Research Article

Volleyball Movement Object Detection and Behavior Recognition Method of Artificial Neural Network

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Movement object detection method is the basis and key of the modem intelligent video surveillance system. It combines advanced technologies in many fields, such as artificial intelligence, image processing, and pattern recognition, and is the research area of computer vision technology. Therefore, it is important to explore the motion detection and target recognition algorithms. The data collection method has concluded that $T > 60$ is absent from four different videos. The T value is traversed from 0–255 to select the largest T value as the split threshold. Through the analysis, the range of the threshold selection can be reduced to 0-60, thus improving the operational efficiency.

1. Introduction

More than 80% of people's information about the world comes from visual information. Vision is an indispensable part of intelligent or autonomous systems in manufacturing, inspection, medical diagnosis, military, and other application fields. Visual information is an important way for people to perceive the world. Computer vision is the technology of acquiring, processing, and analyzing visual image information by computer simulating human visual perception abilities. It emerged in the 1980s but has evolved greatly in recent decades, and it has developed new concepts, methods, and theories. It has been widely used in robotics, medical image analysis, aerospace, public safety, and many other fields.

Motion detection, as a subfield of image processing and computer vision, is essential in both the theory and practice of computer vision. Due to the limitation of computer hardware, one can often only process the area of interest in the image to ensure the real-time performance of the algorithm. For video image sequences, the areas of interest are generally motion target areas (such as pedestrians and cars). Therefore, the motion object detection algorithm is widely used, has become one of the difficulties and hot spots in the field of computer vision, and has attracted more attention from scholars from all over the world.

Rapid and accurate detection of mobile targets by computer video analysis, without human intervention, can further analyze and judge the next step of the target. When a dangerous situation occurs, it makes a fast and accurate judgment, so it is often used in the field of intelligent transportation, security, and other intelligent video processing. Movement object detection and recognition constitute the most basic and key part of the video surveillance system, and the detection effect will directly affect the subsequent processing. In reality, the monitoring scene is often complex and changeable: shadow, light transformation, local occlusion, target scale change, and so on bring great challenges to the detection and identification of moving targets. Researchers conducted in-depth research on the detection and recognition algorithms of motor targets and proposed improvements to the related algorithms. They proposed a new motion object detection and recognition method, which has good recognition performance in complex and changeable background conditions and meets the requirements of the real-time algorithm. And they

applied the algorithm in the video monitoring system of the tram track crossing to ensure the safe operation of the trams at the track crossing.

2. Related Work

This paper studies some techniques based on artificial neural network, volleyball moving target detection, and behavior recognition methods, which can be fully applied to the research in this field. Ko and Chen believed that the neural network manipulation system is obtained by fitting the data generated by the best manipulation simulation [1]. Goh considered a neural network to be an information processing system whose structure is basically a biological system that mimics the brain [2]. Zhao and Ding discussed the stochastic Cohen–Grossberg neural network with time delay, by constructing a suitable Lyapunov function and adopting the semimartingale convergence theorem to ensure the stability of the network [3]. Alanis and Alma presented the results of using the training algorithm for recurrent neural networks based on extended Kalman filtering [4]. Chen et al. proposed an adaptive neural network (NN) consensus control method for a class of nonlinear multiagent systems with state delay [5]. Jiang et al. proposed a novel unified framework that jointly exploits feature relations and category relations to improve classification performance. Specifically, these two types of relationships are estimated and exploited by imposing regularization during the learning process of deep neural networks (DNNs) [6]. Perna and Rocca proposed a strategy for choosing the size of hidden layers in a feed-forward neural network model, based on a comparison of the out-of-sample predictive capabilities of different models under a specific loss function [7]. Zhang et al. studied the delay-dependent stability of generalized continuous neural networks with time-varying delays. A new Lyapunov–Krasovskii function (LKF), which takes into account more information about the activation functions and delay upper bounds for delayed neural networks, was developed [8]. Ge et al. focused on the asymptotic stability of neural networks with time-varying delays and derived a new stability criterion by employing a new Lyapunov–Krasovskii function and integral inequality [9]. Liu et al. proposed a visual analysis method to better understand, diagnose, and refine deep neural networks [10]. Pimenta et al. investigated the incidence and risk factors of volleyball injuries among elite Brazilian volleyball players [11].

3. The Method of Volleyball Moving Target Detection and Behavior Recognition Based on Artificial Neural Network

3.1. Classification of Artificial Neural Networks.
The 1940s opened the era of modern neural network research. A psychologist and mathematician first proposed a simple network model called the MP model. The scientist is from Chicago, USA. The MP model is an abstract and simplified model constructed according to the structure and working principle of biological neurons. It is actually modeling of a single neuron. Although the network model he proposed is very simple and can only perform simple operations, it has pioneering significance in neural network research and has laid a foundation for further research.

Artificial neural network is an algorithmic mathematical model that imitates the behavioral characteristics of animal neural networks and performs distributed parallel information processing. The distributed processing structure of neural networks and their ability to learn and generalize enable them to solve complex problems that are currently difficult to grasp. In summary, the neural network has the following characteristics: 1. Nonlinearity: the neural network is composed of a large number of nonlinear neurons, which has inherent nonlinear characteristics, and can solve very complex and highly nonlinear pattern recognition problems on the boundary of the segmented image space. 2. Parallelism: each unit of the network is an independent computing unit, and all its calculations can be carried out independently, while large-scale interconnected complex neural networks are calculated in parallel. 3. Self-organization and self-learning: the neural network is similar to the human brain and has a learning function, and its knowledge acquisition work is much simpler than the current traditional artificial intelligence method. 4. Fault tolerance: in the neural network system, each weighting factor stores different information or knowledge; that is, the information or knowledge is stored in the neural network in a distributed manner [12].

Neural networks have different classifications, and biological nervous systems with different levels of simulation and abstraction are represented by them from different perspectives. Therefore, artificial neural networks can also be classified from different angles, such as the following: 1. Classification into connected networks and decentralized networks, deterministic networks, and arbitrary networks is based on network performance. 2. They are classified into networks without teaching and networks with teaching, based on the perspective of reading. 3. They can be classified into higher-order nonlinear correlation networks and first-order linear correlation networks, based on the properties of adjacent synapses. 4. According to the structure of the network, they can be further divided into recurrent networks, neural network, and neural networks of arbitrary structure, as shown in Figure 1.

In the forward neural network, in the process of calculating the output value, the input value propagates forward layer by layer from the input layer unit and finally reaches the output layer through the hidden layer to obtain the output. Forward neural networks are usually used in the field of simulation and function approximation. Commonly used networks are wavelet network, RBF (radial basis function) network, GRNN (generalized regression neural network), MLP (multilayer perceptron) network, BP network, etc. The recurrent network is mainly used to solve optimization problems, and its representative is the Hopfield network [13].

3.2. The Method of Volleyball.
Volleyball is one of the ball sports. The court is rectangular with a high net in the middle. Both sides of the game (six players per side) occupy one side of the court. The players hit the ball into the net with their
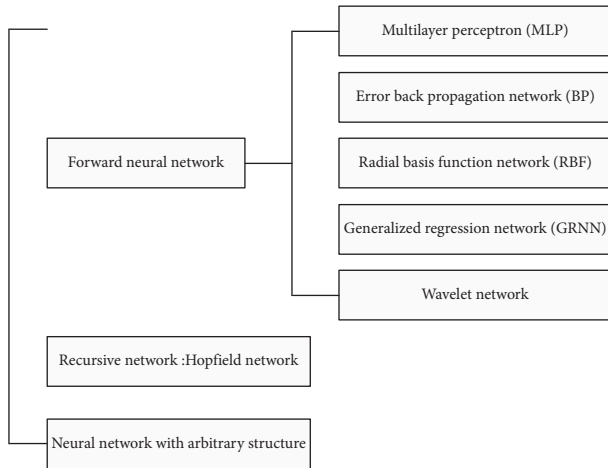
FIGURE 1: Classification of classical neural networks.

hands. Since its inception, volleyball has shown strong vitality because of its unique competition rules and sports characteristics. Since its introduction into China in 1905, it has been well promoted and developed and has made significant contributions to the development of Chinese sports. Volleyball has won a total of nine world championships for China. Volleyball has not only brought golden trophies to the Chinese people, but also inspired the tenacious fighting spirit of generations of Chinese people. On the other hand, the development of Chinese volleyball has also promoted the development of its own techniques and tactics, such as "back flying," "fast ball," "floating ball," and other technologies invented in China, which enriches the technical and tactical content of sports and creates a flexible and changeable play system. Volleyball now has a large influence all over the world, and various international and commercial events continue to emerge. The big reason for this is that the constant revision of competition rules has adapted to the development needs of sports in different periods, and some forward-looking competition rules have been revised to provide directional guidance for the development of sports. The research methods for volleyball are as follows.

Literature Data Methods. According to the research content of this article, we searched and read the materials related to volleyball in the university library, CNKI, VIP Information Network, and Wanfang Paper Database [14].

Mathematical Statistics. An in-depth analysis of the evolution of volleyball rules was carried out with and a clear understanding of the changes at each stage. It also explains how changes to the rules of volleyball have had a large impact on the technical and tactical aspects of the sports and on the development of volleyball.

Logic Comparative Analysis Method. By sorting out the collected volleyball competition rule data, the changes of volleyball competition rules and the specific situation of sports development in each period are classified and summarized. The collected documents of volleyball competition rules and sports development in various periods are logically compared and analyzed by methods such as induction, classification, comparison, and deduction.

3.3. Methods of Target Detection and Behavior Recognition.
Segmenting and extracting useful information such as continuously moving objects or colors, contours, and shapes from continuous video sequences are moving target detection. The flowchart of moving target detection is shown in Figure 2.

Moving object extraction is a simple image segmentation. Image segmentation is the technology and process of dividing an image into several specific areas with unique attributes and proposing interesting objects. It is a key step from image processing to image analysis. The motion of objects can only be represented in a continuous stream of images, such as video streaming. Moving object extraction is also a process of difference detection, which mainly includes finding and extracting the differences due to the motion of objects [15].

Inter-frame Difference Method. The most commonly used moving object detection and segmentation method is to use the temporal dependence of the image sequence to detect moving objects according to the changes between the images. This method works well for the detection of small changes in the background.

Background Difference Method. It is a method to detect moving objects by comparing the current frame in an image sequence with a background reference model, and its performance depends on the background modeling technique used. After the image is collected by the camera device, the image is preprocessed by converting the dynamic image sequence, and finally the foreground target is extracted by background modeling. The background difference method process is shown in Figure 3.

The background difference method is simple and easy to implement, and it has the advantage of fast operation speed. In most scenes, the detection results are relatively complete and the outline is clear, so it has become the most popular and widely applicable moving target detection algorithm. However, this algorithm requires the camera to be stationary when detecting moving objects, and there are differences in the gray levels of foreground and background pixels. In addition, the detection results of this method are prone to noise and cannot cope well with scene changes, resulting in inaccurate detection results. Based on such problems, scholars in various countries have done a lot of research to improve the accuracy of algorithm detection results, such as mixed Gaussian model method and single Gaussian model method, nonparametric model method, and Kalman filter and Wiener filter based on prediction method. However, the most widely used and the best effect is the Gaussian model [16].

Mixture Gaussian Background Modeling Method. It uses sampling statistics to represent the background, and the effect is better in the background modeling algorithm. The
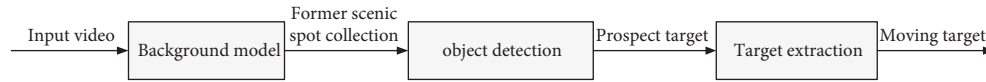
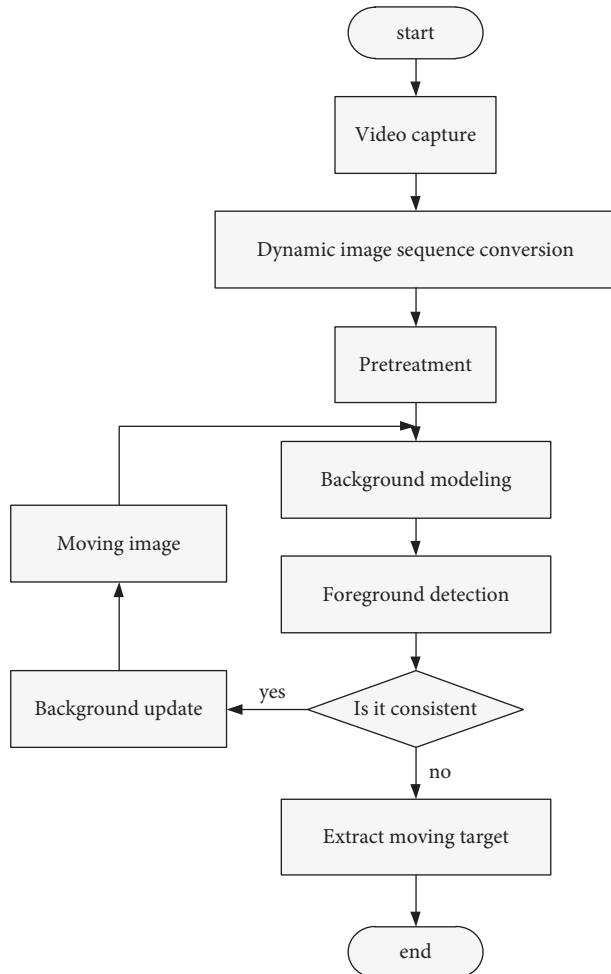FIGURE 2: Flowchart of moving target detection.

FIGURE 3: Background difference method.

moving object is also highlighted by subtracting the current image from the background image. Therefore, many scholars believe that the mixed Gaussian background modeling method is also a kind of background subtraction.

Event recording and analysis, that is, capturing events of interest and analyzing or understanding the behavior of objects, constitute one of the most important areas of third-generation video surveillance systems. Because of the simplicity of the analysis method, the ability to systematically analyze accidents at present is also very limited. Behavioral understanding includes the analysis and recognition of movement patterns (people or vehicles) and provides high-quality descriptions of target behaviors and interactions. It can be simply viewed as a problem of classifying time-varying features by comparing an unknown measurable sequence to a reference set of labeled sequences of typical behavioral targets. The basic principle of intelligent video surveillance is shown in Figure 4.

Motion detection and tracking are two basic technologies of intelligent video surveillance systems. Motion detection is the process of detecting changes in the position of an object relative to its surroundings, or changes in its surroundings relative to it. Motion detection and tracking form the basis for subsequent advanced processing and analysis applications, such as semantic indexing, event retrieval, action analysis, behavior detection, intelligent alarming, and compressed video formation coding, which are important for the use of automated and real-time video surveillance technologies [17].

"Background Subtraction" for Moving Object Detection. Despite the noise, the scene background is more stable and less volatile than the changing shape of moving objects in the real scene. The technical principle of "subtracting the background" is shown in Figure 5.

The "background subtraction" technology is a widely used method in the current moving target detection technology. While the principle behind background reduction is simple, the way in which the background model is created and updated is essential because it has a direct impact on the ability of the background model to adapt to changes in lighting, background disturbances, etc. Illumination changes include continuous illumination changes (usually outdoors) and sudden illumination changes (such as lights turning on and off indoors, or clouds on a sunny day outdoors), while background disturbances include global background disturbances (for example, when the camera is slightly shaken by the wind blowing outdoors) and local background disturbances (such as tree trunks, leaves, and their shadows, or when outdoor puddles are blown by the wind), which are the main factors that change the background pattern [18].

4. Experiment of Volleyball Moving Target Detection and Behavior Recognition

4.1. Experimental Study Results of Volleyball. Volleyball is a recreational game designed for adults to train. Initially, there were no technical content and no uniform rules of competition. With the improvement of volleyball's technical and tactical level and the increasingly obvious tendency of competition, some countries have established volleyball associations and officially announced the general rules of volleyball competition. The evolution of volleyball court area and number of people is shown in Table 1.

It can be seen from Table 1 that the size of the volleyball court depends on the responsibilities of the players on the court. The larger the court, the greater the responsibility of each player. A properly sized court makes offense and defense easier. Typically, the relative length changes more than the width. After years of research, the results show that the
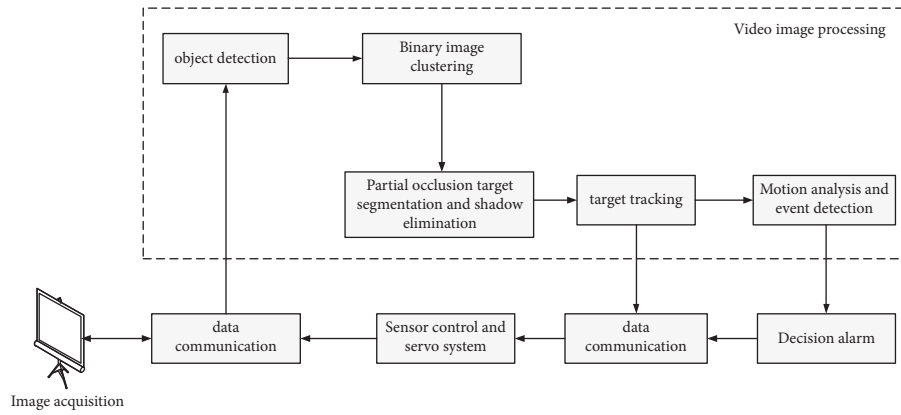
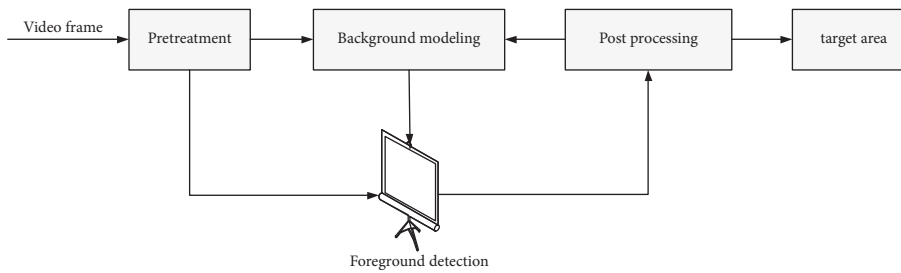FIGURE 4: Basic principles of intelligent video surveillance.

FIGURE 5: The principle of "background subtraction" technology.

TABLE 1: The evolution of volleyball court area and number of people.

Particular year	1896	1897	1912	1913	1917	1918	1922	1923	1950–present
Number of participants	Arbitrarily	Arbitrarily	9	16	9	6	6	6	6
Site area	7.62 * 15.24	7.63 * 15	10.76 * 18.3	12.192 * 24.3	11 * 22	9 * 18	18.29 * 9.14	18.2 * 9.1	9 * 18

current field size of 18×9 meters is suitable, which is also more conducive to the level of players and the distribution of attention [19]. The evolution characteristics of volleyball nets are shown in Table 2.

As can be seen from Table 2, with the increasing popularity of volleyball, the net height, especially for male players, is also increasing. Therefore, the old volleyball net does not meet the height requirement. The height of the net is too low, so the ball is more likely to be smashed, which is not conducive to the defense of the volleyball player during the game, nor does it reflect the actual level of the volleyball player. Now, men's and women's volleyball nets have reasonable heights to accommodate human physiology and promote offensive and defensive balance. The evolution characteristics of barrier-free areas are shown in Table 3.

In addition to the volleyball court, another important area is accessibility, which is an area of space that includes the area around the court and the area above the court. Table 3 clearly shows the evolution history of the barrier-free zone and its site size. On the whole, the unobstructed area will become larger and larger, which enables players to fully develop their potential in attack and defense, and can ensure the full play of

techniques such as strong jumping and receiving [20]. The establishment of the sign pole and the distance between the sign poles at both ends are shown in Figure 6.

The sign poles are two flexible poles, 1.80 meters long and 1 centimeter in diameter, made of fiberglass or similar materials. The two marker rods are, respectively, arranged on different sides of the net along the outer edge of the marker band. It can be seen from Figure 6 that there were no sign poles in the early competition venues, and the sign poles did not appear until 1968, when the distance between the two sign poles was 9.40 meters. After practical application, in 1976 and 1979, the width between the two ends was fixed after the pole was moved inward twice by 20 cm, and the width between the two poles is still 9 meters. Signposts are set up to limit offense. Through the two inward shifts of the sign bars at both ends, we can see some ideas for the revision of the rules of volleyball competition, that is, to make up for the weak defensive strength by restricting and narrowing the scope of the attack, to maintain the relative balance of the offensive and defensive forces, to make the volleyball game develop healthily. The number of volleyball serves and attempts are shown in Figure 7.

TABLE 2: Evolution characteristics of volleyball nets.

Category	1896	1900	1912	1917	1918	1924	1950	1954–present
Net height (male)	1.94	2.14	2.31	2.41	2.44	2.44	2.44	2.44
Net height (female)		2.11	2.11	2.11	2.11	2.31	2.24	2.25

TABLE 3: Characteristics of evolution of barrier-free areas.

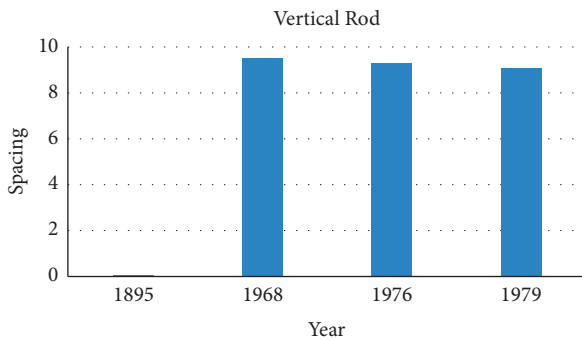| Year	1896	1955 (m)	1956 (m)	1980 (m)	1994 (m)	1995–present (m)
Height from the ground	Arbitrarily	6	8	13.5	13.5	13.5
Length from end line	Arbitrarily	4	4	9	10	10
Distance from edge line	Arbitrarily	4	4	6	7	10

FIGURE 6: The establishment of the signpost and the distance between the signposts at both ends.

From Figure 7, from 1900 to 1998, serving attempts were allowed, which had two benefits for the serving side: (1) The serving side can use the serving to try to fake the opponent to disrupt its defensive rhythm. (2) If the server throws the ball into the air, seeing that the height of the throw may lead to a failure of the serve, he/she can catch the ball and serve again. However, this did not please the receiving team and caused a delay in the game. It was not until 2000 that serve attempts were banned, and with the introduction of the point-per-ball rule, the serving technique became more important. Therefore, players and coaches pay more attention to the practice of serving skills. After all, the serve is the start of the offense, a strong or difficult serve can destroy an opponent's first pass or direct score, and a good or bad serving technique affects the outcome of the game.

4.2. Experiments on Moving Target Detection and Behavior Recognition. The key of the background difference method in moving target detection is whether it can accurately model the complex background. A reliable and effective background model is directly related to the final result of detection and monitoring. However, in real-world scenes, weather, lighting, and clutter can cause changes in the scene background, which can make background modeling very difficult. Although there is no background modeling algorithm that can model any scene accurately and effectively, thanks to the rapid development of mathematics, computer vision, biomedicine, and other related disciplines, the background difference algorithm has also made rapid

progress in recent decades, and the algorithm has been improved day by day.

The current background difference method can be mainly divided into the following categories according to the difference of the background model:

(1) Parametric and nonparametric modeling. Before establishing the parametric background model, it is first necessary to assume the pixel distribution model of the background; afterwards, these parameters are initialized in the process of establishing the background model, and the parameters are updated with the new input image in the process of updating the background model.

(2) Iterative and non-iterative modeling. Non-iterative methods need to store video images over a period of time to build and update the background model. The simplest non-iterative background model is the median filtered background model. The basic principle of median filtering is to replace the value of a point in a digital image or digital sequence with the median value of each point value in a neighborhood of the point, so that the surrounding pixel values are close to the true value, thereby eliminating isolated noise points.

(3) Pixel-level and region-level modeling methods. Most of the current background modeling methods are based on pixel-level background models; that is, each pixel is regarded as independent. The advantage is that the method is simple and easy to implement, but it ignores the connection between pixels and is prone to noise and holes.

Fixed background motion detection algorithms assume that the background does not change for a long period of time, and the range of motion is determined on this basis. However, in fact, even in the indoor environment, there are interferences caused by various changes such as light, so the method of fixing the background has great limitations. The choice of the adaptive threshold can be improved by experimenting with different videos, observing the value of the putative adaptive threshold T, and building a histogram of the region where it is located. The histograms of different video sequence adaptive thresholds T are shown in Figures 8 and 9.
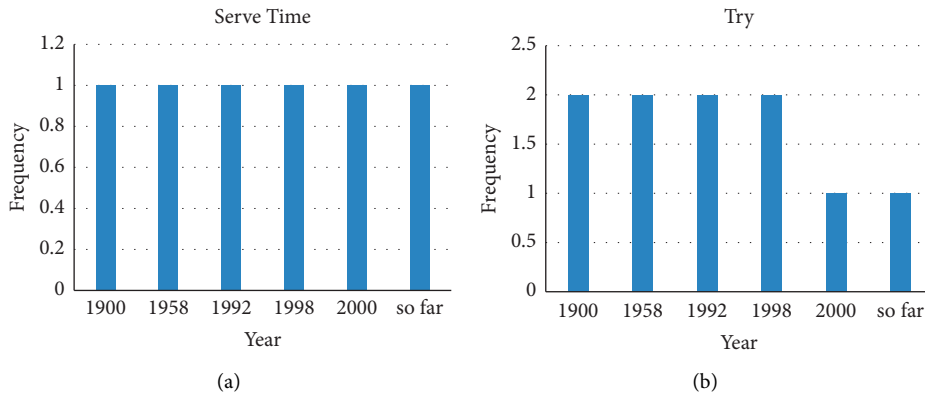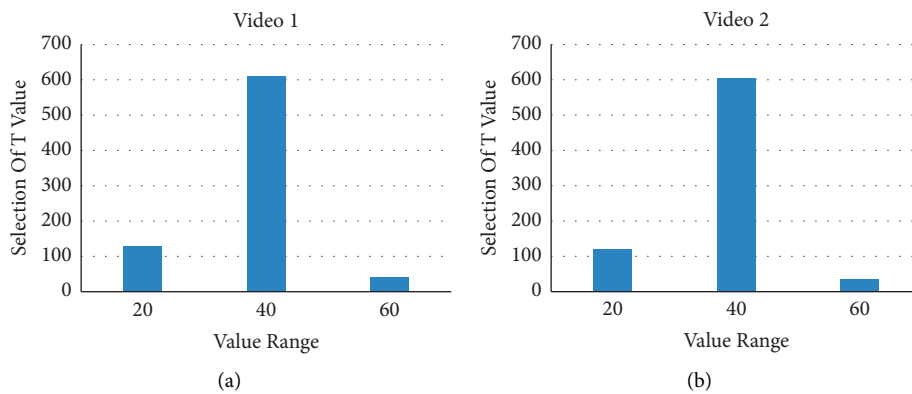
FIGURE 7: Volleyball serves and attempts.

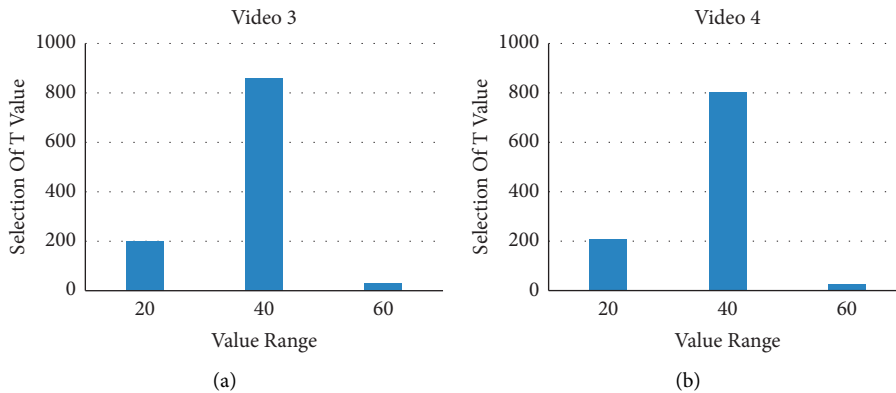FIGURE 8: Histogram 1 of adaptive threshold T for different video sequences.

FIGURE 9: Histogram 2 of adaptive threshold T for different video sequences.

The histograms of the adaptive threshold T for four different video sequences show that the value of T is in the range (0, 60); i.e., there is no case of $T > 60$. Based on the analysis of the T values of a large number of video sequences, the maximum interclass difference method algorithm selects the T value in the range of 0 to 255 and thus selects the highest value as the segmentation threshold. Through the above analysis, the selection range of the threshold can be narrowed to 0-60, thereby improving the efficiency of the operation.

5. Volleyball Moving Target Detection and Behavior Recognition Based on Artificial Neural Network

5.1. Algorithm of Artificial Neural Network. One of the most important reasons that affect neural networks is the activation function of the neuron that represents its properties. The transformation functions applied to neurons in the BP algorithm have to be read everywhere. Sigmoid functions are commonly used, including tan-sigmoid and log-sigmoid

functions. Different types of neural networks have different activation functions. The following are commonly used activation functions in BP networks:

(1) A linear function with a very wide range of output values is usually used to approximate the activation function of the output layer of a neural network.

(2) S-shaped function is a kind of characteristic function of S-shaped curve with high gain in the middle, low gain at both ends, which is suitable for processing small and large signals. It corresponds to the excitation mechanism of biological neurons, so it is widely used in BP networks.

Which conversion function is used depends on the relationship between the input and output. When the output value does not contain negative values, the log-sigmoid function is used, and when the output value contains negative values, the tan-sigmoid function is used. The log-sigmoid function and tan-sigmoid function expressions are as follows:

$$f(x) = \frac{1}{1 + a^{-x}} f(x) \in (0, 1),$$
$$f(x) = \frac{a^x - a^{-x}}{a^x + a^{-x}}, f(x) \in (-1, 1). \tag{1}$$

(3) The Gaussian function is also widely used in neural networks because it can naturally reduce the input space and improve the convergence speed of the gradient waste method. The expression of the Gaussian function is as follows:

$$f(x) = a^{(x-c)^2/2\sigma^2}. \tag{2}$$

The two function parameters are c and σ, which are often in standard form in applications, as shown in the following formula:

$$f(x) = a^{-x^2}. \tag{3}$$

(4) The above equation uses a periodic function, where f(x) has the differentiable and continuous characteristic

$$f(x) = f(x) \cdot [1 - f(x)]. \tag{4}$$

The perceptron is a single-cell neural network processor based on the MP model, which has the basic properties of neurons. The mathematical model can be summarized as follows:

(1) The operating system of the perceptron is a single-output, multi-input system. Its operating characteristics represent a neuron, and the equation of its input state vector is as follows:

$$a^n = (a_1, a_2, ..., a_n), \tag{5}$$

where each input component a_i is the state of the i-th neuron, denoted as follows:

$$b^n = (b_1, b_2, ..., b_n), \tag{6}$$

where b^n is the weight vector, where b_i is the link weight coefficient between the i-th neuron and the perceptron.

(2) The output data of the perceptron is equivalent to the state data of the perceptron. The vector a^n represents the state of its input, which is determined by the threshold represented by h and the weight vector represented by b^n. Therefore, it can be expressed as follows:

$$z = T(b^n, h, a^n). \tag{7}$$

The operation function is represented by $T(\cdot)$. The perception function of the first layer, which is easier to see, can be expressed as follows:

$$z = f\left(\sum_{i=1}^{n} b_i a_i - h\right). \tag{8}$$

In the single increasing function of the above formula, $f(u)$ is used as the excitation function that is bounded between -1 and $+1$. And we get the following formula:

$$u = u(a^n, b^n, h) = \sum_{i=1}^{n} b_i a_i - h, \tag{9}$$

where u is the integration function of the perceptron.

5.2. Target Detection and Behavior Recognition Algorithms.
A 3D scene model can be seen as a mathematical model. 3D models are usually created using specialized software, such as 3D modeling tools, but can also be created using other methods. A 3D model in a Cartesian coordinate system was used in the study. Since the shape of stereoscopic objects is considered constant over time, the structure of 3D objects in a scene is stereoscopic. And it can be represented as a combination of the relative positions of groups of 3D points that remain constant in time, representing part of the plane, the invisible plane, or the outer surface of the object. A 3D coordinate vector and its transformation are used to resolve the motion and position of each densely packed object.

The simulation model of the table injection transformation can represent the three-dimensional position of the rigid body, which can only be realized on the basis of the Cartesian coordinate system. Its expression is as follows:

$$N' = RN + T, \tag{10}$$

where N and N' are based on coordinates representing the center of rotation of a fixed point relative to T and T', and

$$N = \begin{bmatrix} n \\ m \\ z \end{bmatrix}, N\prime = \begin{bmatrix} n' \\ m' \\ z' \end{bmatrix}. \tag{11}$$

The three-dimensional transformation vector is represented by T, and the 3 * 3 rotation matrix is represented by R; namely,

$$R = \begin{bmatrix} 1 & -\Delta\theta_n & \Delta\theta_m \\ \Delta\theta_n & 1 & -\Delta\theta_z \\ -\Delta\theta_m & \Delta\theta_z & 1 \end{bmatrix}. \tag{12}$$

The projection forms a mapping table from four-dimensional space to three-dimensional space because a two-dimensional projection of the three-dimensional space scene evolves when the camera is acquired. This is a video imaging system, and its mapping table can be expressed as the following equation:

$$f : R^4 - > R^3, \\ (n, m, z, t) - > (n_1, n_2, t), \tag{13}$$

where (n, m, z, t) are the three-dimensional global coordinates, (n_1, n_2) is the coordinates of the projected two-dimensional image plane, and t is a continuous time variable. The formula of the model parameters is repeatedly calculated, and then the parameters are solved, so that the parameters can be applied to the image for global motion compensation.

Kalman filtering is a recursive method for solving the linear filtering problem of discrete data. Kalman filtering uses a set of formulas to estimate the covariance correction and reduces the covariance estimation error. The discrete process of $m \in R^y$ in the state variable is estimated based on the Kalman filter. The motion of the system is described by the following differential equations:

$$m_k = Am_{k-1} + Bu_{k-1} + \omega_{k-1}. \tag{14}$$

We define observation variable $z \in \Re^x$, and the system observation equation is as follows:

$$z_k = Hm_k + v_k. \tag{15}$$

Among them, m_k and m_{k-1} are the system state vectors at time k and time $k-1$, respectively; A is called the state transition matrix; and B is called the control matrix, which is also assumed to be a constant. Random signals v_k and ω_k represent process excitation noise and observation noise. Assuming that they are independent of each other, the normally distributed white noise distribution is as follows:

$$p(\omega) - Y(0, Q), \\ p(v) - Y(0, R). \tag{16}$$

In a real system, the observation noise represented by the covariance matrix R and the process noise represented by the covariance matrix Q may change during the iterative calculation process.

The observation refresh equation and the time refresh equation constitute the Kalman filter. The measurement update equation in one of these two parts is responsible for feedback, that is, combining previous estimates with new measurements to achieve improved subsequent estimates. The time update equation is responsible for deriving the values of the current state variable and the estimation error variable to obtain a previous estimate of the next state. The error correction equations can also be considered as measurement update equations, and the prediction equations can also be considered as time update equations. The final estimation algorithm becomes prediction: an improved algorithm with a numerical solution.

6. Conclusions

In today's society, the importance of volleyball is no longer limited to sports and play but is increasingly integrated into people's daily life and social sports culture. The continuous development and changes of society will inevitably lead to changes in people's cultural and psychological concepts and needs in the field of sports, and increasingly people play volleyball. They are no longer willing to sit in the stands as spectators but prefer to play volleyball by themselves, experience the joy of volleyball, and move their bodies. They also hope to be inspired by volleyball in sports through the social and cultural value of volleyball, experience the social and cultural significance of volleyball, and realize themselves. Volleyball culture has important social values that can fulfill their cultural goals. The research on the method of volleyball moving target detection and behavior recognition by artificial neural network is also of great significance for promoting the current scientific development.

Data Availability

Data sharing is not applicable to this article as no datasets were generated or analyzed during the current study.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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