Hindawi
Scientific Programming
Volume 2022, Article ID 9330798, 10 pages
https://doi.org/10.1155/2022/9330798

Research Article

A Football Shot Action Recognition Method Based on Deep Learning Algorithm

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Received 24 January 2022; Revised 26 February 2022; Accepted 3 March 2022; Published 25 March 2022

Academic Editor: Punit Gupta

Football is regarded as the world's number one sport and is loved by all countries, and large-scale football matches are held basically every year. The key to football matches is to shoot goals, and how to improve the accuracy of football shooting requires the identification and analysis of football shooting actions. Deep learning enables machines to imitate human activities such as seeing, hearing, and thinking. It solves many complex pattern recognition problems. Especially, the deep learning algorithm is unique in the recognition of pictures with high accuracy, and it provides technical support for the recognition and analysis of football shooting actions. What this paper will discuss is the recognition method of football shooting action based on a deep learning algorithm. Experiments show that the football shooting action recognition method developed in this paper has a great effect on promoting the accuracy of football shooting, which can make the accuracy rate reach about 96%. The research in this paper has great reference value and practical significance for the team's ability to shoot and grasp the opportunity to score.

1. Introduction

There are many sports, but the most popular one is football. Every football match needs to be scored by scoring, and the one with the most points wins. Hence, how to improve the accuracy of shooting in ordinary football training is of top priority. At present, in football teaching in colleges and universities, the training of football shooting action is one of the extremely important courses [1]. However, there are still a lot of problems in the training of football shooting. For example, in the training process, the coach observes the player's shooting movements with the naked eye. The movements are basically standardized, and there is no requirement for excellence. In addition, the shooting movements in training are not standardized. The coach only pursues a one-sided shooting rate rather than seeing whether the shooting movements of the players are accurate and standardized. Therefore, the current football shooting training requires more advanced technology to identify the player's shooting technique and correct it to make it more standardized.

The research in this paper has great comparative significance for improving the shooting action of football shooting training. In the process of shooting training, athletes can use high-definition cameras to record the whole process and use deep learning algorithms to analyze and check whether the movements are standardized to slowly correct the shooting movements and improve the accuracy of football shooting [2]. Introducing deep learning to the recognition of football shots can facilitate the formation of a high-quality team. At the same time, deep learning can identify the shooting action, which can analyze the rules and methods of scoring goals. It greatly promotes the improvement of football training methods and improves the accuracy of football shooting. The identified standard data can be introduced into the football robot's system so that the intelligent robot can train with the players and guide the players' training.

To rectify the current problems in football shooting training, improve the accuracy of football shooting, and cultivate a high-tech football team, the research on football shooting action at home and abroad has never stopped. Among them, Yang proposed a motion recognition method based on random projection for the problem of the speed and accuracy of human action recognition being difficult to balance. The experimental results show that this algorithm significantly improves the recognition rate of multicategory actions and effectively reduces the computational complexity and running time of the recognition algorithm [3]. Kamble et al. proposed a new deep learning method for 2D ball detection and tracking (DLBT) in football videos. Unlike most published algorithms, DLBT does not require human intervention to identify the ball from the initial frame. Compared to other contemporary 2D trackers, DLBT produces exceptionally accurate and robust tracking results [4]. The improved neural network proposed by Long is used to extract the video of players in football games, and the algorithm can be used to distinguish the trajectories of players. The experimental results show that the algorithm has a good application effect in the football field, the accuracy rate is more than 90%, and it is better than the traditional convolutional neural network [5]. Seki et al. proposed a real-time object detection system for humanoid football robots. They used YOLO, a deep learning-based object detector, and trained it to detect soccer balls and goalposts from images [6]. He proposed a text classification algorithm based on machine learning and constructed an effective sports injury prediction model that can accurately predict athletes' injuries and reduce athletes' injuries during training. Experimental results show that this model can ultimately prevent injuries, improve training levels, and reduce rehabilitation costs [7]. Bergkamp et al. proposed that football talent identification research include the prediction of football elite performance and discussed the advantages and limitations of the design, validity, and practicality of current football talent identification research [8]. Although their research has a certain role in promoting changes in the way of football training, there is no specific research on how to promote the standardization of football shooting actions. Some studies lack the support of theory and data, and there is little mention of how to promote team training. Moreover, there is no specific mention of the recognition of football shooting actions, and there is no feasibility study for each decomposition action of football shooting.

The research in this paper has the following innovations: (1) the article uses deep learning to identify and analyze the football shooting action, and then, according to the recorded action images and data, it can effectively correct the player's shooting action to make the player's action more standardized. (2) The article imagines an intelligent sparring robot by the recognition of the shooting action using a deep learning algorithm and hoping to improve the training efficiency of the players. At the same time, the intelligent sparring robot identifies and analyzes the physical fitness and strength of the players and makes reasonable training arrangements based on these data to promote the physical fitness and strength training of the players. (3) The article, by the decomposition of football shooting actions, understands the inherent skills of football shooting to improve the accuracy of shooting and the pertinence of training.

2. Football Shooting Action Recognition Method

2.1. Image Recognition with Deep Learning Algorithms. In recent years, with the rise of deep learning and other related technologies, deep neural networks have made breakthroughs in various fields, such as human action recognition [9]. Deep learning is an umbrella term for a pattern analysis method. Deep learning algorithms include neural networks, backpropagation, feedforward neural networks, convolutional neural networks, recurrent neural networks, recurrent neural networks, autoencoders, deep belief networks, and the first Boltzmann machines and generative adversarial networks [10]. What this paper needs is a feedforward neural network and a convolutional neural network suitable for image recognition and video recognition. The basic structure of the feedforward neural network and convolutional neural network is shown in Figure 1.

The use of a feedforward neural network for the recognition of football shooting movements can make the decomposition of football shots more detailed and data-based [11]. It not only needs to identify the algorithm but also needs to store the picture or video into the picture recognition model based on the feedforward neural network. The image will be input in the form of data in the incoming model system. When N images are input, the length of the image is x, the width is y, and the pixel of the image is r. Then, the image is converted into the amount of data Q in the input. The algorithm is as follows:

$$\begin{aligned} G &= x * y, \\ O &= \frac{(G * J)}{8}. \end{aligned} \tag{1}$$

In the formula, firstly, while calculating the resolution G of the picture, J represents the bit depth of the picture, /8 calculates the number of bytes of the picture, and O represents the size of the picture. As the pixels and resolutions of each image are different, the amount of data converted by the image is also different when stored in the feedforward neural network.

$$\begin{aligned} Q_1 &= r_1 * G_1 * O_1 * \int_u i, \\ Q_2 &= r_2 * G_2 * O_2 * \int_u i, \\ &\cdots \\ Q_n &= r_n * G_n * O_n * \int_u i. \end{aligned} \tag{2}$$

Among them, i is the weight in the feedforward neural network, and u is the threshold in the strong deficit neural network. The formula for calculating the amount of data stored in the system after the image is converted into data is as follows:

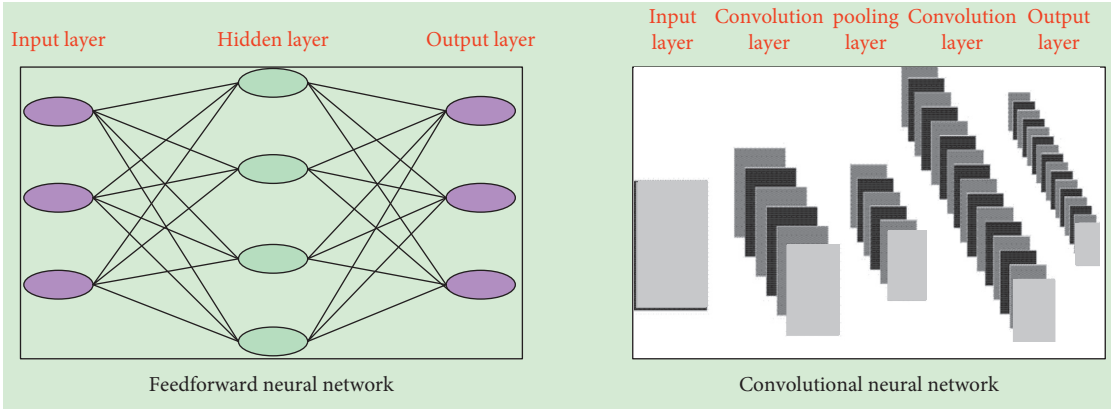

Figure 1: Basic structure.

$$Q = \int_u i * (Q_1 + Q_2 + \cdots + Q_n). \tag{3}$$

After inputting the image into the feedforward neural network model system, the image will be recognized, as shown in the image recognition process shown in Figure 2.

In Figure 2, the green point refers to the action of the athlete shooting, which is also the picture that the feedforward neural network needs to identify. The green points represent the pixels that need to be identified, and the specific identification process is shown in Figure 3.

In Figure 3, the circle represents the pixel point, the data of the input layer will be analyzed in the hidden layer, and the hidden layer will be analyzed in the area that needs to be analyzed in the image. Then, the output layer will output a series of accurate data of the required analysis area and aggregate it into a picture with specific and accurate data for reference. Then, the data volume Y from the input layer to the hidden layer is calculated as follows:

$$\begin{aligned}
Y_1 &= l * \sum_i w_1 * u^2, \\
Y_2 &= Y_1 * l + \sum_i w_2 * u^2, \\
Y_3 &= (Y_1 + Y_2) * l + \sum_i w_3 * u^2, \\
Y_4 &= (Y_1 + Y_2 + Y_3) * l + \sum_i w_3 * u^2, \\
&\cdots \\
Y_n &= \left(Y_1 + Y_2 + \cdots + Y_{(n-1)}\right) * l + \sum_i w_{(n-1)} * u^2.
\end{aligned} \tag{4}$$

Then, the amount of data of the remaining pixels in the input layer can be deduced by analogy. The sum of the data input to the hidden layer can be obtained, and the sum of the data Y of l can be obtained as follows:

$$Y_l = \frac{(Y_1 + Y_2 + \cdots + Y_n)}{n} * l + \sum_i w_n * u^2. \tag{5}$$

In the hidden layer, it can be seen that the green circle represents the size of the area that needs to be filtered by the feedforward neural network.

$$\begin{bmatrix} x_1 & x_3 \\ x_2 & x_4 \end{bmatrix}. \tag{6}$$

Then, the calculation method of the data amount A of the area to be identified in the hidden layer is as follows:

$$A = \frac{1}{2} * (Y_l + Y_b + Y_e + Y_x) * \varphi * u^2. \tag{7}$$

Among them, φ is a matrix in the hidden layer, and its form is as follows:

$$\varphi = \begin{bmatrix} x_1 & i_2 & x_3 \\ x_2 & i_3 & x_4 \end{bmatrix}. \tag{8}$$

Then, the data volume F of the output layer is as follows:

$$\begin{aligned}
F_{x_3} &= \frac{1}{2} A * (u_1 + u_2) * i, \\
F_{x_4} &= \frac{1}{2} A * (u_3 + u_4) * i.
\end{aligned} \tag{9}$$

Then, the formula for getting F is as follows:

$$F = \left(F_{x_3} + F_{x_4}\right) * i * u * \varphi. \tag{10}$$

In this way, when the whole picture is recognized by the feedforward neural network, the output picture will see the detailed data of the player's shooting action. Then, compared with the standard shooting action left, this action is corrected to improve the player's training efficiency. The deep learning algorithm has high accuracy for image recognition, and it is widely used in the recognition of human actions. The use of deep learning algorithms to identify the decomposition of football shots will greatly facilitate the daily training of players.

2.2. Football Shooting Action and Problems in Training. Shooting is a technical term in football, and in football games, the standard shooting action can improve the probability of entering the goal to score higher and win the game. There are a total of 26 shooting actions in football [12]. One is shooting with the instep, in which the instep shot also includes a positive instep volley, a volley from the inside of the instep, and a rubbing shot, as shown in Figure 4.

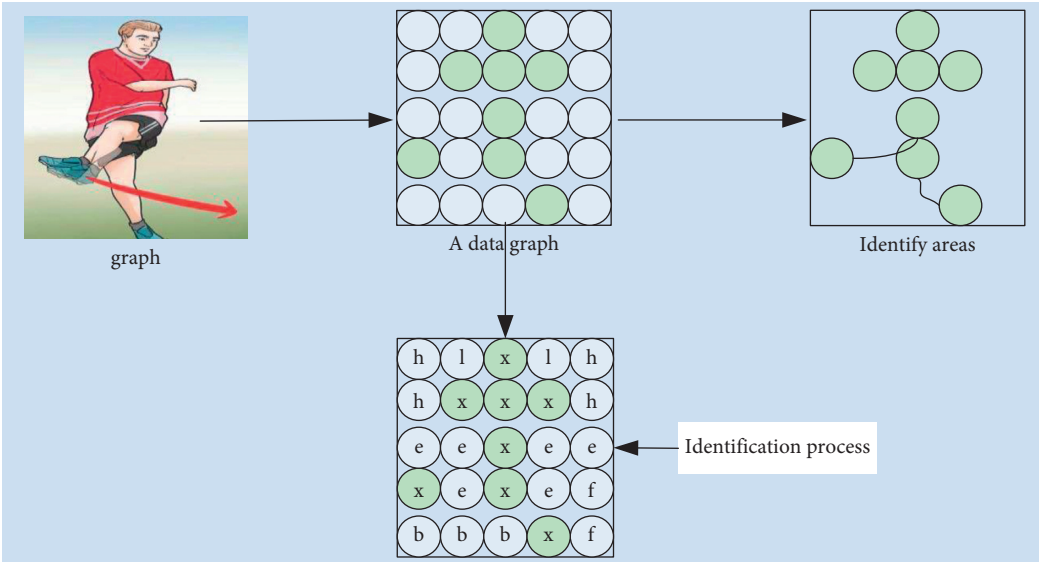

Figure 2: Image recognition process.

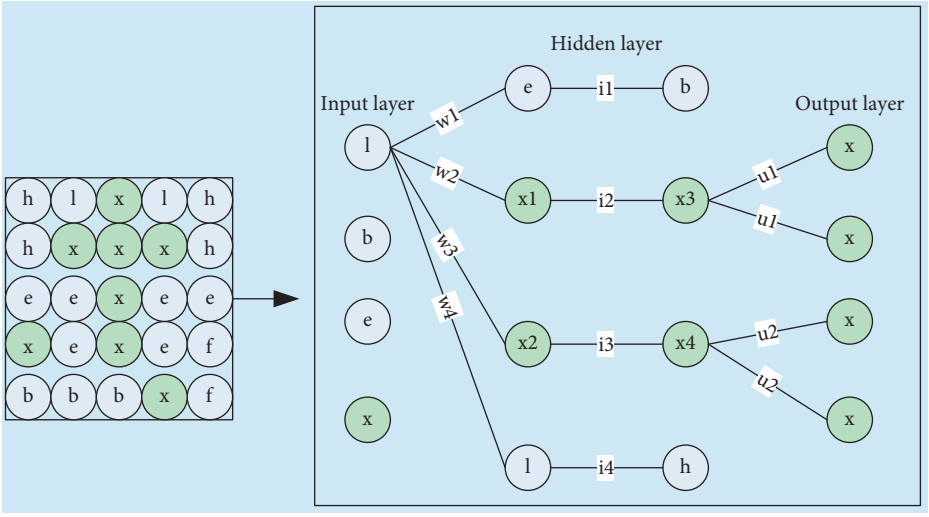

Figure 3: The specific identification process.

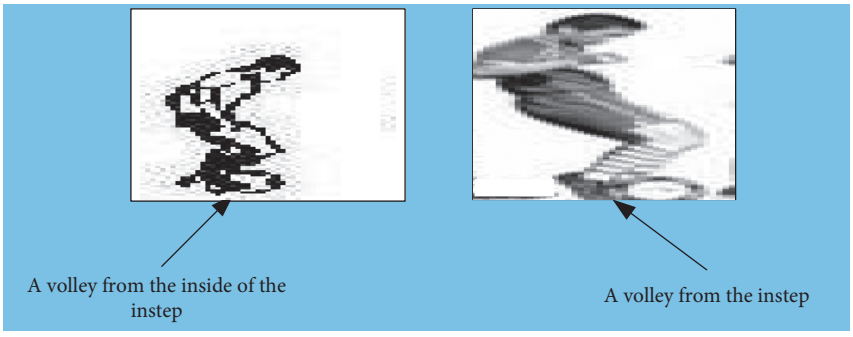

Figure 4: Frontal instep volley and inner instep volley.

As shown in Figure 4, the instep shot needs to make the starting point, the football and the goal in a straight line, and the knee should be close to the football. Lifting the foot close to the side of the soccer ball, keep the eyes on the top of the soccer ball and slowly swing the calf to the center of the soccer ball. After hitting the football, the body tends to move

forward to complete the whole action [13]. The inside of the instep volley needs to keep the toes up and hit the football with the trademark position of the sneakers so that it is easier to grasp the shooting direction of the football.

In the technique of football shooting, straightening the instep is the key, otherwise, there will be an ankle sprain. In ordinary football training, the coach may remind the instep to be kept straight, however, the instep of the player may be loose in training during the shooting action, and the coach cannot see with the naked eye whether the shooting action is done as per the standard or whether the player is loose [14]. Another action in the football shooting action is to bend the outside of the foot. The main point of the action is to point the toes down and use the instep to the outside plane to pull and hit the football, which is easier to form a football outbend castration. The greater the kicking force, the greater the curved path of the ball. If the force of the shot is not enough on the field, it will be difficult to bypass the opponent and enter the goal [15]. Every shooting action has its technical essentials, and it is impossible to achieve true precision in the process of training.

In addition to training the legs in the process of shooting, strength and accuracy are also the top priority. Among them, the run-up is quite critical. It requires the soles of the feet to touch the ground. The center of gravity of the body sinks slightly, and the body leans forward. In a football shot, it is a small-angle diagonal run-up. At the same time, the pace of the run-up should be strong. The arms should be synchronous with the legs to make a swinging motion, and at the beginning of the run-up, do not run in large strides but accelerate in small steps. The last step is to support the foot to step next to the ball, and the pace should be fast and large so that it can be more powerful when kicking the ball. In all, in football training, most movements need to be trained and corrected countless times to make a team with a high level of skill.

However, in daily training, there are often a lot of irregularities in coaches and players, which makes the shooting movements in the training process irregular. Irregular movements will make players lose power while kicking and result in low shooting accuracy in the field [16]. The basic shooting action is shown in Figure 5.

As shown in Figure 5, the running, arm swing, and kicking postures need to be trained to form muscle memory. If the training movements are not standardized enough, then the muscle memory is not accurate enough. Therefore, in the process of training, it is necessary to use deep learning algorithms to analyze the body movements of the players, compare them with the standard shooting posture, and adjust them again and again to guide the formation of correct muscle memory [17]. As the physical state of each shooting action is different, some shooting actions will make the body vacate, i.e., many actions of the player are in the vacated state when shooting. In this state, the player must keenly judge the landing point and the point of contact with the ball to improve the stability of the player himself, thereby improving the accuracy of shooting [18]. Therefore, it is necessary to use the deep learning algorithm to judge whether the shooting action of the player in training is standard to improve the accuracy of shooting and reduce the physical injury of the player.

2.3. Deep Learning Algorithm for Recognition of Football Shooting Actions. Deep learning is a new field in machine learning research. Its purpose is to establish and simulate the neural network of the human brain for analysis and learning, i.e., deep learning algorithms, which can imitate the mechanism of the human brain to interpret data, such as images, sounds, and text. It is used in many fields, such as artificial intelligence and construction [19], by the recognition of images, and so on. In the recognition of football shooting action based on the deep learning algorithm analyzed in this paper, shooting is the climax of the football game, and because each shot may have a change in the score, it also plays a key role in winning or losing the match [20]. To improve the efficiency of football training, it is necessary to carry out recognition research on the action of detecting the shot in the video of the game to provide a reference for ordinary football training. Shooting action recognition is shown in Figure 6.

In Figure 6, it can be seen that the recognition of the shooting action by the deep learning algorithm can accurately see the various angles of the player during the training process, such as the inclination of the human body, the height of the feet from the ground for different shooting actions, and the distance between the legs, span, and sight angle. In addition, it can also accurately observe whether the player's feet are stretched during training. It can not only guide the training of players well and provide targeted opinions but also avoid the problem of injury caused by the sudden relaxation of the instep of the athlete during training. According to the identified data, it can provide targeted guidance for the training of players and promote the improvement of training efficiency.

Of course, the current popular football robot is a robot that is endowed with artificial intelligence by the recognition of football video actions by deep learning algorithms. Since football robots can be on the field one day in the future, people can also develop a sparring robot that accompanies players to train by recognizing shooting movements. In addition to using artificial intelligence, the robot also needs to store standard shooting actions into the robot' s internal system. The robot also needs to incorporate deep learning algorithms into the system and incorporate video recording technology, as shown in Figure 7.

In Figure 7, the sparring robot also has the function of intelligent error correction. The purpose is to identify the unreasonable points of the player's shooting action through the camera when training with the player and correct the player's action. In this way, the traditional artificial coach training can be changed to be more accurate through naked eye observation, and it can also improve the training efficiency of the players and make the muscle memory formed by the players more accurate.

The recognition of the football shooting action by the deep learning algorithm can eliminate the background of the picture to identify the specific human action. It is to denoise

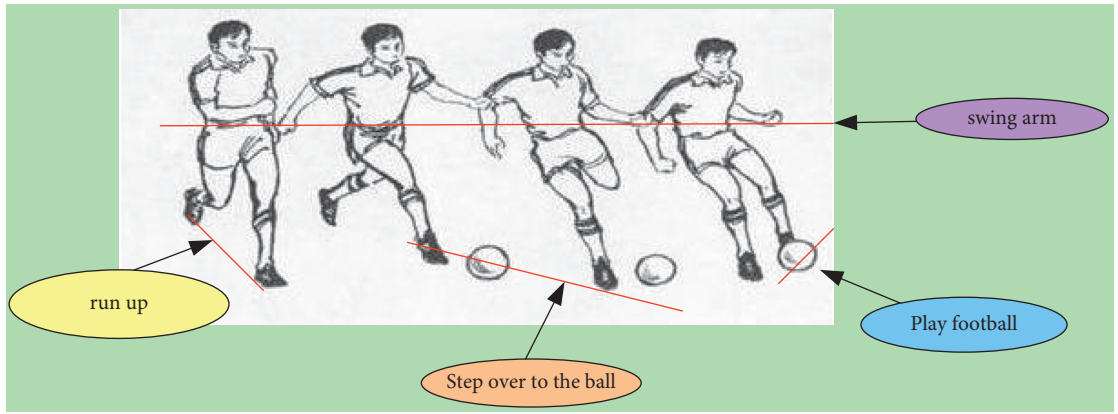

Figure 5: Basic shooting action.

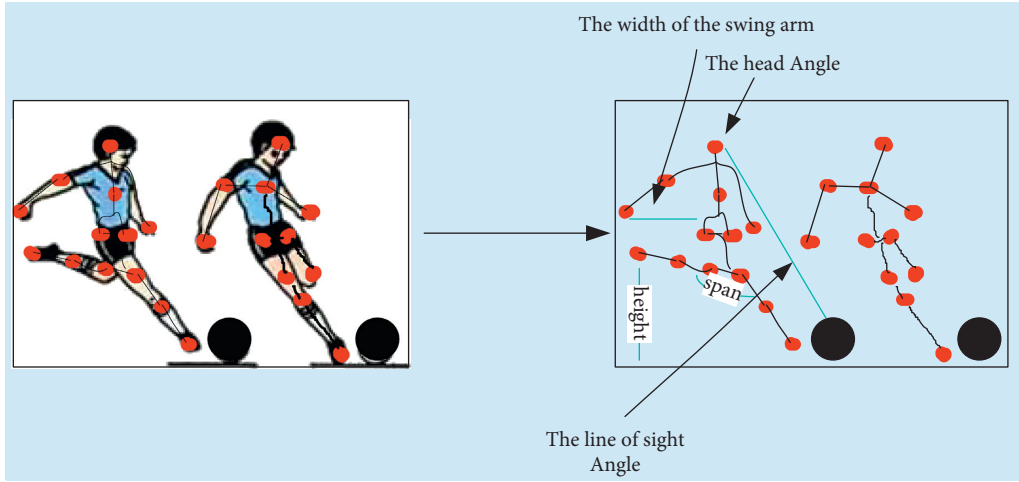

Figure 6: Shooting action recognition.

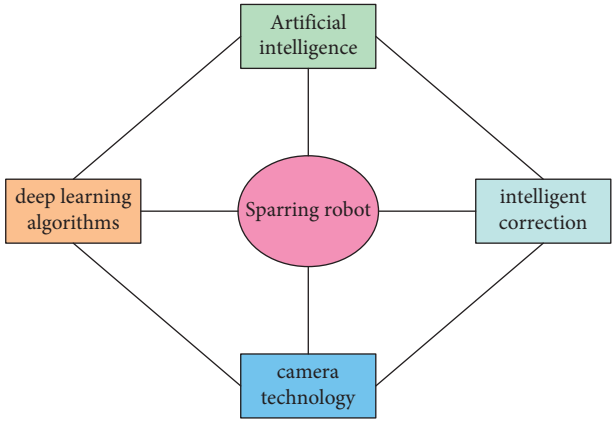

Figure 7: Sparring robot.

or process the collected data, extract the feature quantity, train and classify them, and finally realize the recognition of human actions so that the recognized shooting action has better accuracy. To a certain extent, it can evaluate the technical level of the players and provide a specific data reference for the subsequent training plans that need to be arranged. It has the ability to identify the player's physical fitness and strength and can arrange the athlete's physical fitness training and his own strength training in a more balanced manner [17]. Deep learning algorithms have high recognition and accuracy for motion tracking, feature extraction, dynamic system description, and the identification of deformable bodies.

3. Experiment of Football Shooting Action Recognition

3.1. Accuracy Experiment of Football Shooting Action Recognition. This experiment identifies the basic movements of 8 football players' football skills and records the data they need. There are generally seven standard steps in football shooting, which are run-up, support, leg swing, hitting, forward action, kicking, and kicking power [21]. The elements of the four steps are shown in Table 1.

Table 1 is for the basic correct comparison of the shooting action in the subsequent data. These are the decomposition actions of the shooting action, which can provide a control for the following experiments. The

Table 1: Basic elements of the four shooting actions.

Steps	Run-up	Prop	Leg lift	Hitting the ball
Function	Good for supporting foot in correct position and increasing hitting power	Move the body's center of gravity and maintain body balance so that the kicking leg can coordinate power	The power of the shot depends mainly on the swing of the kicking leg	The heart of kicking
Types	Straight line	—	Swing of the leg to drive the leg to hit the ball	—
	Oblique	—	Calf flexion with the hip joint as a shaft and with the thigh to drive the calf swing ball	—
Key	Start in small steps, run the last step, and stride should be appropriately enlarged	Support foot position, toe direction, and maintain body balance	Depends on the swing of the kicking leg	Foot contact also involves the action of the ankle at the moment the ball is hit

shooting action and its standard data that need to be verified in this paper are shown in Table 2.

Table 2 shows the shooting actions that need to be identified in this experiment, which are the positive instep volley, outer instep volley, inner foot curve ball, and barb shot. To this end, this paper performed deep learning algorithm identification on 4 shooting actions of 8 athletes, and the recorded data is shown in Figure 8.

In Figure 8, from the data of the instep shooting action in (a) and the standard data in Table 2, it can be seen in the span that the span of the legs of the No. 2 athlete is 45 degrees, which is 15 degrees away from the standard. The height of the feet from the ground is very different for the athletes of No. 4 and No. 6. The arc of the swing arm is basically OK, however, most of the athletes have deviations in the angle between the line of sight and the ball. (b) Comparing the standard data of the instep volley in the picture, in fact, most athletes can do it. Although there are some deviations in the results, the overall effect is similar. There is also the inclination angle of the body of the No. 1 athlete. Basically, the angles of these 8 athletes are too large, and none of the athletes have achieved the standard angle of body inclination. (c) Comparing the shooting action data of the inner foot curve ball with the standard in the figure, it is concluded that the leg spans of the four athletes are basically the same, and the rest of the athletes have a wide span of twins. From the perspective of the distance between the feet and the ground, the movements of the athletes are basically within the standard distance, however, some athletes' movements may deviate, and very few athletes meet the requirements of the standard movements. (d) Comparing the barb shot action data in the figure with the standard data, each decomposing action will have different degrees of deviation, especially in the decomposing action of the height of the foot from the ground, most athletes do a larger deviation. Among them, the shooting action of the No. 2 player basically has a greater deviation, and it is necessary to strengthen the training of this shooting action in a targeted manner.

As each decomposition action will affect the support and balance of the body, this experiment compared the average data of the four movements of the eight athletes with the standard average data to analyze the support and balance ability of the eight athletes. The figure is shown in Figure 9.

In Figure 9, AS represents the average standard data. A1, A2, A3, and A4, respectively, represent the average data of 8 athletes completing the four actions of instep volley, outer instep volley, inner foot curve ball, and barb shot. Judging from Figure 9, there will still be some deviations in the shooting movements of these 8 athletes, especially the deviation of the arc ball and the barb shot on the inside of the foot. The athletes should step up the training of this action.

3.2. Effect of Recognition of Football Shooting Action on Training. From the perspective of accuracy identification, it can more accurately detect the deviation of the players' movements during the training process to judge the strength and weakness of physical fitness and strength and then arrange reasonable training for them. From the experiments, the athlete's strength has not been fully exerted because the strength cannot be exerted to the extreme under the nonstandard conditions of each decomposition action. That is to say, when the ball is not strong enough to hit the goal, it may be intercepted. Hence, it is necessary to arrange reasonable training for the players. What a player needs to shoot is leg strength, and of course, arm strength is also indispensable. This experiment needs to verify the changes in leg strength and physical fitness. Arm strength can be measured by the weight of the barbell bench press, and leg strength can be measured by the number of squats. Before arranging reasonable training, the identification data of leg, arm strength, and physical fitness of 8 athletes are shown in Table 3.

In Table 3, running records the time of the 100-meter sprint, and push-ups record the number of times done in one minute. For this reason, this paper arranged reasonable training for the athletes based on the data of the accurate identification of the athletes. After a period of time, the changes in their strength and physical fitness are shown in Figure 10.

Table 2: Shooting action and standard data.

Types	A high volley shot from the instep	Volley from the outside instep	A curveball inside the foot	Pour hook shot
Span	60	45	30	120
The height of the leg above the ground	45 cm	45 cm	30–45 cm	100 cm
Swing your arms in an arc	75	45	15–20	80–90
The head angle	45	75	75	60
Body angle	45	70	80	180
Average	54	56	49	109

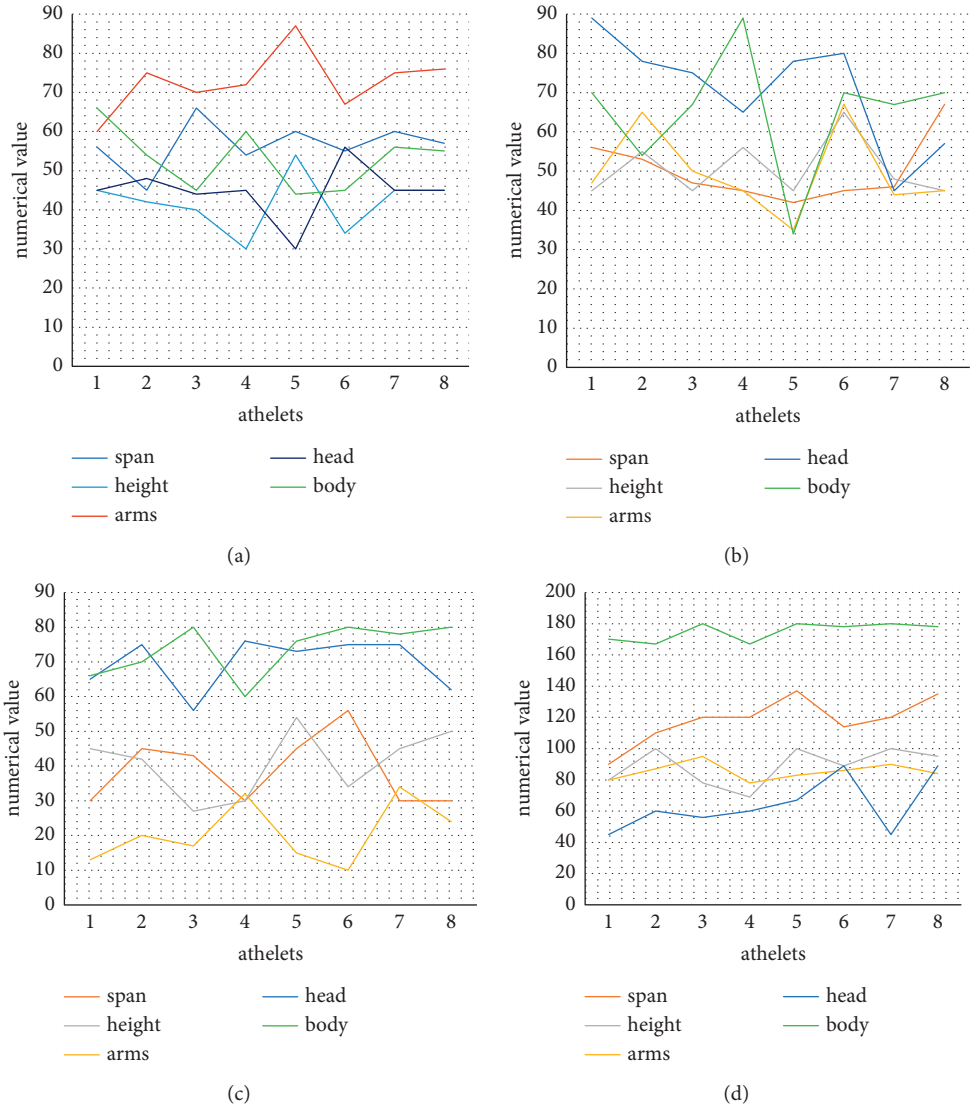

Figure 8: Shooting action recognition data. (a) Instep volley. (b) Outer instep volley. (c) Curved ball on the inside of the foot. (d) Barb shot.

Comparing the data in Figure 10 with the data recorded when no training has been arranged, it can be clearly seen that the physical fitness and strength of the athletes have improved, which can provide better balance and support for football shooting movements.

3.3. Experimental Summary. It can be seen from the experiments that the deep learning algorithm has a high accuracy for the recognition of the football shooting action. Its accuracy can reach about 96% to a certain extent. It has a good identification of each decomposition action in the

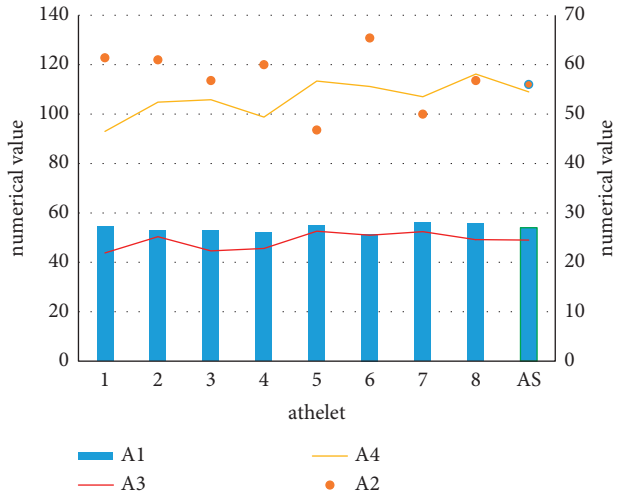

Figure 9: Comparison chart.

Table 3: Data logging.

Athlete	Arm (kg)	Leg (kg)	Running(s)	Push-ups
1	67	65	6	47
2	76	68	7	67
3	87	64	6	65
4	76	65	5	57
5	67	76	6	54
6	74	67	5	65
7	72	68	8	54
8	75	63	6	48

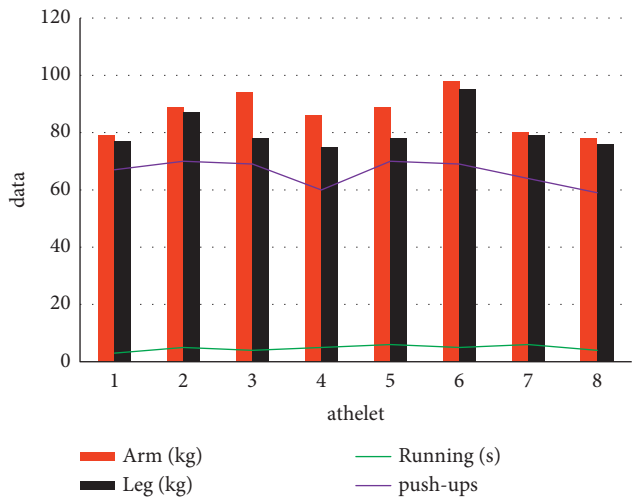

Figure 10: Changes in strength and fitness after training.

shooting action, and it has clear data for comparison, which points out the direction for the training of athletes and can improve the training efficiency. The identification of these decomposition actions has important reference significance for building a high-level and high-quality team. Moreover, it can also identify the physical fitness and strength of athletes to a certain extent and has a certain promotion effect on the physical fitness and strength training of athletes.

4. Discussion

This paper analyzes the deep learning algorithm and mainly introduces the recognition of the feedforward neural network and the image. Of course, there are many types of deep learning algorithms, and there are other algorithms that can be applied to image and algorithm recognition. The recognition of pictures by deep learning algorithms can facilitate the development of various fields, especially in artificial intelligence. The recognition of the football shooting action in this paper can promote the quality and level of the team. Hence, the deep learning algorithm has high practicability as an advanced computer field. Deep learning algorithms are used in artificial intelligence, and today, their use is not limited to artificial intelligence. Its recognition of images can be used in many fields, such as medical care, infrastructure construction, etc. Its application in all fields has a high time value.

The analysis of football shooting action in this paper can find that there are many types of football shooting action, and each type of shooting action has different essentials and skills. However, these movements have something in common, i.e., they need to maintain the balance of the body and also need the strength of support. In addition, the legs are the key when shooting. There is no need to keep the instep straight to prevent injury. The balance of the body is extremely important, and when shooting, the athlete must consider the center of the body and a series of effects after kicking the ball to prevent inertial falls. Of course, when shooting, athletes need to better grasp the decomposition movements, such as run-up. The performance of leg strength depends on each decomposition movement, and the standardization of decomposition movements will affect the performance of strength.

The experiments in this paper can also see that the deep learning algorithm can have a very clear accuracy for the recognition of football shooting actions and have a clear guiding effect on the training of players. Of course, the recognition of football movements can not only be effective

for training but also create a new intelligent sparring robot based on this to provide more effective and accurate guidance for player training. It can train a consistently high-quality football team and guarantee victory in football matches.

5. Conclusions

This paper explores the application of deep learning algorithms in football shooting action and has a deep understanding of the deep learning algorithm, which is a key technology in the field of intelligence. It has a very high recognition ability for the recognition of football shooting actions, and the recognition of football actions can promote the normal training of players. Of course, it can also be combined with artificial intelligence to form an intelligent robot to accompany the training of the players, which can further promote the specific training of the players. The experiments in this paper show that the deep learning algorithm can accurately identify which of the athlete's decomposing actions is not in place and make targeted corrections. It can also promote the training of players' strength and physical fitness, which has great guiding significance for building a high-quality team. However, this paper only analyzes the action of football shooting and does not take into account all the factors that affect the goal of football. It is hoped that future research can be more comprehensive.

Data Availability

No data were used to support this study.

Conflicts of Interest

The authors declare that there are no conflicts of interest with any financial organizations regarding the material reported in this manuscript.

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