, the sports target detection method of SIFT algorithm is used to extract the image from the video stream, and then three main methods can be used to detect the sports

target: macroblock difference method, comparative difference method and inter frame difference method. When the SIFT descriptor is too large, the search effect is not ideal. The two nearest neighbor method can be used, that is, search the nearest neighbor and next nearest neighbor points. When the ratio of these two distances is less than a certain value, it can be judged as a matching point pair, which can eliminate a certain amount of wrong matching points. When some parts of the body of a specific senior athlete are blocked in sports, such as gymnastics and diving somersault rotation, input the specific athlete's height, weight, upper and lower limbs, trunk and other link parameters, so that the three-dimensional information can be accurately inferred.

In addition, in the long-term follow-up diagnostic test, input all the parameters of the tracked athletes, which can make the test results more accurate. Considering the framework design of SIAS, there must be motion overlapping regions between sports targets detected by continuous multi frame differential binary images, which have certain stability, and the noise point distribution is random, using this property, the middle overlapping regions of sports targets can be extracted by multiplying multi frame differential binary images, accurately detect the sports image analysis, and effectively eliminate the random noise points. Differential multiplication has a strong ability to resist noise interference. In the framework design of SIAS, the main characteristics of SIFT algorithm are

①SIFT features have affine transformation invariance; It can also maintain a certain degree of stability for the change of viewing angle, illumination and noise in the image, and at the same time show strong robustness in the change.

② SIFT algorithm accelerated by parallel computing platform can even meet the requirements of real-time computing.

③SIFT descriptor generates relatively standard feature vector data, which can be easily combined with other forms of feature vectors.

④ The amount of SIFT feature data generated by ordinary images is suitable for the feature data needed for image recognition, which can better reflect the local characteristics of images and help to improve the accuracy of feature matching.

After differential multiplication, the irregular contour of the moving target may still leave some isolated noise points in the binary image. Using morphological image processing technology optimization, through expansion, corrosion and other means to make up the broken contour, eliminate small holes, further filter out the residual noise points, and finally accurately segment the moving target. The evaluation criteria are composed of

recognized technical principles, parameter indexes and characteristic data of the best athletes. These parameter indexes will be printed out together with the similar parameter indexes of the analyzed athletes for the analysts to judge the technical quality of the analyzed athletes. It should be emphasized that with the continuous improvement of science and technology and sports technology, the data curve and evaluation criteria of the database will be updated. In this paper, firstly, the sports target detection method of SIFT algorithm is used to extract the image from the video stream, and then three main methods can be used to detect the sports target: macroblock difference method, comparative difference method and inter frame difference method. When the SIFT descriptor is too large, the search effect is not ideal. The two nearest neighbor method can be used, that is, search the nearest neighbor and next nearest neighbor points. During display, the compared images can be displayed on the same screen at the same time or cross displayed.

4.2. Experimental results and analysis

The sources of sports images based on SIFT algorithm include Xinhua net Sports Picture Library, China Sports Online Gallery, Sports Network Gallery, NBA Chinese Website, Sohu Sports, Ten cent Sports and many other online media. These sports images are downloaded from common media, not special picture libraries, so they have strong universality. In addition, the size distribution of the pictures used in the experiment ranges from the minimum of 300 × 294 pixels to the maximum of 2592 × 3222 pixels, which basically covers almost all the picture sizes provided by the current network media, which means that the sports images obtained by most digital devices can basically be analyzed by this method. Take 400 pictures, 60 for each sport. The extracted image features are analyzed by the above analysis method, and three experiments are conducted respectively, as shown in Figure 3, Figure 4 and Figure 5.

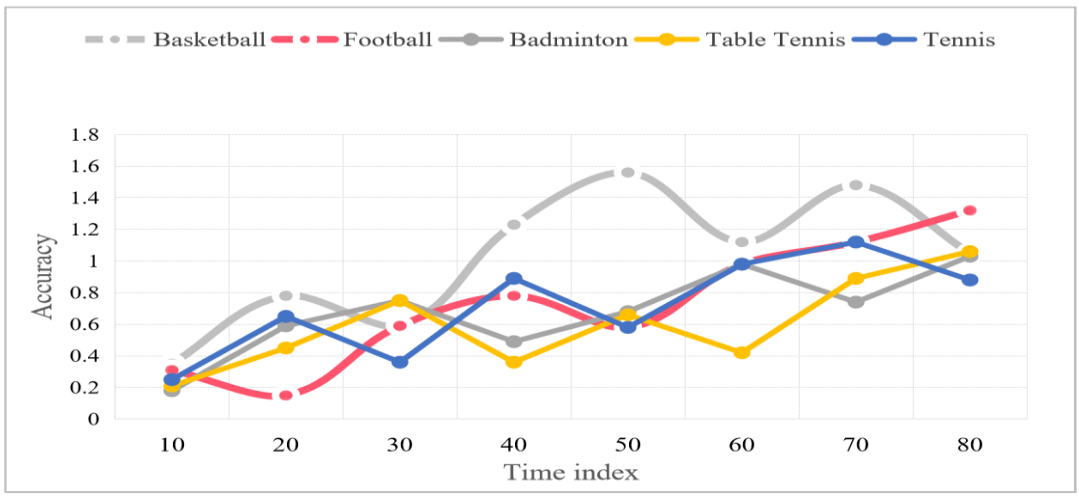

Figure 3: Statistical data of sports image analysis

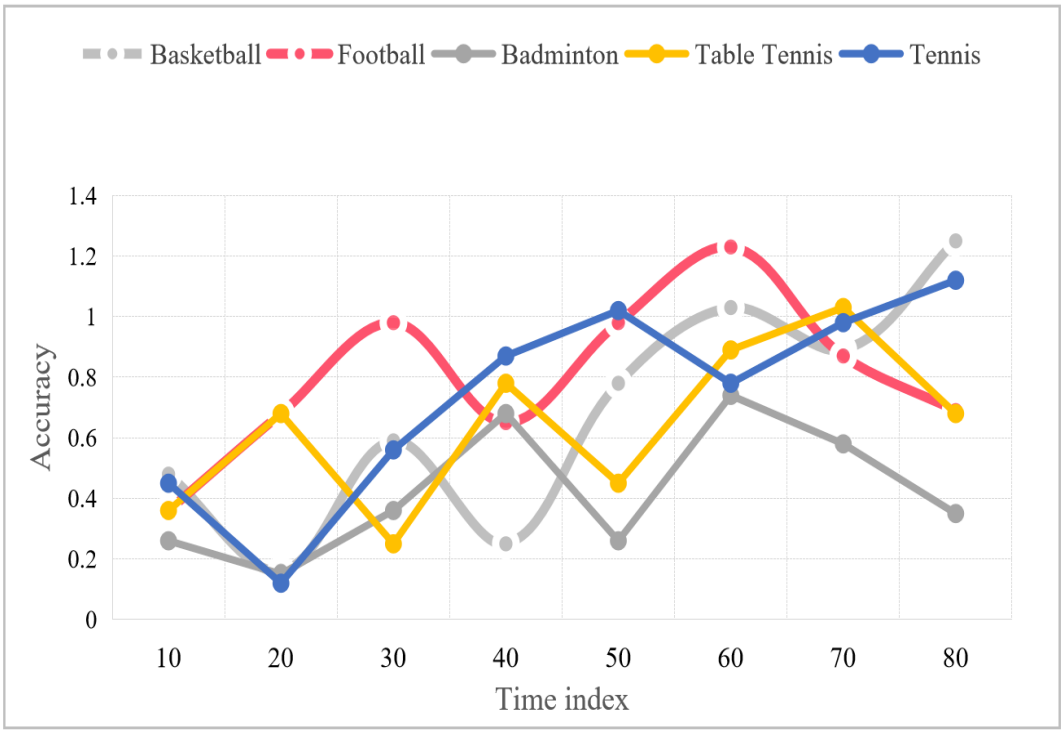

Figure 4: Statistical data of sports image analysis

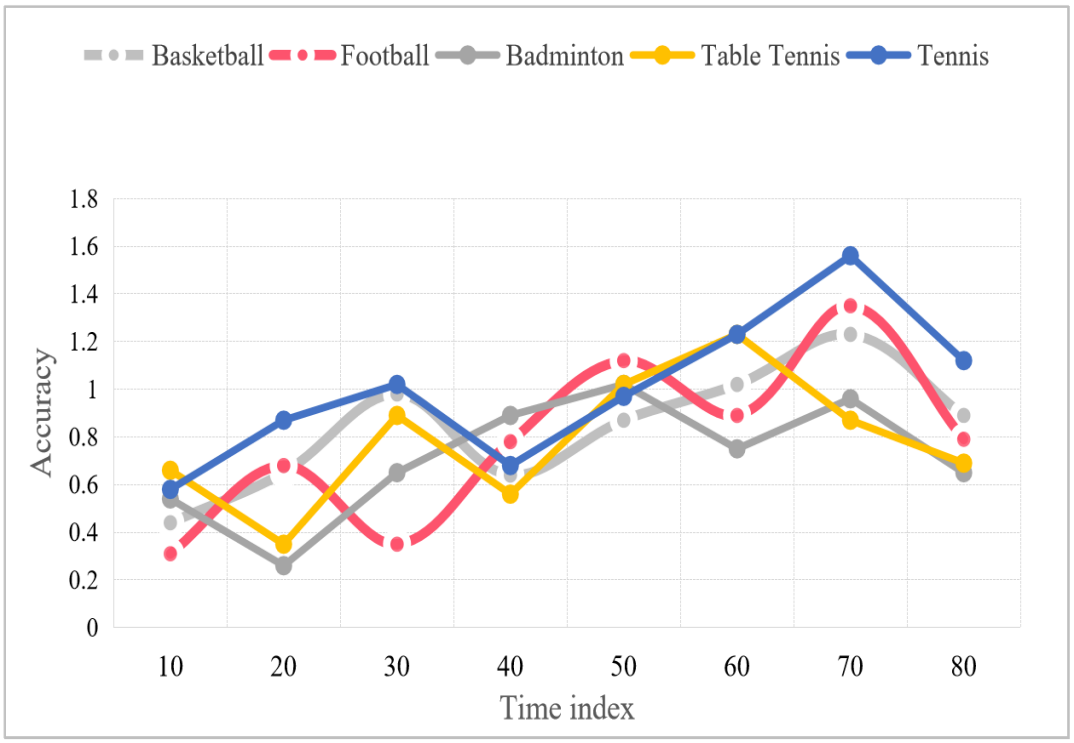

Figure 5: Statistical data of sports image analysis

The experimental results show that 60 images contain a huge amount of feature information, but some of these features are useful features, while others are not very useful for image classification. Therefore, some outlier

feature points need to be removed. Therefore, we use SIFT algorithm to gather features with high frequency and retain them.

The priority is set according to the increasing order of describing the sub nodes to be detected, which can clarify the search order and further shorten the search time. According to the queue mechanism, when searching along a branch in a certain direction, a member is added to the priority queue. If it is different from the standard, it must be corrected with the correction measures of the system to reduce the error and ensure the accuracy.

After the new feature set is obtained, because the feature set is still too large, the too large feature set seriously lags behind the speed of calculation, thus affecting the speed of analysis. Therefore, we continue to process the feature set, that is, merge the feature points with high similarity, so as to simplify the feature set. The two nearest neighbor method can be used, that is, search the nearest neighbor and next nearest neighbor points. When the ratio of these two distances is less than a certain value, it can be judged as a matching point pair, which can eliminate a certain amount of wrong matching points. Taking sports as the research object in the framework design of SIAS, a SIAS framework system based on SIFT algorithm is designed.

From the point of view of the framework design of SIAS, this paper adopts four methods, namely kernel choices, weighting scheme, stop-word removal and SIFT algorithm in this paper, and makes three experiments and comparisons, as shown in Figure 6, Figure 7 and Figure 8.

Figure 6: Comparison data of sports image analysis effect

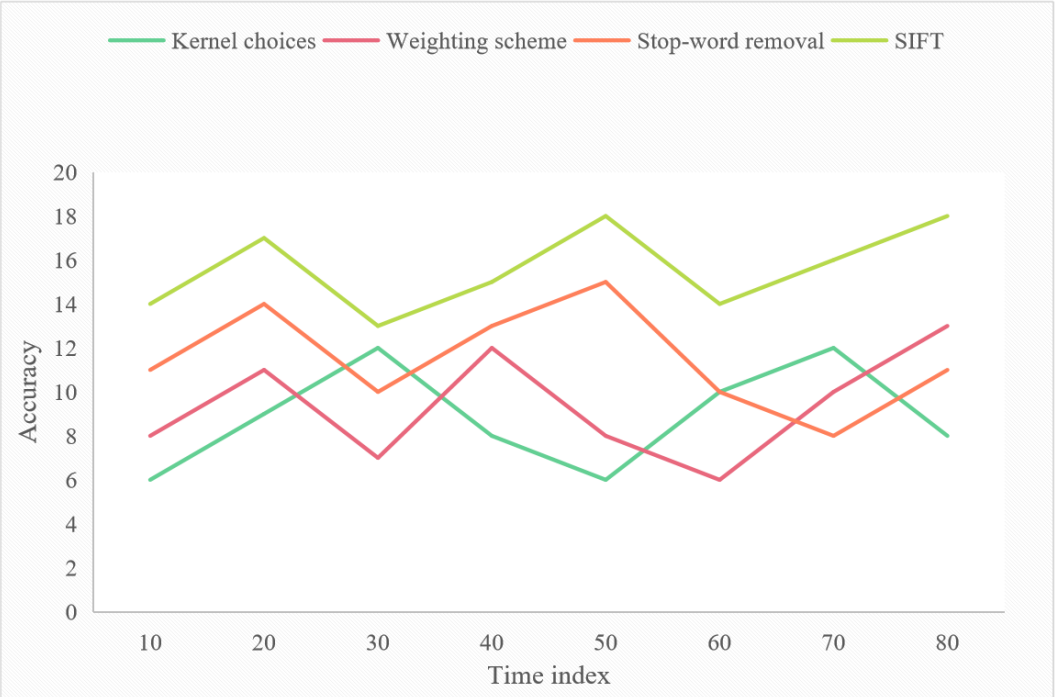

Figure 7: Comparison data of sports image analysis effect

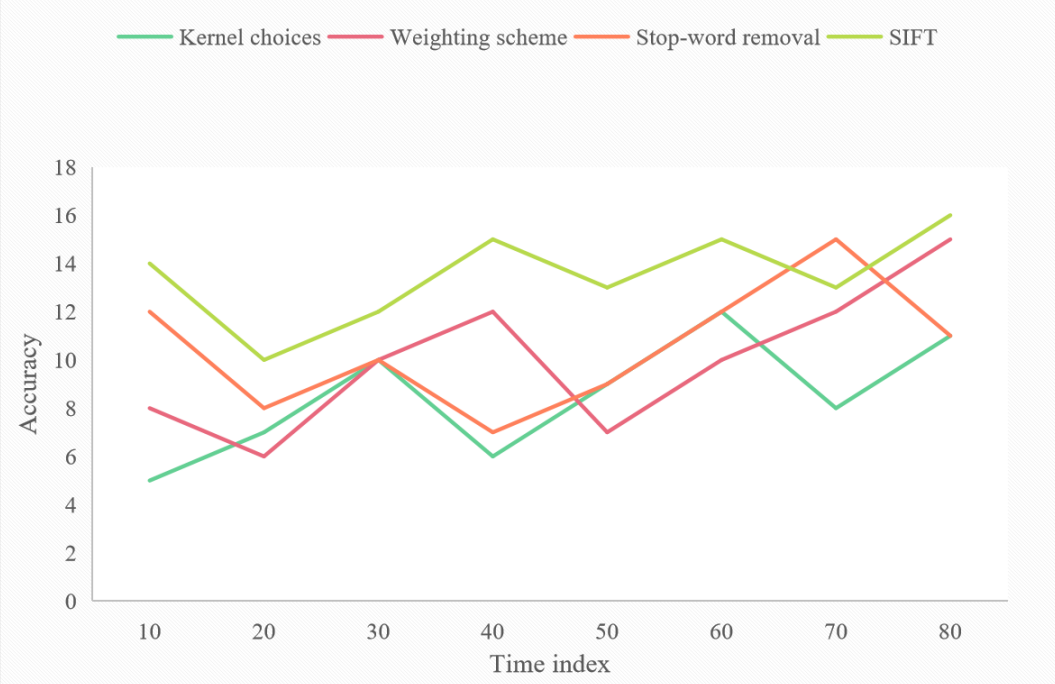

Figure 8: Comparison data of sports image analysis effect

The experimental results show that the SIFT algorithm used in the three experiments has the highest accuracy. The processed feature set contains only 260 feature points that can represent the classification. Because the data processed by SIFT algorithm uses the center of its cluster to replace

the characteristics of this cluster, after such processing, the parameters of feature points may change and become unable to represent the original library features, so we use the center point algorithm in SIFT algorithm, the nearest center point is used to replace the clustering center point to solve the possible error caused by this algorithm.

Typical applications include: using SIFT algorithm to solve the detection of repeated shots in sports image analysis, which has achieved good results in terms of processing speed and effect. In SIFT algorithm, a maximum leaf node tree is set to shorten the search time. At the same time, taking the sports image analysis distance as the starting point, the system framework design is established. The framework design of SIAS is divided into several sub blocks, and each sub block is matched. If the similarity of one sub block is high, it is considered that the target is found and the matching is stopped; If the similarity is low, continue the matching of the next sub block until a higher similarity is found. If the similarity of all sub blocks is very low, that is, the target is completely blocked.

5. Conclusions

Aiming at the difficult problem of moving target detection in the framework design of SIAS, this paper proposes a new moving target detection method combining SIFT and differential multiplication. Image registration is completed by SIFT feature matching algorithm, and the background image under the moving camera can be accurately compensated by obtaining the rotation, scaling and translation of the moving image.

Aiming at the difficult problem of moving target detection in the framework design of SIAS, this paper proposes a new moving target detection method combining SIFT and differential multiplication. After comprehensively processing the action images of the best athletes, with explanations and instructions, we can make TV teaching materials integrating images, curves, characters, indicators and explanations. With the popularization of audio-visual teaching in schools, the demand for TV teaching materials in the teaching and training of sports events will increase continuously, and the establishment of this system will make it very easy to make sports TV teaching materials.

The accuracy of sports image analysis will be relatively low. In the future work, it is worth looking forward to applying this method to image analysis, plus the probability and statistics method. In addition, because SIFT features are characteristic values based on pixel values, they are sensitive to noise, so fuzzy matching method can be considered. This method makes use of the advantages of SIFT feature matching algorithm in information content, image matching ability, algorithm robustness, etc., reduces the dependence

on image content, and has strong anti-noise ability.

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