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Intelligent Algorithms for Remote Classroom Physical Education Teaching Based on 5G Communication Technology

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ABSTRACT

With the rapid development of 5G communication technology, distance education is becoming a trend, and physical education teaching is no exception. This study aims to explore the research on intelligent algorithms for remote classroom physical education teaching based on computer 5G communication technology. A solution based on intelligent algorithms is proposed by analyzing the existing distance education and physical education teaching technology and their problems. This study will focus on key technologies such as real-time interaction, action recognition, and feedback in remote classrooms and design corresponding intelligent algorithms. Experimental results show that the intelligent algorithm for remote classroom physical education teaching based on computer 5G communication technology can effectively improve the effect and experience of distance teaching, providing an innovative method for the intelligence and remoteness of physical education teaching.

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1. Introduction

With the rapid development of computer science and communication technology, distance education is becoming an important trend in the field of education. As an important part of education, physical education teaching is gradually realizing remote teaching with the help of computer technology and communication technology. The widespread application of 5G communication technology brings more possibilities and challenges for remote physical education teaching. This study aims to explore the research on intelligent algorithms for remote classroom physical education teaching based on computer 5G communication technology. Distance education, with its flexibility and convenience, is widely used worldwide. However, traditional distance education models have some problems in physical education teaching [1]. Distance education makes it difficult to achieve real-time interaction and action recognition. The interaction and feedback between students and teachers are limited, which cannot meet the needs of physical education

teaching [2]. Secondly, traditional distance education models cannot provide high -quality video transmission and stable network connections, leading to poor teaching effects. The emergence of 5G communication technology provides new opportunities and challenges for remote physical education teaching. 5G communication technology, with its ultra-high speed, low latency, and large capacity, can provide high quality video transmission and stable network connections, providing strong support for remote physical education teaching [3]. At the same time, developing intelligent algorithms also brings new possibilities for remote physical education teaching. Through intelligent algorithms, real-time interaction, action recognition, and feedback can be realized, improving the effect and experience of distance teaching [4]. At present, some studies have explored remote classrooms for physical education teaching based on computer technology. Research on action recognition and analysis based on computer vision technology can capture students' actions through the camera and provide real-time analysis and feedback. In addition, some studies have used virtual reality and augmented reality technologies to achieve a more realistic and immersive remote physical education teaching experience. However, these studies still have some problems. Firstly, the current remote physical education teaching technology still faces challenges such as unstable network transmission quality and high latency. Secondly, existing intelligent algorithms in real-time interaction, action recognition, and feedback still need improvement and optimisation. This study aims to design and implement an intelligent algorithm based on computer 5G communication technology to optimize the teaching effect and experience of remote classroom physical education teaching. Specific research content includes the following aspects: Firstly, research on network transmission quality and latency optimization. By using the advantages of 5G communication technology, a suitable network transmission algorithm is designed to improve the quality and stability of video transmission and reduce latency. Secondly, research on real-time interaction and action recognition algorithms [5]. Utilize computer vision and machine learning technology to achieve real-time recognition and analysis of students' actions. Through real-time interaction, teachers can correct students' action problems in time and provide personalized guidance and feedback. Finally, research on the feedback mechanism of remote classrooms. By analyzing students' learning conditions and progress through intelligent algorithms, provide personalized feedback and assessment to help students improve and improve. This study will use experimental methods to design and implement intelligent algorithms for remote classroom physical education teaching based on computer 5G communication technology [6]. Through experimental verification and analysis, assess the performance and effect of the algorithm. The expected result is to design and implement an efficient, stable, and experience-intelligent algorithm for remote classroom physical education teaching, providing new ideas and methods for the development of remote physical education [7].

2. State of the Art

Distance education technology is a mode of education based on computer and communication technology. With the development of the internet, distance education has rapidly advanced. Traditional distance education mainly employs video conference technology and online teaching platforms to deliver instruction. However, these conventional remote education technologies present some challenges in physical education teaching, such as difficulties in real-time interaction and action recognition. Therefore, exploring using computer and communication technology to improve the effects of remote physical education teaching is necessary[8]. Remote physical education teaching faces several technical challenges. Firstly, the network transmission quality is unstable, and latency is high. Physical education teaching requires real-time video transmission and action recognition, and instability in network transmission quality and high latency can result in video buffering and delayed action recognition[9]. Secondly, the precision and effectiveness of real-time interaction and action recognition are limited. Current action recognition algorithms still face certain difficulties in complex action and multi-person action recognition. Additionally, traditional distance education technology cannot provide an immersive learning experience, often leaving students feeling a lack of engagement and interactivity. In recent years, computer vision technology has been used for action recognition in remote physical education classes. Real-time action recognition and feedback can be achieved by using cameras to capture student movements and applying computer vision algorithms for analysis[10]. AR technology can overlay virtual sports scenes onto real ones, providing a more realistic and immersive experience. The application of VR and AR technologies can enhance student engagement and interactivity, improving the effectiveness of remote physical education teaching. In summary, current research mainly focuses on using computer vision and machine learning technology for action recognition and analysis, as well as

using VR and AR technology to provide an immersive teaching experience. However, these studies still have some issues, such as real-time interaction and network transmission quality optimization. Future research should further explore intelligent algorithms for remote physical education classes based on computer 5G communication technology to improve the effectiveness and experience of remote physical education teaching.

3. Design of Classification Algorithms

*The design of classification algorithms is a key step in research on intelligent algorithms for remote physical education classes. In remote physical education classes based on computer 5G communication technology, classification algorithms are used to identify and classify students' actions for real-time feedback and assessment. This paper will introduce several commonly used classification algorithms and discuss their application in remote physical education classes. Support Vector Machines (SVM) is a commonly used classification algorithm. Its basic idea is to find an optimal hyperplane in feature space that separates samples of different categories. In remote physical education classes, students' motion features can be used as input samples, and SVM can be used to classify different actions. SVM has good generalization capabilities and robustness, suitable for small-scale action classification problems. In text processing, the convolution operation is defined as the operation between each weight matrix Wk∈Rc*d (Wk represents the kth convolution kernel, c represents the size of the convolution kernel, d represents the dimension of the word vector) and each sentence vector S = (e1 , e2 , …, en), where ei∈ Rd, n is the sentence length. The convolution process uses a convolution kernel with a sliding window size of C for convolution calculations with each input sentence vector. Each convolution kernel will produce a feature vector when convolving with the sentence vector, ultimately resulting in a matrix Ck (features extracted from K different convolution kernels), calculated as follows:*

$$C_k = f(W^k e^{i:i+c-1} + b^k) \quad (1)$$

In the above, ei:i+j represents the concatenation of feature vectors ei…ei+j, with i = 1,2, …, n-c+1, and f represents the ReLu activation function. Wk, bK are the parameters to be learned. The convolutional kernel usually has a stride of 1 and slides over the input vector matrix, ultimately obtaining a collection of local feature representations ck.

Random Forest is an ensemble learning algorithm that classifies by building multiple decision trees. In the context of remote physical education teaching, Random Forest can be used to classify students' movements. Random Forest is able to handle large-scale datasets, and it has good robustness towards missing data and noise. Xt denotes the input of the time series at moment t, St represents the value of the hidden state at moment t, which reflects memory unit information. The memory unit information depends on the current input Xt and the previous unit state St-1. The computation formula is as follows:

$$S_t = f(Ux_t + WS_{t-1}) \quad (2)$$

In the above formula, U and V respectively represent the weight matrices between the input layer to the hidden layer and the hidden layer to the output layer; f refers to the activation function in the neural network, often using the tanh function. At moment t, the output vector Ot depends on the unit state St at moment t. Its calculation process is shown in formula 3, where V represents the weight coefficient matrix from the hidden layer to the output layer.

$$o_t = VS_t \quad (3)$$

The output at current moment t represents all information from previous moment t-1 and current input. The output at the last moment represents the information of the whole sentence learned. Finally, Ot is input into the Softmax function to get the probability distribution of various relations. During the entire training process, parameter matrices U, V, and W share the time dimension, which greatly reduces the parameters and improves the training speed. The backpropagation algorithm is used to update the training parameters.

Furthermore, Random Forest can also provide an importance ranking of features, used for screening and selecting the most representative features. In recent years, deep learning algorithms have achieved remarkable results in computer vision tasks, and they also have great potential for action recognition and classification in remote physical education classrooms. Deep learning algorithms are usually based on neural network models and can extract effective features and perform classifications through training large-scale datasets. Commonly used deep learning models include Convolutional Neural Networks (CNN) and Recurrent Neural Networks (RNN). In the context of remote physical education teaching, deep learning algorithms can be used to perform more refined and accurate classification of students' movements. Ensemble learning algorithms combine multiple basic classifiers, making the final classification decision through voting or weighting. In the context of remote physical education teaching, ensemble learning algorithms can be used to classify students' movements. Common ensemble learning algorithms include Bagging, Boosting, and Stacking. Ensemble learning algorithms can improve the accuracy and robustness of classifiers, and they are effective for complex action classification problems.

4. Experimental Design and Analysis

Experimental design and analysis is a crucial aspect of research in intelligent algorithms for remote sports education classrooms. In the context of remote sports education classrooms based on 5G communication technology, we need to design suitable experiments to verify the effectiveness and performance of algorithms. The designed algorithms should be compared with existing ones to evaluate their relative performance. The improved model proposed in this paper combines the advantages and characteristics of CNN and BiLSTM, compensates for the shortcomings in feature extraction due to their own network limitations, extracts features within sentences, including adjacent words and word features, and then further selects and optimizes features through the attention mechanism. Finally, two features are combined as the final relation classification vector. Under the premise of using the same input, this model considers the structural features within the sentence, obtains features directly from the original sentence, and extracts more feature information from the inside without relying on manually designed features or external knowledge bases, thereby improving the effect of the model.

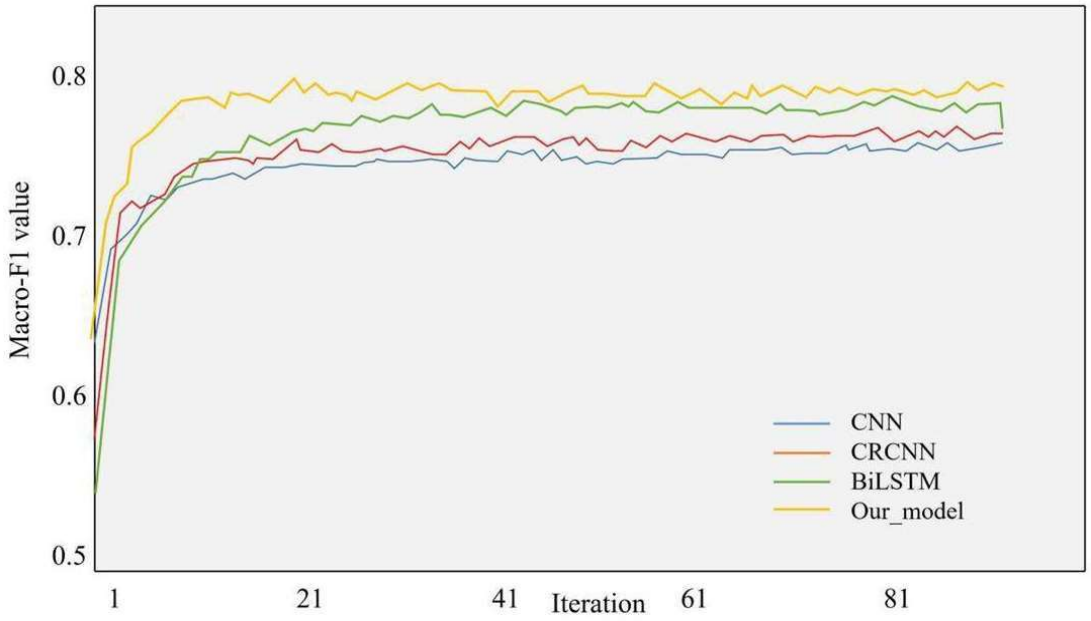

Figure 1. Shows the macro-F1 values on the SemEval dataset with the number of iterations

As shown in Figure 1, the F1 values on the two datasets tend to stabilize as the number of iterations of each model increases, and the overall effect of the model proposed in this paper is better than all comparison models. Data analysis is conducted on collected data, such as the

frequency, amplitude, duration of actions, etc. Data characteristics can be visualized for better understanding. Algorithm performance analysis is performed based on experimental evaluation indicators. Differences in performance metrics such as accuracy, recall, F1-score, etc., across different algorithms can be compared. Additionally, to uncover the relationship between the experimental results and the distribution of categories in the dataset, this paper conducts statistical analysis on the test data, exploring the performance differences of different categories in relation to classification. This experiment statistically evaluates the performance of each model's accuracy, recall, and F1-score under each relation classification in two datasets.

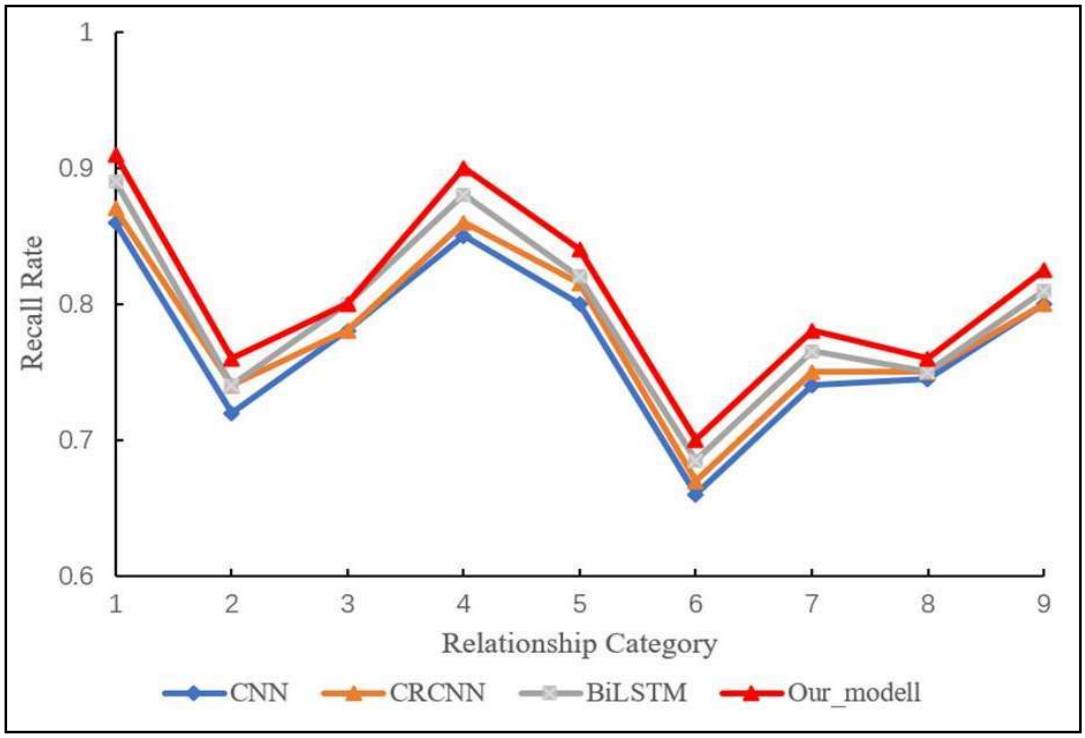

Figure 2. Comparison of Recall Rates for Different Relations on the SemEval Dataset

Figure 2 shows the recall rates of various models on relation extraction using the SemEval dataset. It can be observed that the relation extraction model proposed in this paper, which incorporates word features and features between neighboring words, outperforms the comparative models in all relation categories, demonstrating better overall performance. In certain specific relation categories, it significantly outperforms other parameter settings, highlighting the importance of parameter tuning to enhance the algorithm's performance. Grid search, cross-validation, and other methods can be employed to determine the optimal parameter combinations. To analyze the generalization capability, the trained model can be applied to different datasets to evaluate its generalisation ability. Validation can be done using new test datasets. The experimental results can be visualized through graphs, charts, or interactive interfaces, providing an intuitive representation of the algorithm's performance and effectiveness.

Figure 3 shows that with an increase in the number of iterations, the objective function values of all three algorithms gradually decrease and eventually stabilize. Compared to the PSO and CPSO algorithms, the MACPSO algorithm, which incorporates chaotic optimization during iterations, enhances its ability to find local optima, resulting in a relatively faster convergence rate and the ability to search for better values. The MACPSO algorithm utilizes Multi-Agent System (MAS) techniques to compare fitness values between agents and neighboring agents, utilizing the randomness and exploration of chaos to achieve a deeper local search, thereby improving optimization capability. The results show that the MACPSO algorithm performs the best in terms of optimization.

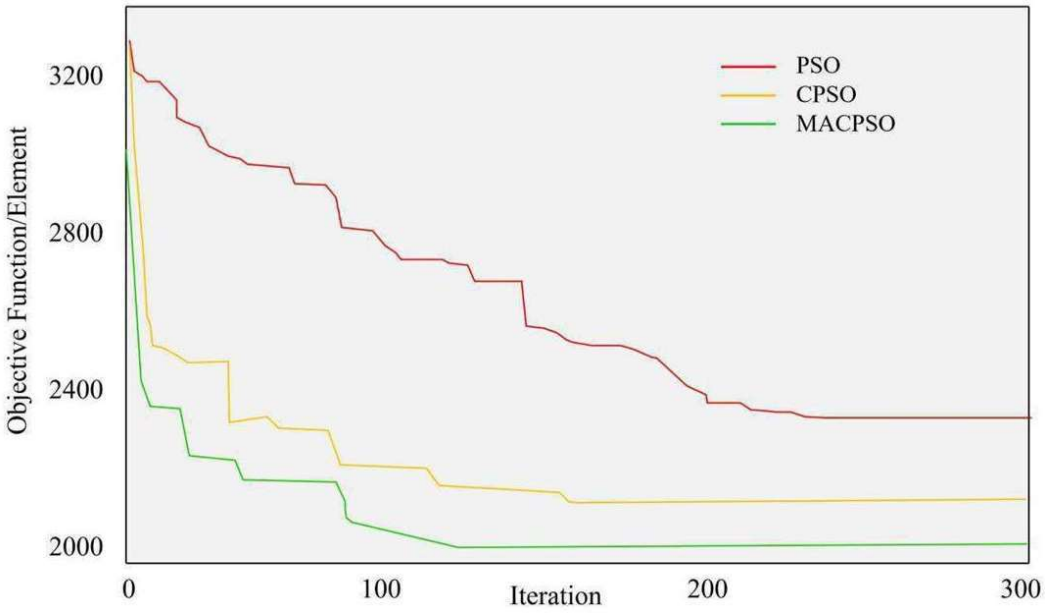

Figure 3. Convergence Comparison of Algorithms

5. Conclusions

Based on the experimental design and analysis of intelligent algorithms for sports teaching in remote classrooms under the context of computer 5G communication technology, the following conclusions can be drawn: With a well-designed experiment, including data collection, preprocessing, experimental design, and algorithm implementation, high-quality data can be obtained, and the algorithm can be accurately validated in terms of accuracy, real-time performance, and robustness. Sports action data under different actions, body postures, and lighting conditions can be collected through appropriate sensors and cameras. The data preprocessing includes cleaning, denoising, and labeling, ensuring data quality and accuracy. Based on the experimental plan, algorithms can be implemented using classification algorithms such as Support Vector Machines (SVM), Random Forest, and Deep Learning. Through experimental verification, algorithm performance and effectiveness can be evaluated. Suitable evaluation metrics can be selected for algorithm performance evaluation, such as accuracy, recall, and F1 score, which reflect aspects of the algorithm's classification accuracy, omission rate, and error rate, respectively. The experimental results can be deeply analysed by employing data analysis, algorithm performance analysis, parameter tuning, and generalization analysis. These analyses help understand the strengths and weaknesses of the algorithm and guide improvement and optimization efforts. Based on the above experimental design and analysis, it can be concluded that intelligent algorithms for sports teaching in remote classrooms under the context of computer 5G communication technology exhibit certain accuracy, real-time performance, and robustness. Effective data collection, preprocessing, algorithm implementation, and evaluation can enhance the intelligence level of sports teaching in remote classrooms, improving teaching effectiveness and learning experience. However, continuous research and algorithm improvement are still necessary to adapt to different sports actions and teaching scenarios, enhancing algorithm performance and adaptability. In the future, with the continuous development of 5G communication technology, intelligent algorithms for sports teaching in remote classrooms will be further improved, providing students with better teaching experiences and outcomes.

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