Hindawi
Mobile Information Systems
Volume 2022, Article ID 2845115, 11 pages
https://doi.org/10.1155/2022/2845115

Research Article

Sequence Analysis and Feature Extraction of Sports Images Using Recurrent Neural Network

Ju Xu

Henan College of Transportation, Zhengzhou, Henan 450005, China

Correspondence should be addressed to Ju Xu; xuju498962466@hncc.edu.cn

Received 7 February 2022; Revised 3 March 2022; Accepted 11 March 2022; Published 7 April 2022

Academic Editor: Mian Ahmad Jan

Image sequence analysis is attracting significant attention at present, but its principles and techniques have rarely been applied to the field of sports biomechanics. As far as the technology of automatic recognition of joint points by computers is concerned, it is still in the experimental stage. The purpose of this paper is to study and analyze the sequence analysis and feature extraction of sports images based on cyclic neural network. This paper puts forward the basic concepts of sports image sequence analysis and feature extraction and analyzes the importance of sports in this context. As the experimental results demonstrates, the application rate of detecting human motion by using template matching technology detection is between 15% and 47%, while the accuracy of image sequence analysis method has increased from 17% to about 65%. Generally speaking, although the template matching technology detection method is more popular than the image sequence analysis method at the beginning, the popularity of the image sequence analysis method is significantly higher than that of the template matching technology detection method after time precipitation. Therefore, it is very important to study the sequence analysis and feature extraction of sports image based on cyclic neural network.

1. Introduction

In recent years, as the sequence image motion analysis becomes more and more important, scholars also began to apply the sequence image motion analysis to sports. The motion of the sequence may be caused by the motion of the camera, the motion of the object, the change of lighting or the change of the structure, and size and shape of the object, so it is very difficult to track such changes. In order to achieve a specific purpose, reliability and accuracy are often two important indicators when tracking moving targets in complex background. With the continuous development of competitive sports, sports known as the "new Olympic Games" have attracted more and more attention. Popular sports have become an activity of great social significance in people's daily life. The active development of collective movement has also played a more and more obvious positive role in accelerating the improvement of productivity, maintaining social stability and protecting human health.

The innovations of this paper are as follows: (1) This paper introduces the theoretical knowledge of sequence image motion analysis and cyclic neural network. And this paper analyzes how the cyclic neural network algorithm plays a role in the research of sports image sequence analysis and feature extraction by using the cyclic neural network algorithm. (2) This paper investigates and analyzes the characteristics of sports image sequence analysis and feature extraction and its advantages. Finally, this paper concludes that sports image sequence analysis and feature extraction based on cyclic neural network will promote the development of sports.

The rest of this paper is organized as follows. In Section 2, the related work about sequence analysis and feature extraction of sports images via recurrent neural network is presented. In Section 3, the proposed approach is presented followed by experimental results in Section 4 and a brief discussion of the results in Section 5. Finally, the concluding remarks and some future directions for further improvements are discussed in Section 6.

2. Related Work

With the vigorous development of sports in recent years, people pay more and more attention to sports. In [1], the authors witnessed the unprecedented interest and active participation in extreme sports. The uniqueness of extreme sports is that they involve physical fitness and special attitude towards the world. The authors interviewed 15 extreme sports participants and elaborated on three aspects of extreme sports experience. The findings provide valuable insights into the experience of participants. However, the scholars did not explain in detail what the main aspects are and what the survey results are [1]. In [2], the authors proposed a new condition of complex valued activation function, which is less conservative than the assumed Lipschitz condition. Based on the new conditions and linear matrix inequalities, they established some new criteria to ensure the existence and stability of the equilibrium point. They also gave a numerical example to illustrate the effectiveness of the theoretical results. However, the scholars did not specify the concept of activation function, and there was no specific experiment to prove the reliability of the function. In [3], the authors found that the computational strategy used to generate biological targets has good affinity. However, the scholars did not explain why the cyclic neural network can be used to train new molecules of the model, and there is no specific data to prove whether the model can really be applied to the language model. The authors of [4] found that a large part of residential and commercial buildings need intelligent applications to predict power consumption with the progress of sensors and intelligent technology, in which cyclic neural network can play a vital role. However, the scholars did not list the advantages of cyclic neural network, nor did they explain why they chose this method to predict power consumption. In [5], the authors found that in the data-driven prediction method, the prediction accuracy of the remaining service life of the bearing mainly depends on the performance of the bearing health index. These indexes are usually fused from some statistical features extracted from vibration signals. However, there are many deficiencies in many existing bearing health indicators. They proposed to input the selected features into the cyclic neural network, but the scholars did not explain what the shortcomings of bearing health indicators are and how to deal with them.

In [6], the authors considered the use of distributed cyclic neural network for cooperative motion control of multiple manipulators and provide an easy to handle method. It can extend the existing results of single manipulator control using cyclic neural network to scenes with multiple manipulator coordination. His simulation proves the effectiveness of the proposed method. However, the scholars did not describe the whole simulation process, and there was no evidence to support his view. In [7], the authors proposed a neurodynamic optimization method for synthesizing linear control systems through state and output feedback. The challenge is expressed as an optimization problem with robustness measurement. They proposed two coupled recurrent neural networks to solve formulated problems in real time. Compared with the existing methods, the exponential convergence of the global optimal solution can also be guaranteed. The scholars proposed that neurodynamics can ensure the exponential convergence of the global optimal solution, but they did not prove that this conclusion is correct through specific data [7]. In [8], the authors proposed a fractional order recurrent neural network and studied several topics related to the dynamics of this network, such as stability and undamped oscillation. Based on the stability analysis, the critical value of fractional order is determined, and then they estimated the parameter range of undamped oscillation. However, the scholars did not describe the parameter range of undamped oscillation, nor did they explain how to determine the critical value of fractional order.

3. Image Sequence Analysis and Feature Extraction Method Based on Cyclic Network

The world is changing, and sequence images provide people with more information than a single still image. The significance of sequence image analysis is to transfer image processing from still image to sequence image. By analyzing multiple continuous images, information that cannot be obtained can be obtained [9]. Only sequence images can recognize and analyze dynamic processes. Due to the rapid development of hardware technology, the storage capacity and processing speed of images are greatly improved, and real-time sequence image analysis is realized [10].

A difficult problem in sports teaching is how to solve the comparison between the coach's action and student's action. The traditional comparison methods mostly rely on the naked eye for direct comparison or use the motion comparison method based on video. One of the problems of these comparison methods is that they cannot accurately give an accurate measure of the similarity between the students' actions and coaches' actions. Whether it is the overall similarity or local similarity, there is no effective algorithm to solve this problem. The recognition in motion is shown in Figure 1.

In Figure 1, a method of extracting useful data or information from an image and obtaining a "nonimage" representation or description of an image such as a number or symbol has been shown. This process is called feature extraction. If these functions are used in numerical or vector form, the computer can be trained to understand these functions so that the computer can recognize images [11]. Human feature recognition is shown in Figure 2.

As shown in Figure 2, how to use huge sensor data to improve human activity recognition accuracy and real-time performance is an important research direction in the field of life. In recent years, the deep learning algorithm of various tasks that abandon manual feature extraction and constantly update the world record has become the focus of the cognitive field of research activities [12].

3.1. Cyclic Network Algorithm Based on Artificial Neural Network. Artificial neural network is a research hotspot in the field of artificial intelligence since the 1980s. It abstracts

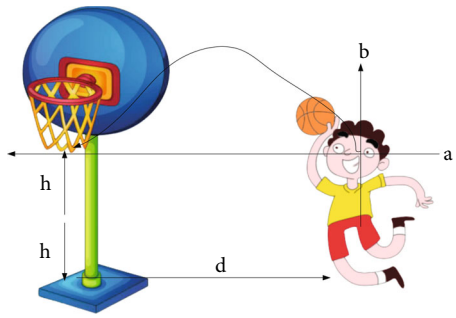


Figure 1: Recognition in motion.

the human brain neural network from the perspective of information processing, establishes a simple model, and forms different networks according to different connection modes. This paper mainly studies the application of cyclic neural network in deep learning algorithm in the field of motion recognition based on sensor data [13]. The application of recurrent neural network is shown in Figure 3.

As shown in Figure 3, artificial neural network is the technical replication of biological neural network in the sense of simplification. Its main task is to build a practical artificial neural network model and design the corresponding artificial neural network model according to the neural network principle of biology and the needs of practical application. It simulates the specific intelligent activities of the human brain and implements its technology to solve practical problems [14].

3.1.1. Perceptron. Perceptron is a typical structure of artificial neural network, and its main feature is a simple structure. It is a convergence algorithm that can solve problems and plays an important role in the research of neural networks [15]. Perceptron can not only realize simple Boolean operation, but also fit any linear function. Any linear classification or linear regression problem can be solved by perceptron. The perceptron model is shown in Figure 4.

As shown in Figure 4, the input vector will pass through the parameter vector (w_1, w_2, w_3) of the perceptron model to obtain the intermediate result as

$$v = \sum_{i=1}^{3} w_i a_i + b. \tag{1}$$

When the two types of sample distributions have multimodal properties and interleave with each other, the simple linear discriminant function often leads to large classification errors. Piecewise linear classifier can often be effectively applied to this situation, where the limiter a_i is nonlinear and the threshold function is

$$\sigma(v) = \left\{ \frac{1, if\, v\phi \text{ threshold}}{0, if\, v \le \text{threshold}} \right\}, \tag{2}$$

where *threshold* is the threshold of perceptron model.

The offset b term is recorded as $w_i a_i$, so the output of the sensor is

$$b = \sigma\left(\sum_{i=0}^{n} w_i a_i\right). \tag{3}$$

In the field of artificial neural network, perceptron is also called single-layer artificial neural network to distinguish it from more complex multilayer perceptron. As a linear classifier, perceptron is undoubtedly the simplest form of feedforward artificial neural network [16]. Despite its simple structure, perceptron can also learn and solve quite complex problems. The main defect of perceptron is that it cannot deal with the problem of linear separation [17].

Cyclic networks can identify patterns of sequence data, such as text, genome, and sensors. This is an artificial neural network for identifying time series data [18]. Cyclic neural network has memory, parameter sharing, and Turing completeness. Therefore, it has certain advantages in learning the nonlinear characteristics of sequences. Recurrent neural network is applied in natural language processing, such as speech recognition, language modeling, machine translation, and other fields. It is also used in all kinds of time series prediction. Circular network is undoubtedly the most powerful neural network. It can also decompose the image into a series of image patches and process them as sequences [1]. The cyclic neural network is shown in Figure 5.

As shown in Figure 5, the difference between cyclic network and feedforward network is that feedforward network always receives its own output as input at the last moment. Using this information, the cyclic network can complete the impossible task of feedforward network [19]. The RNN model with the number of output layer units of H and K is

$$\alpha_h^t = \sum_{i=1}^{I} w_{ih} a_i^t + \sum_{h}^{H} w_h b_h^{t-1}, \tag{4}$$

$$b_h^t = \theta_h\left(\alpha_h^t\right). \tag{5}$$

Formula (4) and Formula (5) are iteratively calculated from the time $t = 1$ until the whole input sequence is completed. The value calculated by the collection of hidden layer elements is represented by the relevant technology of Formula (5) position prediction [20], where a_i^t is the value of the input unit at time t and b_h^{t-1} represents the value of the neural network hiding unit. Formula (5) indicates that the nonlinear differentiable activation function is applied to the collection value of the hidden unit.

3.1.2. Output Layer. The output result vector of multilayer neural network is given by the activation of output layer. The input value of each output layer unit K of the neural network is calculated by the unit output values of all hidden layers connected to the unit and is shown in

$$\alpha_k = \sum_{h \in H} w_{hk} b_h. \tag{6}$$

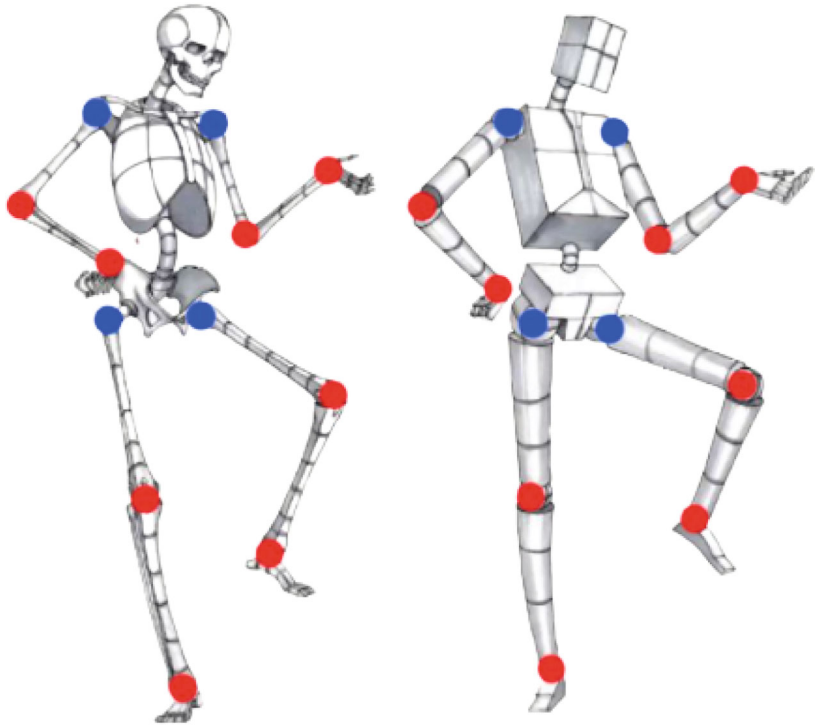


Figure 2: Human feature recognition.

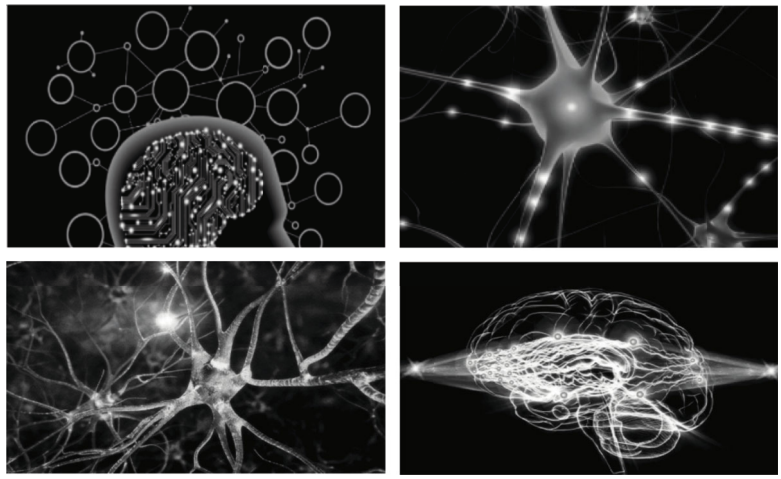


Figure 3: Application of recurrent neural network.

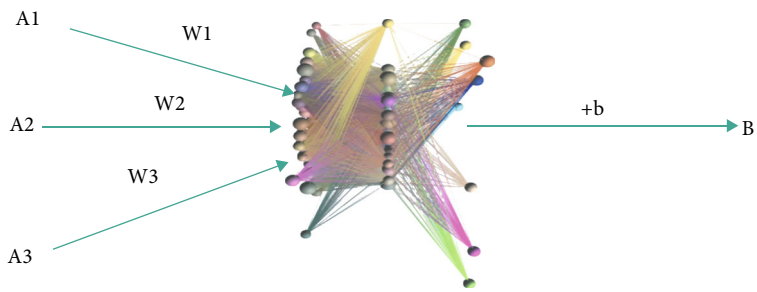


Figure 4: Perceptron model

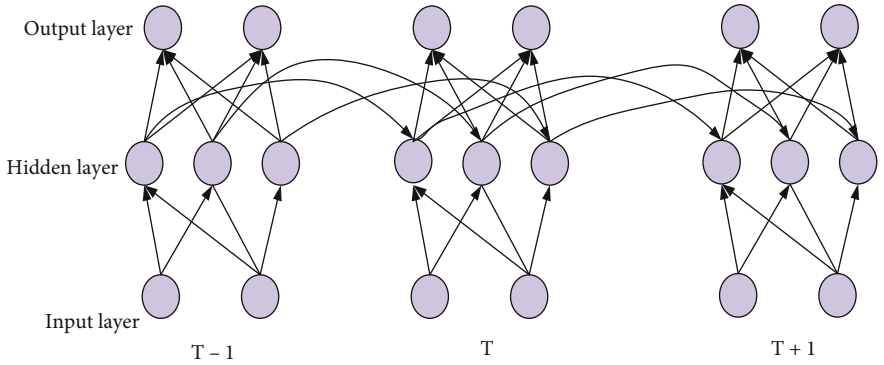
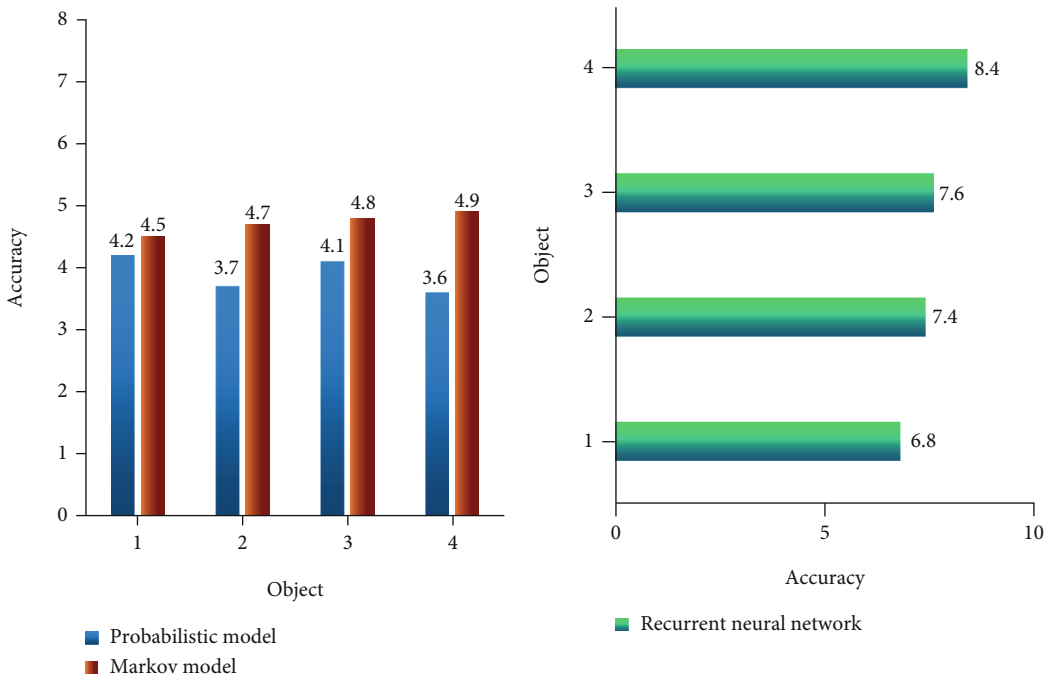


Figure 5: Cyclic neural network.



(a) Accuracy of probability model and Markov model

(b) Accuracy of neural network model

Figure 6: The accuracy of probability model, Markov model and neural network model.

The so-called activation function is the function running on the neurons of artificial neural network, which is responsible for mapping the inputs of neurons to the outputs. For a binary classification task, logistic sigmoid is generally used as the activation function, and the number of output units is 1. Since the interval of logistic sigmoid value is $(0, 1)$, the activation function can be expressed as

$$P(C_1|a) = b = \sigma(a_k). \tag{7}$$

When the classification number k is greater than 2, that is, the output layer has k units. The probability value of using softmax function as the activation function to obtain the classification result is

$$P(C_1|a) = b_k = \frac{e^{ak}}{\sum_k^K e^{ak}}. \tag{8}$$

To sum up, the target probability in this paper is

$$P(z|a) = \prod_{k=1}^{k} b_k^{zk}. \tag{9}$$

In order to further verify the reliability of the feature extraction model based on cyclic neural network and the

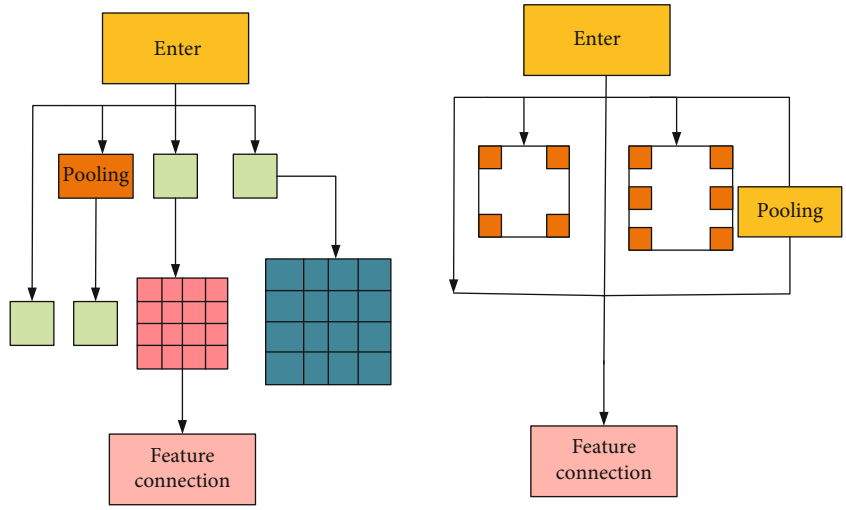


Figure 7: Image sequence.

Table 1: Main advantages and disadvantages of interframe difference method.

Features	Object	A	B	C
Advantage	High detection rate	56%	67%	66%
	The algorithm is simple	78%	77%	72%
	Low complexity	23%	16%	12%
Shortcoming	Low precision	15%	11%	13%
	Low accuracy	26%	25%	22%

necessity of research, this paper makes a corresponding comparison with some traditional feature extraction. The traditional feature extraction models are mainly probability model and Markov model. Markov model generally refers to Markov model. Markov model is a statistical model, which is widely used in speech recognition, automatic part of speech tagging, phonetic word conversion, probabilistic grammar, and other natural language processing applications. Obviously, the accuracy is the main factor to evaluate a feature extraction model. The accuracy of probability model, Markov model, and neural network model is shown in Figure 6.

As shown in Figure 6, the cyclic neural network is superior to the traditional Markov probability model based on transfer formula in feature extraction and has certain research value.

3.2. Image Sequence Analysis. Image sequence analysis uses computer vision technology to detect motion and moving objects from image sequence and analyze, track, or recognize them. Image sequence analysis is widely used in many aspects of national economy and military field.

3.2.1. Basic Algorithm. Its general expression can be written as

$$\{f(a_i, b_j, t_0), f(a_i, b_j, t_1), \cdots, f(a_i, b_j, t_{n-1})\}(i, j = 0, 1, \cdots, n-1). \tag{10}$$

The so-called relative sequence generally refers to the time t_k after $t_{k\text{-}1}$ $(k = 1, 2, \cdots, n-1)$. The time interval between acquisition of two adjacent images is defined as

$$\Delta t_k = t_k - t_{k-1}, (k = 1, 2, \cdots, n-1), \tag{11}$$

where Δt_k is usually equal; that is, the acquisition time interval of all images is the same. The image sequence is shown in Figure 7.

As shown in Figure 7, since the image sequence is usually composed of multiple frames, each image along the time axis can maintain short-term detection, and continuous motion can be formed through the persistence of human vision.

3.2.2. Interframe Difference Method. Interframe difference method is a method to obtain the contour of moving target by performing difference operation on two adjacent frames in video image sequence. It can be well applied to the case of multiple moving targets and camera movement.

The difference image is obtained by calculating between the kth frame image f_k and the $K\text{th}^{-1}$ frame image f_{k-1}. It is shown in

$$D_k(a, b) = |f_k(a, b) - f_{k-1}(a, b)|. \tag{12}$$

The main advantages and disadvantages of interframe difference method are shown in Table 1.

As shown in Table 1, the main advantage of this algorithm is that the detection rate is very high, and the image can be detected effectively and quickly. The algorithm is also very simple. Compared with the traditional complex algorithm, the process of the algorithm is not only much simpler, but also the results are more correct. However, the algorithm also has some disadvantages, such as low segmentation accuracy and low detection efficiency.

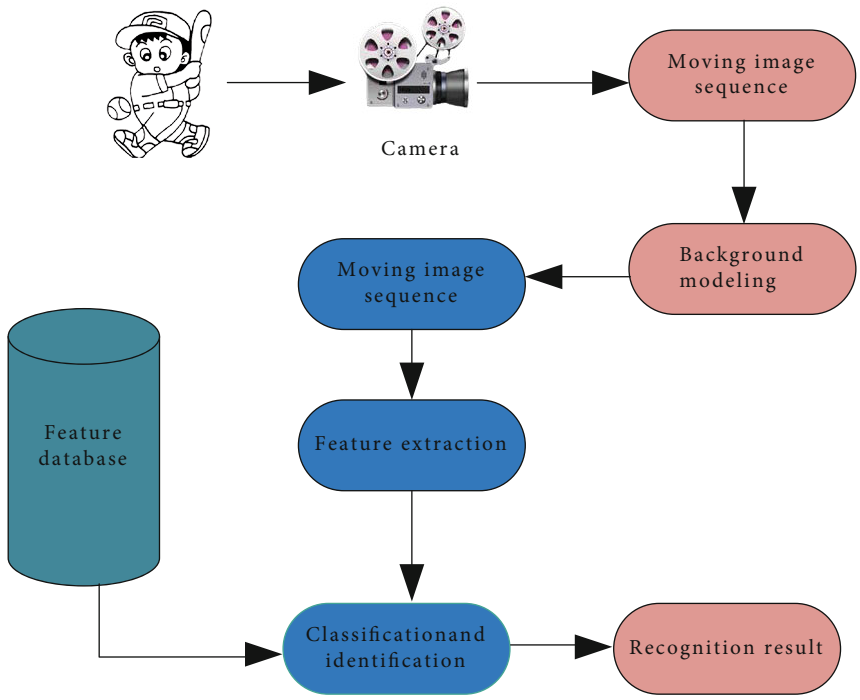


Figure 8: Typical motion feature recognition system.

3.3. Human Motion Feature Recognition and Extraction Algorithm

3.3.1. Human Motion Feature Recognition. In the process of human walking, each person's human contour feature is unique and can represent a specific identity. The contour shape of human body has integrity, which describes the movement of human body as a whole, which belongs to static characteristics. The structure diagram of specific motion feature recognition system is shown in Figure 8.

As shown in Figure 8, when walking, people will make a series of characteristic actions reflecting the changes of limb contour and shape, such as the natural swing of arms, the shaking of head, the stepping of thighs and lower legs, and the movement of hips.

3.3.2. Human Motion Feature Extraction. Background subtraction algorithm is a very important preprocessing algorithm in many machine vision based applications. For example, use a fixed camera to count the number of people in and out of a room, or the traffic camera to extract information about vehicles, and so on. In all these examples, the first thing to do is to extract people and vehicles separately.

The moving target extracted by background subtraction in static background has high accuracy. Set the current image frame as $f_c(a, b)$, the background image reference frame as $b_c(a, b)$, and the foreground image as

$$d_c(a, b) = |f_c(a, b) - b_c(a, b). \tag{13}$$

The foreground image obtained by $Sd_c(a, b)$ background subtraction is still gray image, so it is usually not suitable to use gray image directly for feature processing. The calculation method of image value is

$$R_c(a, b) = \begin{cases} a_i, d_c(a, b) \geq T \\ b_i, d_c(a, b) \geq T \end{cases}. \tag{14}$$

In this paper, the closed operation is used to further process the image, and the matrix operator is selected as the structural element. The expansion operation expression is

$$E = B \oplus S = \left\{a, b \middle| S_{a,b} \cap B \neq \varphi\right\}. \tag{15}$$

B is the original image to be processed, E is the processed image, represents the structural element, and $S_{a,b}$ represents when the origin of S moves to the point. The decay candle operation Formula is expressed as

$$E = B \otimes S = \left\{a, b \middle| S_{a,b} \subseteq B\right\}. \tag{16}$$

In this paper, the series of operations are used to process the binarized moving human body image, so as to fill the small holes in the image area and eliminate the background noise outside the individual area.

Therefore, this paper uses moment invariants to transform the image contour into one-dimensional features to describe the contour features of human motion. Compared with the traditional way of using Fourier descriptors to

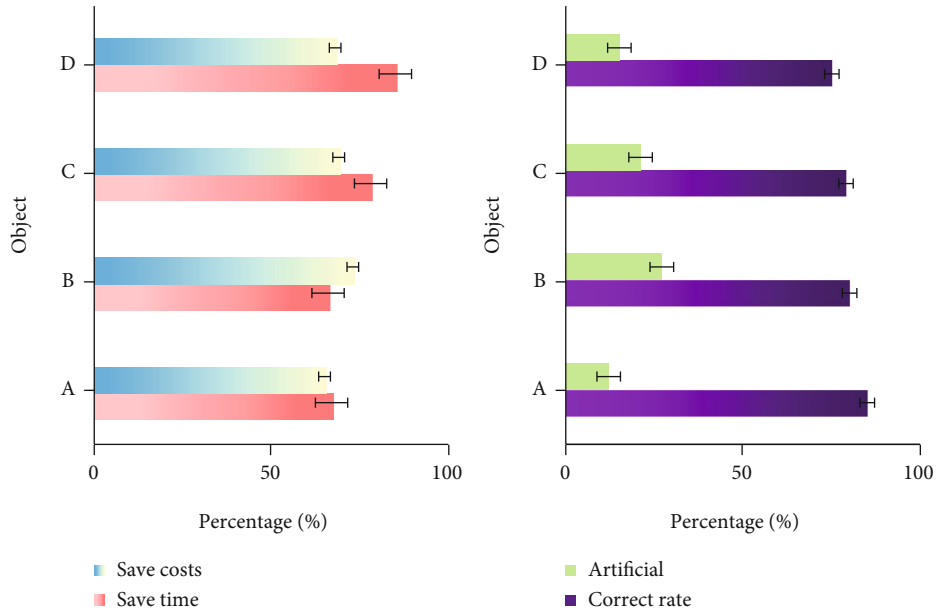


Figure 9: Advantages of human motion sequence image and feature extraction.

Table 2: Traditional motion analysis methods.

Test subject	Time spent(min)	Accuracy	The complexity
a	65	20%	65%
b	78	16%	67%
c	74	15%	63%
d	69	21%	69%
e	72	18%	68%

Table 3: Template matching technology detection method.

Test subject	Time spent(min)	Accuracy	The complexity
a	54	48%	53%
b	52	49%	51%
c	50	52%	50%
d	47	58%	52%
e	46	56%	54%

Table 4: Image sequence analysis.

Test subject	Time spent(min)	Accuracy	The complexity
a	32	87%	21%
b	31	88%	17%
c	28	84%	19%
d	30	85%	22%
e	25	86%	20%

represent motion contour features, it has the advantages of less data and simple operation process.

For the bounded two-dimensional function $f(a, b) \in L(R^2)$ with $o \longrightarrow ab$ set on the plane, define its order origin moment, as shown

$$m_{pq} = \int_{-\infty}^{+\infty} a^p b^q f(a, b) dxdy. \tag{17}$$

However, the step center distance is defined as

$$\mu_{pq} = \int_{-\infty}^{+\infty}\int_{-\infty}^{+\infty} (a - a_1)^p (b - b_1)^q f(a, b) \mathrm{dxdy}. \tag{18}$$

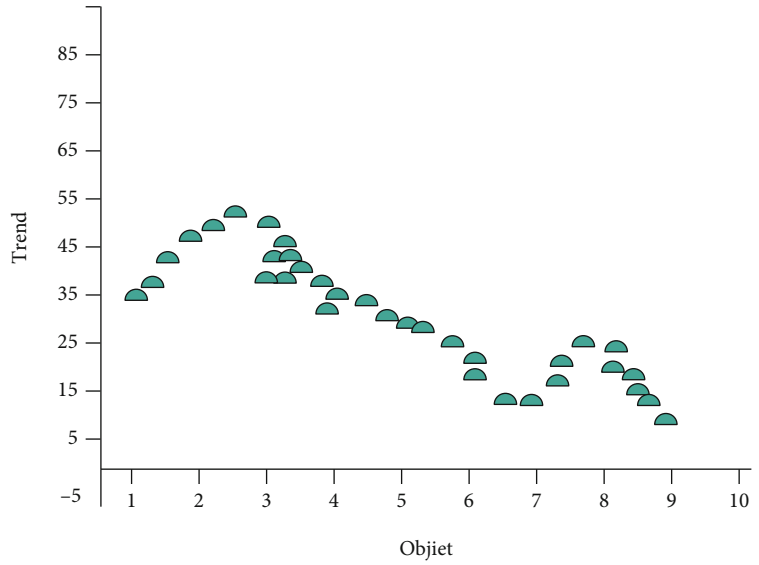
If $f(a, b)$ is piecewise continuous and has non-zero values only in a finite region in the $o \longrightarrow ab$ plane, then its moments of all orders exist.

Transversely scan the abscissa al, ar, of the longitudinal coordinate b_1 of the neck joint in the human motion contour image, and then, calculate the abscissa of the neck joint as

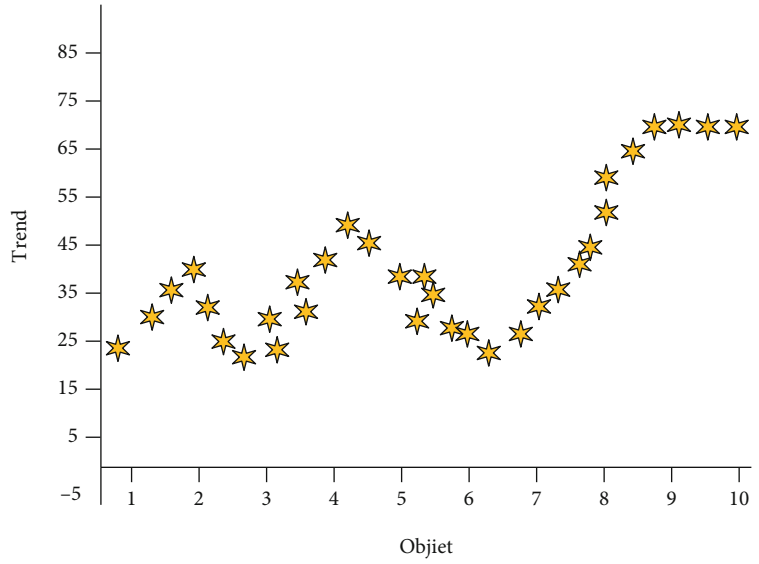
$$A_1 = \frac{al(ar - al)}{2}. \tag{19}$$

After extracting the human joint points, it is necessary to locate the joint points in each frame, calculate the position of the joint points in each frame, and use the centroid of the joint point area to represent the joint points. The abscissa of the center of mass is the average of all abscissa on the object contour, and the ordinate of the center of mass is the average of all ordinates on the object contour. The definition of centroid is shown in

$$c_a = \frac{\sum_{(i,j)\in \mathrm{Contour}} i}{n}, \tag{20}$$



(a) .Template matching technology detection method



(b) Image sequence analysis

Figure 10: Application trend of template matching technology detection method and image sequence analysis method.

where n is the number of pixel points in the region. That is, the abscissa of the center of mass is the average of all abscissa in the region, and the ordinate of the center of mass is the average of all ordinates in the region.

4. Experiment and Analysis of Image Sequence Analysis and Feature Extraction Based on Cyclic Network

4.1. Advantages of Human Motion Sequence Images and Feature Extraction. With the accelerating pace of life, people get fewer and fewer opportunities to exercise. The popularization of mass sports has become very difficult. The reasons include that people suffer from the lack of correct guidance methods to help them exercise effectively.

Human motion feature extraction is the core part of motion feature recognition. The selected classification and recognition method and recognition performance are directly related to it. Through computer vision technology to detect and recognize human motion characteristics, the key problem is how to reasonably describe human motion.

This paper analyzes the advantages of human motion sequence images and feature extraction, as shown in Figure 9.

As shown in Figure 9, the advantages of human motion sequence image and feature extraction mainly include saving time and cost and higher accuracy. The percentage of time saved is 66%-85%, and the percentage of cost saved is 65%-73%. When the human body is moving, the circular neural network automatically determines the position of joint points, which greatly shortens the time spent by the

operator on video analysis. It saves costs and can even avoid mistakes caused by operator fatigue and many other reasons.

4.2. Three Motion Analysis Methods. In this paper, five experts analyze, compare, and score the three known motion analysis methods, as shown in Table 2, Table 3, and Table 4.

As shown in Table 2, among the traditional motion analysis methods, the most original method is to manually determine the joint point in each frame and then calculate the motion biomechanical parameters such as the speed and motion trajectory of the point. The time interval required by the traditional motion analysis method is 65 min-78 min, the accuracy is 15%-21%, and the complexity is as high as 63%-69%. However, it is not only a waste of time to determine many points in the image sequence, but also the accuracy is very low, and the process is very complex.

As shown in Table 3, another advanced method is to put some marks on the parts of the human body of interest before movement and then use the template matching technology to detect these marks in each frame of the image for motion analysis. However, in some cases, placing the mark on the human body will lead to inflexible movement. Therefore, people always hope that the less restrictions and interference on motion and image analysis, the better.

As shown in Table 4, the third method is the image sequence analysis method proposed in this paper. The biggest feature of image sequence analysis is that the processing method of the first frame image is different from that of the subsequent frames. Because the characteristic information of the previous frame can be used in the processing of subsequent frames, the processing accuracy and speed are improved. One of the most important problems in image sequence processing is motion estimation, which is a powerful method to identify human joint points.

The biggest difference between motion capture for motion teaching and ordinary motion capture is that it has the function of motion comparison. That is, the system can compare the student's action with the coach's action, so as to give an evaluation of the student's action learning quality. At the same time, it should also point out the names of bone and joint points that students do not move in place in the process of learning movements. This paper compares the application trend of template matching technology detection method and image sequence analysis method, as shown in Figure 10:

As shown in Figure 10, image sequence analysis and feature extraction are developed for human motion recognition. It extracts and classifies the motion features of human moving targets and understands and explains their actions. Human motion feature analysis based on image sequence analysis and feature extraction has a wide application prospect in the fields of intelligent video surveillance, intelligent interface, and virtual reality.

5. Discussion

This paper analyzes how to study sports image sequence analysis and feature extraction based on cyclic neural network. This paper expounds the related concepts of image sequence analysis and feature extraction. This paper focuses on the theory of recurrent neural network and explores the methods of sports image sequence analysis and feature extraction. The influence of sports image sequence analysis and feature extraction on sports is discussed through experiments.

This paper also uses the cyclic neural network algorithm based on artificial neural network and sequential image analysis method. With the wide range of application of cyclic neural network algorithm and sequential image analysis method, the importance is becoming more and more prominent. Many scholars have begun to apply the cyclic neural network algorithm and sequence image analysis method to human motion recognition. The research and analysis of recurrent neural network algorithm and sequence image analysis method can not only promote the development of sports, but also improve the training efficiency of athletes. Through the experimental analysis, it can be seen that under the background of the prosperity of sports, people have higher and higher requirements for movements in sports. Therefore, this paper proposes a sequential image analysis and feature extraction algorithm based on cyclic neural network. Under these two algorithms, the images in sports are better recognized, so that the athletes' actions can be corrected and their training can be carried out normally.

6. Conclusion

With the development of sports in recent years, people pay more and more attention to sports. Sports posture errors in sports will lead to sports injuries and other consequences, so the rational use of technology to identify and analyze athletes' actions can effectively improve the accuracy of athletes' actions and reduce injuries. Therefore, this paper mainly analyzes and extracts the characteristics of sports image sequence based on cyclic neural network and introduces sports and image sequence in detail. In the method part, this paper first analyzes the artificial neural network, which leads to the cyclic network. Because the perception layer of circular network can predict the next action, it is very reasonable to choose this method for feature extraction of human image sequence in this paper. In the experimental part, this paper analyzes the problems existing in sports. This paper compares the traditional motion analysis method with the image sequence feature extraction method based on cyclic network. The results show that the accuracy and speed of image sequence feature extraction method based on cyclic network are higher than that of traditional motion analysis method. Therefore, based on the circular network, this paper analyzes and extracts the features of image sequences in sports, which is of great significance.

Data Availability

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Conflicts of Interest

I declare that I have no conflict of interest for publication of this paper.

References

[1] E. Brymer and R. D. Schweitzer, "Evoking the ineffable: the phenomenology of extreme sports," *Psychology of Consciousness: Theory, Research, and Practice*, vol. 4, no. 1, pp. 63–74, 2017.

[2] T. Fang and J. Sun, "Stability of complex-valued recurrent neural networks with time-delays," *IEEE Transactions on Neural Networks & Learning Systems*, vol. 25, no. 9, pp. 1709–1713, 2017.

[3] M. Segler, T. Kogej, C. Tyrchan, and M. P. Waller, "Generating focused molecule libraries for drug discovery with recurrent neural networks," *ACS Central Science*, vol. 4, no. 1, pp. 120–131, 2018.

[4] A. Rahman, V. Srikumar, and A. D. Smith, "Predicting electricity consumption for commercial and residential buildings using deep recurrent neural networks," *Applied Energy*, vol. 212, pp. 372–385, 2018.

[5] L. Guo, N. Li, F. Jia, Y. Lei, and J. Lin, "A recurrent neural network based health indicator for remaining useful life prediction of bearings," *Neurocomputing*, vol. 240, no. May31, pp. 98–109, 2017.

[6] S. Li, J. He, Y. Li, and M. U. Rafique, "Distributed recurrent neural networks for cooperative control of manipulators: a game-theoretic perspective," *IEEE Transactions on Neural Networks and Learning Systems*, vol. 28, no. 2, pp. 415–426, 2017.

[7] X. Le and J. Wang, "Robust pole assignment for synthesizing feedback control systems using recurrent neural networks," *IEEE Transactions on Neural Networks & Learning Systems*, vol. 25, no. 2, pp. 383–393, 2014.

[8] M. Xiao, W. X. Zheng, G. Jiang, and J. Cao, "Undamped oscillations generated by Hopf bifurcations in fractional-order recurrent neural networks with Caputo derivative," *IEEE Transactions on Neural Networks & Learning Systems*, vol. 26, no. 12, pp. 3201–3214, 2015.

[9] D. Ienco, R. Gaetano, C. Dupaquier, and P. Maurel, "Land cover classification via nulti-temporal spatial data by recurrent neural networks," *IEEE Geoscience and Remote Sensing Letters*, vol. 14, no. 10, pp. 1685–1689, 2017.

[10] D. D'Avino, D. Cozzolino, G. Poggi, and L. Verdoliva, "Autoencoder with recurrent neural networks for video forgery detection," *Electronic Imaging*, vol. 29, no. 7, pp. 92–99, 2017.

[11] S. Bing, Z. Zhen, B. Wang, and G. Wang, "Scene segmentation with DAG-recurrent neural networks," *IEEE Transactions on Pattern Analysis and Machine Intelligence*, vol. 40, no. 6, pp. 1480–1493, 2018.

[12] T. Le, G. Bui, and Y. Duan, "A multi-view recurrent neural network for 3D mesh segmentation," *Computers & Graphics*, vol. 66, pp. 103–112, 2017.

[13] A. K. Rout, P. K. Dash, R. Dash, and R. Bisoi, "Forecasting financial time series using a low complexity recurrent neural network and evolutionary learning approach," *Journal of King Saud University - Computer and Information Sciences*, vol. 29, no. 4, pp. 536–552, 2017.

[14] J. Xu, R. Rahmatizadeh, L. Bölöni, and D. Turgut, "Real-time prediction of taxi demand using recurrent neural networks," *IEEE Transactions on Intelligent Transportation Systems*, vol. 19, no. 8, pp. 2572–2581, 2018.

[15] S. Yang, Z. Guo, and J. Wang, "Global synchronization of multiple recurrent neural networks with time delays via impulsive interactions," *IEEE Transactions on Neural Networks & Learning Systems*, vol. 28, no. 7, pp. 1657–1667, 2017.

[16] M. J. Ellis, D. M. Cordingley, S. Vis, K. M. Reimer, J. Leiter, and K. Russell, "Clinical predictors of vestibulo-ocular dysfunction in pediatric sports-related concussion," *Journal of Neurosurgery. Pediatrics*, vol. 19, no. 1, pp. 38–45, 2017.

[17] S. Namdari, K. Baldwin, O. Anakwenze, M. J. Park, G. Russell Huffman, and B. J. Sennett, "Results and performance after microfracture in National Basketball Association Athletes," *The American Journal of Sports Medicine*, vol. 37, no. 5, pp. 943–948, 2017.

[18] D. Hilgers, W. Maennig, and M. Porsche, "The feel-good effect at mega sport events. Public and private management problems informed by the experiences of the FIFA world cup," *International Journal of Business Research*, vol. 10, no. 4, pp. 15–29, 2017.

[19] G. Kendall and L. Lenten, "When sports rules go awry," *European Journal of Operational Research*, vol. 257, no. 2, pp. 377–394, 2017.

[20] C. P. Kleweno, W. K. Bryant, A. M. Jacir, W. N. Levine, and C. S. Ahmad, "Discrepancies and rates of publication in orthopaedic sports medicine abstracts," *The American Journal of Sports Medicine*, vol. 36, no. 10, pp. 1875–1879, 2017.