Mobile Information Systems

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Research Article

Digital Economy Meets Artificial Intelligence: Forecasting Economic Conditions Based on Big Data Analytics

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Big data economy meets artificial intelligence, making the traditional statistical economy gradually evolve into an intelligent economy. Limited by human consciousness, traditional economic models have low prediction accuracy. In traditional statistical methods, the limited sample data also makes it impossible to effectively control and comprehensively forecast macroeconomic and development trends. Data economy has fundamentally transformed the traditional means of economic analysis. This is because the digital economy enables economic connectivity and precise data sharing, which can be used for precise economic statistics and mathematical analysis. Meanwhile, in terms of statistical methods, artificial intelligence methods no longer rely on human consciousness, but more objectively pay attention to economic cause and effect and are more accurate and comprehensive. This paper proposes an economic forecasting method based on artificial intelligence methods combined with big data analytics. In our model, we consider the economic statistics, equilibrium, and future prediction with the big data. Through the artificial intelligence method based on deep learning, the possible political factors, human activity factors, and social environmental factors in actual economic activities are effectively combined to form the main analysis subject affecting the economy. The results show that our model can be used as a basic model for economic statistics, economic analysis, economic decision-making, economic self-regulation, and other functions under the current development trend of the data economy.

1. Introduction

"Digital economy" was first proposed by American economist Don Tapscott in the 1990s [1]. Subsequently, the digital economy has attracted wide attention and the main research directions of scholars can be divided into three parts: (1) concept and connotation of the digital economy. (2) Proportion and development of the digital economy to each country's economy. (3) Research on digital economy theory. The main carrier of the digital economy is the digital, which is conducive to Internet sharing and dissemination. It is the transmissibility of data that has brought us into the digital age and created a new era product, big data. Big data covers the most raw and real details of each economic activity, which not only has a large number of samples but also has an accurate and detailed numerical description.

This information is very useful for economic analysis and forecasting. However, the traditional artificial economic forecasting method is difficult to carry out statistics and analysis on such a large number of data. The amount of information of these numbers far exceeds the scope of human work efficiency. In this context, the big data analytics method is born [2], which enables people to use artificial intelligence to analyze and count massive data quickly and efficiently [3]. Big data analysis methods based on artificial intelligence are widely applied in stocks analysis and prediction [4], industry analysis [5], capitalist economic development [6], climate warming [7], and program popularity prediction [8]. Big data analysis can not only carry out scientific statistics, analysis, and prediction of our economy but also guide decision-makers to formulate more reasonable economic policies and guidance. With the emergence of big data and the massive increase of data samples, the international social and economic factors are complicated. The traditional economic forecasting model has been unable to meet the development needs of the current digital economy. Therefore, this paper is devoted to the research of the economic modeling and economic forecasting based on artificial intelligence and big data analytics under the current situation of the digital economy.

The economic model refers to the theoretical structure used to describe the interdependence between economic variables related to the economic phenomenon under study. An economic model is an analytical method that describes the situation of the real world in a very simple way. The situation of the real world, made up of primary and secondary variables, is so complex that a rigorous analysis is impossible or rendered uncomplicated unless the secondary factors are excluded. By making certain assumptions, you can rule out a lot of secondary causes, so you can build a model. In this way, the special case specified by the hypothesis can be analyzed through the model. The economic model itself can be represented by equations with graphs or words [9, 10], such as the marginal analysis model and the decision-making process mathematical model. These classical methods can be expressed by explicit formulas, but the new artificial intelligence method can predict the implicit economic model by learning method, which can not be expressed explicitly, but the prediction is more accurate and does not need manual design.

Economic forecasting is based on the theoretical basis of economics, through a certain period of economic data and data calculation and analysis, through the relevant forecasting methods and technologies, so as to be able to study and analyze the economic development and changes. The goal of the economic analysis and forecasting is to calculate and analyze the economic data with a certain period of time in a qualitative or quantitative way to explore the rules of economic development and predict the development trend in the future. The traditional economic forecasting is affected by human factors more, more subjective forecast, and different people forecast results are often widely divergent. While, the artificial intelligence based economic forecasting pay more attention to the historical data and makes objective evaluation and prediction, which has more reference value.

Traditional economic modeling and forecasting rely heavily on manual model design and manual statistics, which cannot be applied to the massive data of the current digital economy. Moreover, the analysis of traditional methods is too subjective and lacks the statistics of massive samples and scientific subjective prediction. To this end, we propose economic modeling methods and economic forecasting methods based on big data analysis and artificial intelligence methods. Because of many influence factors to economic activity, each the influence of different factors on the economy, and at different times have different influence. It is also connected between each factor, therefore it is very tedious to relate these economic factors manually. To this end, we put forward a model based on a graph network economic analysis of the various factors. This graph network structure supports the simultaneous input of multiple factors and is automatically correlated by learning the weight of each factor. In order to make an economic forecast comprehensively, we also propose an economic forecasting model based on Long Short Term Memory (LSTM) [11], which can be used to forecast the future economic trend.

The rest of this paper is organized as follows: Section 2 introduces the related works with our research. The preliminaries of the proposed method are introduced in Section 3. In Section 4, we propose our method and introduce the details. Section 5 reports the experimental results. The final section will introduce the conclusion of our study.

2. Related Work

In this section, we review some related works about economic situation prediction based on artificial intelligence methods including evolutionary algorithms, data mining, machine learning, and computer vision. In the following, we detail these methods.

2.1. Evolutionary-Algorithm-Based Economic Situation Prediction. Chen [12] collected data from 200 listed companies in Taiwan stock exchanges to compare the differences between traditional statistical methods and nontraditional statistical methods for predicting financial distress. Among them, are nontraditional methods such as decision tree classification, neural network, and evolutionary computing technology. Specifically, the author uses principal component analysis (PCA) technology to extract appropriate variables and has done a lot of experiments. The experimental results show that the traditional statistical methods can better deal with large data sets without sacrificing the prediction performance, while the traditional methods, that is, intelligent technology, can achieve better performance on small data sets but does not perform well on large data sets; In addition, experiments also show that particle swarm optimization (PSO) and support vector machine (PSO-SVM) can be combined to predict potential financial distress. Claveria et al. [13] proposed an empirical modeling method based on genetic programming, which realized the way of predicting economic growth from expected survey data. Specifically, the author uses an evolutionary algorithm to estimate the symbolic regression, which links the expectation based on the survey with the quantitative variables used as the measurement standard and deduces the mathematical function form similar to the target variables. The set of economic growth indicators generated from experience is used as a building block to predict the evolution of GDP. In addition, the author also used GDP estimates to evaluate the impact of the 2008 financial crisis on the expected accuracy of the evolution of economic activities. Claveria et al. [14] used the survey expectations of various economic variables to predict actual activities. The author proposes an empirical method to deduce the mathematical function form that links the survey expectation with economic growth. Specifically, the author combines symbolic regression with genetic programming to generate two survey based indicators: perception index, current evaluation and expectation index of using agents, and their expectations for the future. To find the best combination of these two indexes to best replicate the evolution of economic activities, the author uses a portfolio management program called index tracking. Through the generalized reduced gradient algorithm, the relative weights of the two indicators are derived. Hu et al. [15] made a systematic literature review on the discovery of inventory rules in e-commerce technology for the first time. The author divides them into three categories of analysis methods, including basic analysis, technical analysis, and hybrid analysis, and three categories of e-commerce technology, including evolutionary algorithm, swarm intelligence, and hybrid e-commerce technology. In the discovery of technology trading rules, there is an obvious bias between the application based on genetic algorithm and genetic programming technology. In addition, the author also investigates and reveals the research focus and gap of applying e-commerce technology to inventory rule discovery and puts forward the technical roadmap for future research. El-Henawy et al. [16] used the multilayer perceptron neural network to predict the stock index and used three search algorithms to obtain the best network structure and parameters, so as to improve the prediction accuracy of the model and reduce the training time of the model. Specifically, the author carried out the experiments of simulated annealing, genetic algorithm, and the hybrid method combining simulated annealing and genetic algorithm, compared these experimental results, and drew two conclusions: (1) in terms of accuracy, simulated annealing algorithm is the best algorithm, its accuracy is 40% higher than genetic algorithm and 30% higher than hybrid method. (2) In terms of training time, simulated annealing is the best algorithm, followed by the genetic algorithm, and the hybrid method takes the longest time. Mirowski [17] tried to separate and determine the depth of the transformation of economic concepts in recent economic research, focusing on five areas, including mechanism design, zero intelligence agents, market microstructure, engineering economics, and artificial intelligence. The authors claim that this shift can identify concerns about treating the market as a different algorithm and can have a far-reaching impact on the conceptual framework used to solve economic problems. Moreover, the author also designs an implicit alternative of evolutionary computational economics based on automata theory to put the problems existing in different markets at the research center.

2.2. Data-Mining-Based Economic Situation Prediction. As a subject of computer science, data mining has been widely used in the field of finance. As an important means of managing big data, enterprise efficiency and business intelligence, data mining, and machine learning are essential. Moreover, data mining is also of great value in the financial business.

Aiming at the problem that it is difficult to evaluate the going concern of companies, Koh and Low [18] put forward several going concern prediction models based on statistical methods to help accountants and auditors. Specifically, the author compares the availability of logistic regression, decision tree, and neural network in predicting the sustainable operation of enterprises. The experimental classification results show the potential availability of data mining technology in the continuous operation prediction environment. In addition, the decision tree continuous operation prediction model is better than the logistic regression and neural network models. Because data mining technology is very powerful for analyzing complex nonlinear and interactive relationships, traditional statistical methods can be used to supplement when building the going concern prediction model. Sung et al. [19] used data mining methods to develop bankruptcy prediction models that adapts to normal and crisis economic conditions. The model can be used to observe the dynamic changes of the model from the normal state to the crisis state and finally give the bankruptcy classification. The bankruptcy prediction model shows that under normal circumstances, the main variables predicting bankruptcy are total asset cash flow and capital productivity, while under crisis circumstances, they are liability cash flow, capital productivity, fixed assets, and shareholder's equity. When the normal model is applied to the crisis situation, the prediction accuracy of bankruptcy classification will decline significantly. Therefore, the author concludes that it is reasonable to adopt different models under the condition of a crisis economy. Kunnathuvalappil and Hariharan [20] focused on the technical application of data mining in forecasting stock, managing portfolios, and analyzing investment risk, as well as identifying and predicting bankruptcy, foreign exchange rate, financial fraud, and other economic behavior prediction. Zhang and Zhou [21] described the achievements of data mining in financial forecasting from the perspective of technology and application. In addition, the author makes a comprehensive comparison of different data mining technologies and their achievements in different financial application fields. The author also gives the challenges faced by future research in this field and the future development trend. In order to evaluate the application of data mining in finance, such as financial prediction and classification, Kwak et al. [22] proposed a multicriteria linear programming method, which uses the existing bankruptcy data to predict the bankruptcy situation. The experimental results of this method show that the method proposed by the author has better prediction results than the traditional multiple discriminant analysis and logit analysis of financial data. Specifically, the overall prediction accuracy of the proposed model is similar to that of the decision tree and support vector machine. Aiming at the problem of finding the bankruptcy factors of small enterprises, Ptak-Chmielewska [23] designed a complex enterprise bankruptcy prediction model and studied whether the increase in the complexity of the model will improve the prediction efficiency. Specifically, the author analyzed the samples of 806 small enterprises and estimated some simple and complex models, such as logistic regression, gradient lifting, support vector machine, and so on. The experimental results show that the simple model and the complex model have the same effect in bankruptcy prediction. Because data mining models usually have fitting phenomenon, this paper analyzes the most important financial factors that predict the bankruptcy of small enterprises.

2.3. Machine-Learning-Based Economic Situation Prediction. Hasanuzzaman et al. [24] surveyed 130 papers on machine learning financial analysis from 1995 to 2010 and presented the development of the most advanced machine learning technology, including integrated classifiers and hybrid classifiers. The author also expounds on the advantages and disadvantages of the bankruptcy prediction and credit scoring model with machine learning. In terms of the factors that predict the bankruptcy of small enterprises, the author designs a machine learning based enterprise bankruptcy prediction model and studies whether the increase of the scale of the model will improve the prediction efficiency. The results show that the simple size model and the complex size model have similar effects in bankruptcy prediction. The price of financial assets is non-linear, dynamic, and chaotic. Forecasting the price model of the financial market is a subject with high demand and difficult to predict. Due to the high productivity of the machine learning field used to predict the prices of financial markets, Henrique et al. [25] review 57 texts and propose a classification model of markets, assets, methods, and variables. Among the machine learning prediction models mainly investigated, it is particularly noteworthy that more studies use data from the North American market. The most commonly used prediction models include support vector machines and neural networks. Obthong et al. [26] reviewed the research on machine learning models and algorithms for improving the accuracy of stock price prediction. Stock market trading is an activity that investors need fast and accurate information to make effective decisions. Many stocks are traded on the stock exchange, so there are a lot of factors that affect the stock decision-making process. Moreover, the stock pricing behavior is uncertain and difficult to predict. Therefore, the research on finding the most effective prediction model has arisen to realize that the prediction model can generate the most accurate prediction with the lowest error percentage. Huang and Yen [27] investigated a large number of recent work on machine learning models for predicting financial distress, including supervised, unsupervised, and mixed supervised unsupervised machine learning models. The prediction performance of four supervised models including traditional support vector machine, hybrid associative memory with translation, hybrid GA Fuzzy Clustering, and extreme gradient lifting are compared with that of unsupervised classifier deep belief network and hybrid dbn-svm model, and the actual social financial data set is used as the experimental data set for the comparative experiment. The experimental results show that xgboost provides the most accurate prediction of financial distress among the four monitoring algorithms. In addition, the hybrid dbn-svm model can generate more accurate predictions than SVM or classifier DBN alone. Financial crisis prediction is the most complex and promising problem for companies and small-scale enterprises. Vadlamudi [28] investigated how the newly adopted machine learning technology addresses this issue in all areas of private and public business. The author uses systematic literature evaluation to study the impact of machine learning on financial crisis prediction. Specifically, from the selected work, the author determines the main role of these methods in predicting bankruptcy and credit, such as data processing, data privacy, and confidentiality. The author also puts forward the main methods to realize the financial growth and plasticity of the company. Actively monitoring and assessing the economic health of financial institutions is the most basic work of the regulatory authorities. Petropoulos et al. [29] use a series of modeling techniques to predict the bankruptcies of American financial institutions. By comparing with the widely used bank failure model and other advanced machine learning models, the author concludes that the random forest method has excellent sample and time prediction performance, and the performance of the neural network is almost the same as that in the time sample. The author also shows through experiments that in its evaluation framework, the indicators related to income and capital constitute the factors with a high marginal contribution to bank failure prediction and evaluates the generalization of the machine learning model through case studies of major European bank samples.

2.4. Computer-Vision-Based Economic Situation Prediction. In most countries, reliable data on the socio-economic status of individuals, such as personal health index, household consumption expenditure, total household wealth, and assets, are still scarce. The traditional methods of collecting such data include field survey and questionnaire survey. Due to the high cost and labor-intensive nature of these surveys, it is difficult for them to be widely used at the national level. Remote sensing data, such as high-resolution satellite images, are widely used in many countries. In order to avoid the lack of high-grained socio-economic data, computer vision based on remote sensing data has been successfully applied to original satellite images sampled from resource poor countries [30]. The method of automatically counting fruit quantity plays an important role in agricultural crop management. Syal et al. [31] reviewed the previous studies on calculating the number of fruits on trees and their yield estimation and introduced various computer vision and optimization technologies to achieve automatic fruit counting. The author also summarizes the main advantages and disadvantages of existing systems in the field of agricultural automation. The results show that using k-means clustering or color based nearest neighbor classifier can provide color space transformation of RGB images for better classification results. After the color image is segmented, the circular fitting algorithm is applied to carry out the morphological operation, and the fruit on the tree can be separated and counted. The author uses the fruit recognition algorithm to extract various color and shape features of fruits and uses the classification based on fuzzy logic to count fruits. The authors claim that their method implements an efficient fruit counting and yield mapping algorithm.

Breeding crop varieties with high economic benefits is of great significance to social stability and development. The purchase price usually reflects the economic benefits of crops. The traditional method of estimating economic benefits by purchasing price formula based on manual measurement features is very time-consuming and labor-consuming. Motion based structure combined with multiview stereo method can extract plant phenotypic features and estimate the economic benefits of crops efficiently and timely. Xiao et al. [32] developed a framework for obtaining phenotypic traits based on the calculation of non-linear formulas and partial least squares regression models to estimate the economic benefits of various genotypes of crops. Specifically, the author designs a low-cost portable device for acquiring multiview images of crops to facilitate subsequent three-dimensional reconstruction. Then, multiple characters are estimated from the reconstructed three-dimensional reconstruction model, and a model is constructed using the real world data set for prediction. The experimental results show that the proposed model can achieve the expected economic benefits. The appearance of the house, the neighbors around the house, and the incentive factors of the owner will have an impact on its price. Using computer vision technology, Glaeser et al. [33] found that some standard deviation improvements in residential appearance were related to the increase in residential value. Relative to the location and basic family variables, the additional predictive power generated by the image was small, but the external image was superior to the variables collected by the family assessor. When the visual prediction value of the neighbor increases, the value of the house increases. In addition, the author has not found the relationship between the appreciation or depreciation of the rental housing and its appearance, and the owner will not modify and upgrade the appearance of his residence before resale. Most of the textiles produced in the world are mainly polyester and cotton fibers. At the end of the textile life cycle, most textiles are currently buried or incinerated. Mäkelä et al. [34] aim to recycle these textiles effectively. The author discusses the application of hyperspectral near-infrared imaging technology to estimate the content of polyester fiber in textiles, aiming to develop a machine vision model for textile characterization and textile recycling. Specifically, the author first visualizes the differences in textile samples based on the principal component model and then uses the image regression algorithm to predict the polyester fiber content in a single image pixel. The experimental results of this method show that the average prediction error is 2.2%–4.5% in the range of polyester fiber content of 0-1, and the method can visualize the spatial change of polyester fiber content in textiles. Training robot arms to complete manual tasks in the real world has received more and more attention in the academic and industrial circles. Zuo et al. [35] investigated the role of computer vision algorithms in this field. All the authors' decisions are based on visual recognition, such as real-time 3D pose estimation. In addition, the author also proposes an annotation scheme for a large number of training data, then creates a large number of synthetic data using a three-dimensional model, and trains a machine vision model in this virtual data domain to apply the model to the real image after the domain adaptation. Specifically, the author makes full use of the geometric constraints between key points, designs a semisupervised machine learning method, and uses an iterative algorithm to optimize the model. The author also constructs a task control system based on computer vision, which can train a reinforcement learning agent for the real world in the virtual environment.

3. Preliminaries

We introduce some preliminaries frequently use in the text of this paper.

3.1. Machine Learning. Machine learning is a concept, that is, without writing any specific code related to the problem, generic algorithms can tell some interesting conclusions about input data. Without coding, if input data into the generic algorithm, it will build its own logic based on the data. For example, there is an algorithm called the classification algorithm, which can divide data into different groups. The classification algorithm can be used to recognize handwritten digits (A machine learning model prediction example is presented in Figure 1 for predicting digital data); It can also be used to distinguish between spam and nonspam without modifying one line of code. If different training data are input to the same algorithm, it can get different classification logic. A machine learning algorithm is a black box, which can be used repeatedly in many different classification problems. "Machine learning" is an inclusive term that covers a large number of similar generic algorithms. There are two kinds of machine learning algorithms: supervised learning and unsupervised learning. It is simple to distinguish between the two, but it is also very important.

3.2. Deep Learning. Deep learning is a machine learning method. As an artificial neural network, it can independently construct (train) basic rules according to the sample data in the learning process. Especially in the field of machine vision, neural networks are usually trained by supervised learning, that is, by example data and predefined results of example data. How deep learning works? It can divide into four parts (Figure 2 presents the structure of the deep learning).

First, artificial neural network: deep learning uses some form of artificial neural network (ANN) technology, so it must be trained with sample data first. The trained ANN can be used to perform related tasks. The process of using trained ANN is called "inference." In reasoning, Ann will evaluate the data provided according to the learned rules. For example, it is possible to evaluate whether an object in an input image has a defect.

Second, neurons, layers, and connections: Ann is composed of multiple interconnected "neuron" layers. In the simplest case, these layers specifically refer to the input layer and the output layer. Many neurons and connections can be considered as a matrix. The connection matrix contains each value of the input matrix and is connected to the value of the

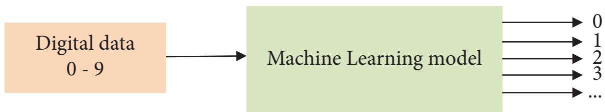

Figure 1: Prediction of a machine learning model for digital data.

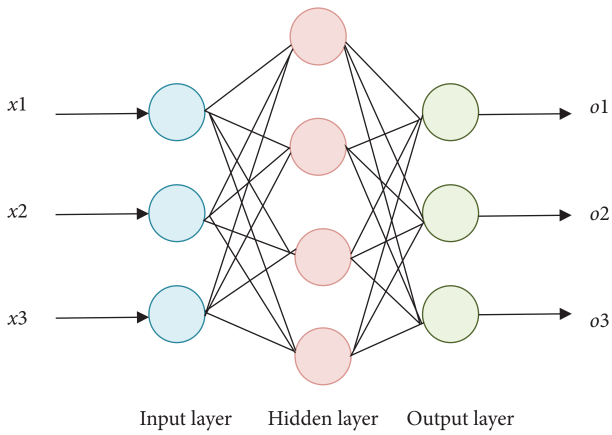

Figure 2: The structure of the multilayer perceptron.

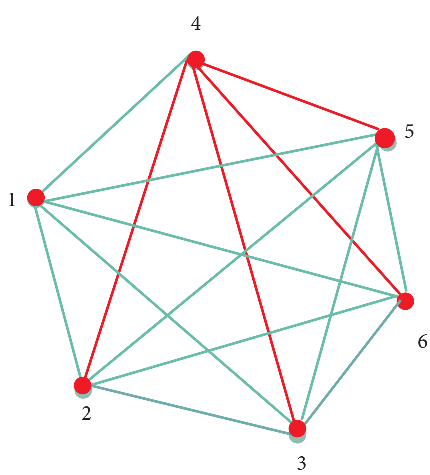

Figure 3: The graph structure of the multiple economic factors.

result matrix. The value of the connection matrix contains the weight of the corresponding connection. The corresponding values can be generated in the result matrix by means of the logic matrix values and the input value weights.

Third, deep artificial neural network: "Deep learning" refers to the training of deep Ann. In addition to the input layer and the output layer, there are hundreds of hidden layers for input and output between the visible layers of the depth Ann. The resulting matrix of each hidden layer is the input matrix of the next layer. Therefore, the results are provided only by the output matrix of the last layer.

Fourth, train: when training ANN, the initial focus is set randomly, and then the sample data is added step by step. The relationship weights should be adjusted according to the input data and the expected results and using the training rules. The final performance of the ANN (i.e., the accuracy of the result evaluation) depends largely on the example data used in the training. If the content used for training has a large amount of sample data with high variability, more accurate inference results can usually be generated. If a large number of very similar or repeated data are used for training, the ANN will not be able to estimate the field when encountering data different from the sample data. This situation is called the overfitting of ANN.

4. Method

The first thing to solve for economic forecasting is the economic modeling. Therefore, our proposed method consists of two parts. The first part is the economic model based on a graph neural network, and the second part is the economic forecast based on LSTM.

4.1. Economic Model. Considering the many factors affecting the economy, we propose a graph neural network as the basic structure of economic modeling. The graph structure is shown in Figure 3. The graph structure consists of nodes and the edges connected between them. As shown in the figure, the connections between these nodes have directional connections, and different edges have different weights. In economics, the weight of these edges is often affected by many factors at the same time. In the traditional economic modeling process, these weights are generally set manually. The weights of manual design are often set to fixed values according to experience. However, these weights may be time-limited and may change in practice, so the traditional model is not accurate.

In order to make the graph structure calculation more efficient, we propose an embedding feature matrix calculation method, which can solve the edge weight between each nodes. The matrix is a square matrix, and the horizontal and vertical index respectively represent the weights between corresponding nodes. Due to the large differences in the form of data between the various factors related to the economy, there are scalar and vector. Therefore, we first unify the data of different data forms into the same feature vectors using the feature embedding method. They have the same dimension, which is conducive to the calculation of the correlation between vectors as shown in Figure 4. The feature embedding is consist of a connected layers and a ReLU function. After each factor is changed into a feature vector, the weight of the matrix is solved by the similarity between vectors. The similarity calculation here uses the vector inner product.

4.2. Economic Forecasting. In order to make the economic forecast more accurate, we adopt the artificial intelligence method to model and analyze the forecasting model. The main reference points for the prediction of the model include historical information, historical results, and current information. Considering that the model needs historical information for prediction, we adopt the LSTM structure. In the LSTM structure, we use a multilayer perceptron to

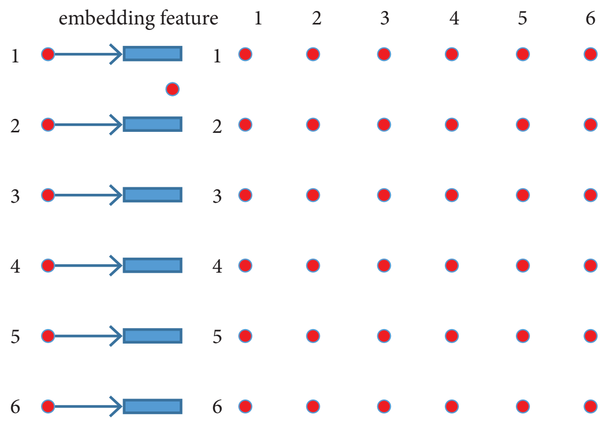

Figure 4: The graph structure can be calculated as a square matrix with the embedding features.

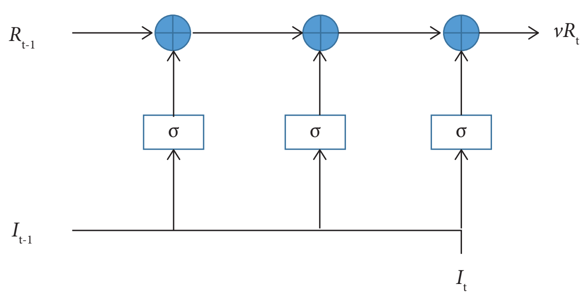

Figure 5: The LSTM structure for economic forecasting.

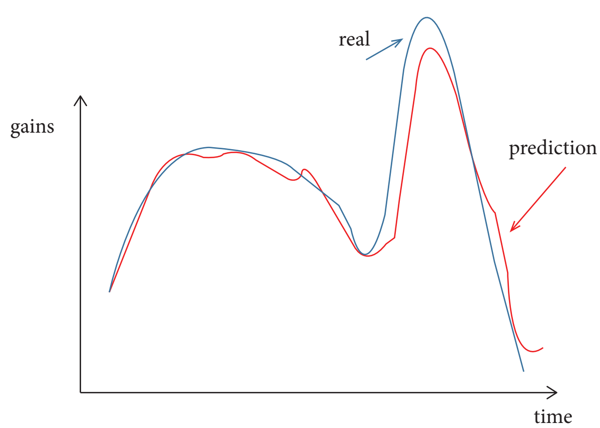

Figure 6: The economic forecasting model is used for stocks prediction.

extract features from input data, fuse features and results through LSTM, and comprehensively predict the current results. The LSTM structure is shown in Figure 5. The notation R_{t-1} is the output or real value at time $t-1$. The notation I_{t-1} is the input information at time $t-1$, which include multiple factors such as mentioned in Section 4.1. The notation σ is a combination of operations, including thah activation function, and a multilayer perceptron. As shown in Figure 4, the prediction results at the current time can be expressed as follows:

$$R_t = R_{t-1}W_{tr} + \sigma(I_{t-1})W_{t-1} + \sigma(I_t)W_t, \tag{1}$$

where W_{tr} is the translation weights between the last time result and the current time result. W_{t-1} is the graph weight between the different economic factors at time $t-1$, and W_t is corresponding to the time t.

Through the LSTM structure, we effectively comprehensively analyze and integrate historical results, historical information, and current information, which makes our network prediction more comprehensive and referential.

5. Results

We use the stock forecasting as an example to validate our economic modeling method and the forecasting model. As shown in Figure 6, the blue curve is the real stocks gains, while the red curve is the prediction results. We input the current news score, historical news scores and stock gains. The LSTM then predicts the output gain of the current time. The results show that the RMSE accuracy decreases from 21.5% to 10.3% after we input the relevant information into LSTM. This indicates that our proposed LSTM method can effectively fuse multimodal data to effectively interact with the current prediction results.

6. Conclusions

In this paper, we first analyze the characteristics of the current digital economy, as well as the status of traditional economic models and forecasts. Then, according to the current advantages and characteristics of artificial intelligence and big data, we put forward economic modeling methods and economic forecasting methods based on artificial and big data analysis. The proposed method fully considers the objective factors of economic development and the characteristics of multi-element influence and proposes the economic modeling method based on graph structure and the economic forecasting model based on LSTM, respectively. The experiment of stock forecasting shows that our method of economic modeling and economic forecasting is effective. In the future, we will optimize this paper from three aspects. At first, we exploit more neural network models to make an effective comparison. Then, we will build a real platform (such as a software) for forecasting economic conditions. Finally, we will adopt more data analysis models to improve the accuracy.

Data Availability

All data used to support the findings of the study is included within this paper.

Conflicts of Interest

The authors declare that there are no conflicts of interest.

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Research Article

Sequence Video and Artificial Intelligence Assisted Basketball Injury Risk Early Warning Method

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Basketball sport is a comprehensive nonperiodic collective sport, in which sports injuries of various parts are also prone to occur. Its higher exercise intensity not only effectively enhances the physical fitness of the athlete but also causes physical damage due to a series of actions such as frequent take-offs and landings, resulting in certain sports injuries. Therefore, the early warning of injury in basketball is very necessary, and it is very useful to protect the safety of players. In this paper, we investigate how to use the sequence video and artificial intelligence method for the basketball injury risk early warning in order to protect the player and better assist the player to improve their efficiency of training. First, we preprocess the video sequence. We convert the video sequence into image data and perform noise reduction and transformation operations on the image. Second, for the processed image data, we designed a convolutional neural network model to determine the damaged area. Third, we use the neural network model to take the image data with the detection area as the input, perform feature extraction on the data, and finally obtain the early warning value of basketball sports injury. The experimental results prove that the method proposed in this paper has good evaluation performance.

1. Introduction

Basketball is a comprehensive nonperiodic collective sport, which is determined by the diversity of its sports content structure and the variability and comprehensive characteristics of the competition process [1–3]. Engaging in basketball competitions and various basketball activities will help to cultivate the overall quality of the players, improve physical health, activate body and mind, and increase knowledge. It has a positive impact on exercising comprehensive talents and developing people's wisdom, cultivating excellent moral character and tenacious will. For example, the practical operation and actual application of basketball skills and tactics systems are completed by running, jumping, shooting, and other means under the requirements of a specific time, distance, venue, and facility conditions that are changing. In this process, both intelligence, physiology, and psychology must bear the comprehensive influence of various complex factors. Participating in basketball activities in an appropriate amount has a positive effect on promoting people's physiological functions, improving health, and comprehensively developing physical fitness and psychological cultivation.

However, in basketball, players have to carry out intense close attack, defense, and confrontation. Under changing and complex conditions, it is necessary to perform technical actions with high difficulty such as shooting, layup, dribbling breakthrough, and stealing, and the exercise intensity is large and the energy consumption is large. Therefore, sports injuries of various parts are also prone to occur [4–6]. Its higher exercise intensity not only effectively enhances the physical fitness of the athlete but also causes physical damage due to a series of actions such as frequent take-offs and landings, resulting in certain sports injuries.

According to the American Orthopaedic Sports Medicine (AOSSM) Sports Trauma and Overuse Prevention (STOP) Program [7, 8], the most common basketball injuries (both amateur and professional) are ankle sprains, finger contusions, knee injuries, thigh contusions, and facial injuries. Basketball injuries can cause unpredictable injuries to players.

The rapid development of informatization has brought technical convenience to basketball injury research. Through the data analysis of basketball injuries, it is possible to accurately understand the distribution of injuries among players of different genders in basketball games, as well as the distribution of injuries. This plays an important and fundamental role in taking targeted injury prevention methods and scientifically formulating recovery training programs. Data collection and analysis on the distribution of injuries in basketball shows that it is not difficult to find that physical injuries caused by basketball are a common phenomenon. Because the main body of basketball is mostly boys, and boys are more competitive. Therefore, among people who have experienced sports injuries, the proportion of boys is much higher than that of girls. Although the vast majority of sports injuries have a low number of injuries, they have a greater impact on the body. Therefore, when engaging in basketball, it is still necessary to pay attention and take preventive measures against sports injuries.

In the context of the rapid development of science and technology [9, 10], in order to effectively improve the professionalism and pertinence of injury prevention and recovery, it is necessary to comprehensively analyze the injury data information based on basketball sports, so as to understand the common injury types, identify the location of the injury, and do a good job of the cause of the injury analysis to minimize damage. According to the situation of sports injuries, combined with the analysis of basketball movements, it can be seen that the common injuries mainly occur in the ankle joint, knee joint, finger joint, and waist. The reasons are mainly as follows: first, before the exercise, the preparation activities were not implemented properly. Second, in the process of exercise, professional technical movements are not mastered in place. The third is the lack of physical fitness and function, and the overload of exercise intensity causes strain on parts of the body. Among the common types of injuries, most of them are contusions, abrasions, sprains, strains, and other minor physical injuries. Although they are less harmful to the body, they occur at a high rate. In addition, there are serious injuries to the body, such as fractures, which need special attention and take effective preventive measures to prevent serious injuries to the body.

Artificial intelligence has surpassed the human level in large-scale image recognition and face recognition [11–13]. Dedicated artificial intelligence systems for specific tasks (such as playing Go) can surpass human intelligence in single-item tests of local intelligence levels due to single tasks, clear requirements, clear application boundaries, rich domain knowledge, and relatively simple modeling. Artificial intelligence (AI) is a new technical science that studies and develops theories, methods, technologies, and application systems for simulating, extending, and expanding human intelligence. Artificial intelligence is a branch of computer science that attempts to understand the essence of intelligence and produce a new type of intelligent machine that responds in a similar way to human intelligence. Research in this area includes robotics, language recognition, image recognition, natural language processing, and expert systems. Since the birth of artificial intelligence, the theory and technology have become more and more mature, and the application field has also continued to expand. The technological products brought by artificial intelligence in the future will be the “containers” of human intelligence. Artificial intelligence can simulate the information process of human consciousness and thinking. Artificial intelligence is not human intelligence, but it can think like human beings and may surpass human intelligence.

The development of artificial intelligence provides more intelligent and accurate methods and technologies for sports injury risk early warning, especially in the application of basketball sports injury risk early warning tasks. A healthy physical state is the basic requirement for basketball players to participate in sports, and it is also the fundamental guarantee to effectively avoid injury. Under the background of informatization, strengthening the informatization management of the health status of basketball players can conduct a comprehensive and systematic health analysis of basketball players in a targeted manner and promote the continuous improvement of their physical health. After the basketball player completes the training task, the actual physical health status of the athlete can be recorded in detail, and the measurement and analysis of the health level and various indicators of the body can be done by means of information technology. Once a basketball player’s body is abnormal or uncomfortable, a preliminary judgment can be made on the player’s physical symptoms according to the analysis data of their health status, so as to prevent the increase of physical exercise burden and increase the probability of physical injury during exercise. This can effectively protect the physical health of athletes participating in basketball training activities and reduce sports injuries.

In this paper, we investigate how to use the sequence video and artificial intelligence method for the basketball injury risk early warning in order to protect the player and better assist the player to improve their efficiency of training. At the same time, we use the convolution neural network model for the video translation, image process, and feature extraction, so as to provide higher performance for the basketball injury risk early warning [14, 15].

The contribution of this paper can be summarized as follows:

(1) We propose the basketball injury risk early warning method by adopting the neural network model to extract more useful features

(2) We design a video transform algorithm and image denoising method based on a convolutional neural network model, which coverts the video data to images and filter the noise of images

(3) We experimentally demonstrate the effectiveness and performance of the method proposed in this paper on different conditions.

The rest of this paper is organized as follows: Section 2 introduces the proposed method for basketball injury risk early warning, including video data preprocessing, Injury area determination, and Injury detection and early warning based on a neural network model. Section 3 presents experimental studies and results to compare and demonstrate the performance of the proposed model for basketball injury risk early warning evaluation. Section 4 concludes the whole paper.

2. Proposed Method

In this paper, we aim to investigate how to use the neural network model and sequenced videos to detect and warn basketball injuries to better protect players and improve training efficiency.

First, we preprocess the video sequence. We convert the video sequence into image data and perform noise reduction and transformation operations on the image. Second, for the processed image data, we designed a convolutional neural network model to determine the damage area. Third, we use the neural network model to take the image data with the detection area as the input, perform feature extraction on the data, and finally obtain the early warning value of basketball sports injury.

2.1. Video Data Preprocessing. We use video data for early warning of basketball sports injuries. First, we process the video data into image data. Video data processing is not just about understanding every image in the video, but more about identifying the few best key themes that describe the video. The research content of video data processing mainly includes video conversion and image data processing. Before a video can be calculated, we design a video conversion algorithm to convert video into pictures.

Videos are made up of a series of still images, usually, 24–30 images per second or more, with each individual image called a frame. The continuous playback of these still images can lead to the false impression that the object is moving, and the faster the images are played, the smoother the motion will appear. Video to picture can be captured frame by frame, or continuous images or frames can be extracted by some software. The video conversion algorithm is shown in Algorithm 1.

After the video processing is completed, we can get the image data corresponding to the video. Because the video capture contains noise interference. Therefore, we denoise the image data. The basic image noise reduction algorithm usually removes the noise in the image by low-pass filtering the image. This method removes noisy pixels, but at the cost of blurring the image-all edges are blurred. More advanced noise reduction algorithms detect edges in images and low-pass filter them along lines perpendicular to the edges, a method that preserves the edges. However, low-pass filtering is not as effective because it has fewer pixels on average.

We use Gaussian low-pass filtering to denoise the image [16, 17]. The process of filtering an image by discrete Fourier transform is shown in Figure 1.

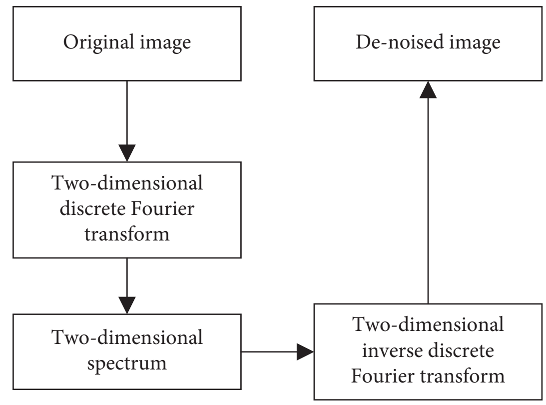

Figure 1: The process of filtering an image by discrete fourier transform.

The formula for the two-dimensional discrete Fourier transform is as follows:

$$F(u, v) = \sum_{x=0}^{M-1} \sum_{y=0}^{N-1} f(x, y) e^{-j2\pi(ux/M+vy/N)}, \tag{1}$$

where x and y are the horizontal and vertical coordinates of the original image, respectively, M and N are the height and width of the original image, and f (x, y) is the gray value at the coordinates (x, y) on the original image. Euler's formula is shown as follows:

$$e^{-j2\pi(ux/M+vy/N)} = \cos\left(2\pi\left(\frac{ux}{M} + \frac{vy}{N}\right)\right) - j\sin\left(2\pi\left(\frac{ux}{M} + \frac{vy}{N}\right)\right). \tag{2}$$

Therefore, each pixel on the two-dimensional spectrum obtained by the two-dimensional discrete Fourier transform [18] of the original image is a complex number. When processed in the Mat data format in OpenCV [19], each pixel value has two channels. The formula for the two-dimensional inverse discrete Fourier transform is as follows:

$$f(x, y) = \frac{1}{MN} \sum_{u=0}^{M-1} \sum_{v=0}^{N-1} F(u, v) e^{j2\pi(ux/M+vy/N)}, \tag{3}$$

where the symbol representation is the same as the above-mentioned two-dimensional discrete Fourier transform.

2.2. Injury Area Determination. After video processing and image denoising, we design an injury region determination method based on the CNN model.

The deep learning models currently used in image recognition and analysis research mainly include Convolutional Neural Networks (CNNs) [20], Deep Belief Networks (DBNs) [21], Stacked Auto-Encoders (SAE) [22], and so on. The convolutional neural network is superior to the latter two methods in detection accuracy and speed. The convolutional neural network was proposed by biologists Huber and Wiesel in the early research on cat visual cortex, it is a variant of multilayer perceptron (MLP). LeCun of New York University proposed the convolutional neural network model LeNet [23] in 1998 and applied it to the detection of handwritten characters. In 2012, Professor Hinton led his student Krizhevsky to The convolutional neural network model AlexNet [24] was applied to the image classification task, and won the first place in the ImageNet [25] Large-scale Visual Recognition Challenge (ILSVRC), which reduced the Top-5 error rate to 15.3%. Currently, Microsoft's ResNet [26] and Google's InceptionV4 [27] reduce the Top-5 error rate to within 4%, surpassing human performance on this specific task. Girshick combined the region prediction + convolutional neural network method in 2014. (R-CNN) [28] was applied to the object detection task and achieved good performance.

CNN have the following advantages in object detection tasks.

(1) Multiple convolution kernels. Adding multiple convolution kernels can learn a variety of features to better describe the image.
(2) Local perception. Generally speaking, people's cognition of the outside world is from local to global, and the spatial relationship of the image is also closer to the adjacent pixel regions, and the correlation of the farther pixels is weaker. Therefore, each neuron first senses the local area and then synthesizes the local information at a higher level to obtain global information. The number of training parameters can also be reduced by local sensing.
(3) Parameter sharing. In the local connection, the parameters of the filter corresponding to each neuron are the same, which greatly reduces the number of training parameters.
(4) Pooling. After using multicore convolution, the extracted feature dimension is huge. In order to reduce the dimension, the maximum or average method is used to reduce the dimension. The pooled features can be maintained when scaling or changing.
(5) Sparsity restriction. The neuron data in the hidden layer is large, so adding a sparsity restriction to this makes most neurons in a suppressed state and only a few neurons are activated, which helps us to extract a small number of neurons. Extract the more essential features of the image. This greatly reduces the number of parameters of the network and speeds up the training speed.

The above advantages enable CNN to extract image features by itself when processing images, including color, texture, shape, and topological structure of the image, which has good robustness and computational efficiency.

In this section, we design a CNN model to mark the region feature of the player in the images. The main process contains two steps. First, we preprocess the images, including crop, data augmentation, resize, and transform. Second, the preprocessed images are input into the CNN model to generate the images with marked regions. The processing flow is shown in Figure 2.

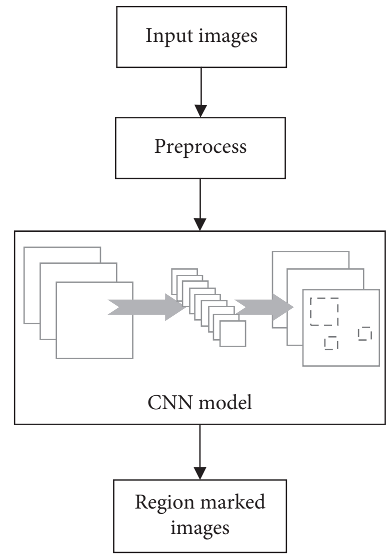

Figure 2: The processing flow of injury area determination based on CNN model.

2.3. Injury Detection and Early Warning. After obtaining the above images with marked regions, we propose an injury detection and early warning method based on a neural network model.

By constructing an adaptive neural network model to determine whether the image sports damage area is sports damage, the neural network belongs to the structure of multiple input and single output. The acquired sports injury signal feature U is used as the input vector of the neural network; the output result is b, which represents the corresponding sports injury type +1 is the value of the training sample, indicating that it is a sports injury; −1 is also the value of the training sample, indicating that it is not a sports injury. The neuron activation functions are all bisexual sigmoid functions, and the formula is as follows:

$$h(U) = \frac{1 - e^{-U}}{1 + e^{-U}}. \quad (4)$$

Suppose q is the number of hidden layer nodes of the output neural network model, hM is the activation function of the hidden layer nodes, θ_a $(a = 1, 2, ..., q)$ is the threshold; 1 is the number of output layer nodes, $h0$ is the hidden layer The activation function of the node, β is the threshold. Z_{xa} is the connection weight between the x-th hidden node and the ath input node, and Z_x is the connection weight between the x-th hidden node and the output node. Then, we can calculate the value of b as follows:

$$b = h_0 \left\{ \sum_{x=1}^{q} Z_x h_M \left[\sum_{a=1}^{10} Z_{xa} U_a + \theta_x \right] + \beta \right\}. \quad (5)$$

The sports injury is classified by the output b value. If $b \geq 0$, it belongs to sports injury, and if $b < 0$, it does not belong to sports injury.

The steps of building an adaptive neural network model are as follows:

```
Input: video data
Output: image data
(1) initialize the parameters;
(2) read the video data steam;
(3) get the frame rate;
(4) for each frame i = 1, 2, . . ., do
(5) get the name of image;
(6) get the save path;
(7) calculate image stream data;
(8) write the image into the path;
(9) end for
(10) Return the image data.
```

ALGORITHM 1: The video conversion algorithm.

(1) Construct a training sample set and a test sample set. When the initial external structural parameters of the adaptive neural network model are certain, the training sample set is learned through the BP (Back Propagation) algorithm of the neural network, and the internal connection weight parameters of the learning model are obtained.
(2) Through the test sample set, test the learning model, calculate the discrimination bias, and obtain the fitness function of the genetic algorithm.
(3) Use the learning mechanism of the genetic algorithm to adjust the external structural parameters of the adaptive neural network model, and based on the adjusted external structural parameters, obtain the internal connection weight parameters of the new adaptive neural network model through the neural network BP algorithm.
(4) Calculate the discrimination bias and fitness function in the same way and then continue to adjust the external parameters until it meets the stopping requirements of the genetic algorithm.
(5) Output the adaptive neural network model with the best generalization ability.

3. Experiments and Results

In this section, we experimentally verify the basketball injury early warning method based on the CNN model proposed in this paper.

In the experiment, we selected 50 basketball sports injury personnel as the experimental objects, and randomly divided the 50 sports injury personnel into 5 groups to test the feasibility and accuracy of the automatic detection of sports injury of this method. The neural network is trained by the training sample set, the neural network is tested by the test sample set, and the best adaptive neural network structure parameters are obtained according to the test results.

The performance metrics adopted in our experiments include Accuracy (Acc), Sensitivity (Sen), Specificity (Spe), and Positive Predictivity Value (PPV), which are common metrics used in the classification task. Their definitions are given as follows:

$$\begin{aligned} \text{Acc} &= \frac{\text{TP} + \text{TN}}{\text{TP} + \text{TN} + \text{FP} + \text{FN}}, \\ \text{Sen} &= \frac{\text{TP}}{\text{TP} + \text{FN}}, \\ \text{Spe} &= \frac{\text{TN}}{\text{TN} + \text{FP}}, \\ \text{PPV} &= \frac{\text{TP}}{\text{TP} + \text{FP}}, \end{aligned} \tag{6}$$

where TP is the number of true positive detections, TN is the number of true negative detections, FN represents the number of false negative detections, and FP represents the number of false positive detections. Each indicator represents the measurement of the classification error between the predicted value of electricity and the actual value of electricity. The more accurate the predicted value is, the bigger each indicator is, and the better the performance of the model is.

In order to verify the influence of the number of layers of the designed deep model on the performance of the model, we tested the models with different numbers of layers. Table 1 shows the performance of the network models with different numbers of layers. According to Table 1, with the increase of the hidden layer of the model, the training accuracy of the network first increases and then decreases. When the number of hidden layers of the model is 7, the maximum number of training steps is 17, and the highest accuracy is obtained. This shows that it is not that the number of hidden layers of the model is better, because the more hidden layers of the model, the easier it is to cause overfitting of the model, but it will reduce the performance of the model.

Furthermore, we compare the impact of two image preprocessing methods on model performance, including noise reduction processing and injury region detection. That is, we compare model performance with and without denoising and injury region detection. We list these conditions as follows:

(1) Without the denoising operation
(2) With the denoising operation

Table 1: The performance of the network models with different numbers of layers.

Layers	Training steps	Acc/(%)
3	20	75.4
5	20	78.7
7	17	90.4
9	15	86.6
11	15	84.2

Table 2: The comparison results of model performance under different conditions.

Conditions	Acc	Sen	Spe	PPV
(a)	82.5	83.9	82.3	80.6
(b)	85.5	82.4	82.7	84.5
(c)	84.6	83.1	84.2	83.8
(d)	88.7	86.3	85.3	87.9
(e)	81.4	80.1	78.3	80.5
(f)	90.4	88.5	89.7	90.1

(3) Without the damage region detection

(4) With damage region detection

(5) Without the denoising operation and the damage region detection

(6) With the denoising operation and the damage region detection

Table 2 shows the comparison results of model performance under different conditions. From Table 2, it can be seen that both denoising operation and injury region detection help to improve the model performance. At the same time, we can also see that the influence of noise interference on the model is not large, while the influence of region detection is relatively large.

The above-given experimental results show that the basketball injury early warning method based on the neural network model proposed in this paper has good performance.

4. Conclusions

In this paper, we propose a basketball injury early warning method based on a neural network model to protect the player and better assist the player to improve their efficiency of training. First, we preprocess the video sequence. We convert the video sequence into image data and perform noise reduction and transformation operations on the image. Second, for the processed image data, we designed a convolutional neural network model to determine the damaged area. Third, we use the neural network model to take the image data with the detection area as the input, perform feature extraction on the data, and finally obtain the early warning value of basketball sports injury.

However, as a novel method, this paper has also some limitations. On one hand, the time complexity of the algorithm has not been analyzed. On other hand, the scale of the dataset is not sufficient. In the future, we will improve the method around the mentioned two aspects. In addition, we also will consider to build one practical platform for the early injury risk warning.

Data Availability

The data used to support the findings of this study is available from the corresponding author upon request.

Conflicts of Interest

The authors declare that there are no conflicts of interest in this paper.

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Research Article

Situational English Teaching Experience and Analysis Using Distributed 5G and VR

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Situational teaching has become an important issue in the current development of new teaching modes. The development of the fifth generation (5G) and virtual reality (VR) technologies provide powerful support for reforming the new teaching method. The smart education application scenario implemented by the immersive 5G+ VR smart classroom renders situational English teaching more efficient. Therefore, in this study, we design and analyze a new teaching scenario based on 5G+ VR technology for situational English teaching. First, we design the overall framework of teaching around teaching goals, learner characteristics, teaching resources, and teaching evaluation. We divide the virtual classroom into three different teaching processes: before, during, and after class. Second, we form a virtual classroom teaching system, which includes a cloud system, communication equipment, and a VR classroom applet. Finally, we design the interaction scheme between teachers and students in situational English teaching. The experimental results demonstrate that our method improves teaching effectiveness, which has significant implications for English teaching.

1. Introduction

The promotion and application of the fifth generation (5G) technology [1, 2] have led to the development of a new mode of coconstruction and sharing of educational resources. In this new era context, 5G was introduced into the campus, thereby helping the creation and development of smart education. Virtual reality (VR) is the use of computer technology to generate realistic visual and auditory tactile integration of a specific range of virtual environments [3, 4]. Utilizing the necessary equipment, the user interacts and influences the objects in the virtual environment naturally, resulting in an immersive feeling and experience.

5G is the next generation of mobile communications, which can provide faster upload and download speeds, wider coverage, and increasingly stable connections. The main direction of the new generation of mobile communication technology development is toward 5G, which forms an important part of the future generation of information and communications infrastructure. Compared with 4G, 5G has the technical characteristics of "ultrahigh speed, ultralow latency, and ultralarge connection," which will not only further improve users' network experience but also bring faster transmission speed to mobile terminals, meet the application requirements, and endow most things with the ability to connect online. The world is transitioning to mobile and consuming more data every year, especially with the growing popularity and increase in video and music streaming. Bandwidths have become more congested now, causing service disruptions, especially when many people in the same area attempt to access online mobile services simultaneously. 5G is better at handling several devices, from phones to device sensors and from cameras to smart streetlights.

One of the advantages of VR is its uniqueness in providing a 360-degree panoramic picture, unlike traditional video content [5, 6]. Users can not only feel the environment through sound but also fully influence it, and the sense of space and distance is more layered. This immersion enlivens the VR experience, which is why the VR industry has emerged as an exciting industry. Neither television nor a computer can generate such a real feeling. Even the best computer gaming footage might not be as good as the experience of passing a blue whale by your side.

VR has a wide range of applications. In addition to its application in the gaming industry, it offers certain unique advantages in sectors such as teaching and medical treatment. However, the application of VR technology requires the support of a high network transmission bandwidth, which 5G can offer. The combination of 5G and VR has revitalized many sectors.

The smart education application scenario implemented by the immersive 5G smart classroom renders situational English teaching more efficient [7–9]. The immersive 5G smart classroom uses the VR teacher classroom mode in the 5G network environment, the remote teaching collaborative 4 K/8 K high-definition video mode, the holographic immersive future teaching mode, and the mobile teaching mode to explore more efficient and interesting teaching methods. Through the 5G + education application, multiple smart education application scenarios can be created, and simultaneously, a new ecology of 5G + smart education can be gradually built [10–12].

Live teachers combined with VR can broaden students' thinking and lead them to the VR world to experience a real and comprehensive teaching experience. For example, in the VR space scene experience, students can virtually travel to space and observe its characteristics such as the shape and color of each planet from 360 degrees. Combined with the classroom VR experience, students can imagine the future application scenarios of VR technology through group discussions.

The traditional video transmission technology has the problems of communication barriers between students and teachers and has difficulty in controlling the effect of students' classroom listening, which adversely impacts teaching effectiveness [13]. The headset of VR technology can better ensure that students keep up with the content of the teacher's lessons, which is more advantageous than traditional methods in distance teaching. The immersive feeling of VR technology, especially the real teaching scene combined with the actual teaching content, is more intuitive, can promote the enthusiasm of students, and is more aligned with the dominant thinking characteristics of primary and secondary school students' intuitive and perceptual image thinking. This is not only conducive to promoting the transfer of students' knowledge and forming a clear understanding but also helps students to form a correct understanding.

Driven by 5G, the picture of education transmission on the VR platform as well as data splitting is clearer [14, 15]. This disassembles and labels the teaching and research content and becomes the basis for recording each student's reflection on the learning content of each stage. Based on this big data, parallelly, the overall analysis and recording of the teaching courses are conducted during the class to control the shape of the classroom scene and run through all aspects of learning. Applying VR technology to teaching applications can present the traditional incomprehensible knowledge points to the virtual scene. Through VR equipment, students are immersed in interactive learning in virtual situations, providing students an immersive experience.

From the perspective of English immersion teaching, VR teaching can create a good teaching situation for college students who are learning English and promote the development of intelligent, scene-based, and efficient English teaching. Immersive English teaching means that learners can interact naturally with the environment, including other learners or mentors connected through the network, implying that learners feel immersed and highly engaged. The best method to achieve English immersion learning is to let students feel and experience a scene that is close to real life. However, time, distance, safety, and other issues encumber reproducing all the scenes in the actual teaching process. The application of VR technology provides the possibility for immersive English teaching, which implies that learners can combine the theory with practice after learning the theory. In the virtual environment, learning is no longer just boring memorization and recitation, but the application of the knowledge they have learned to real scenarios. The precise simulation and real-time interactivity of VR technology directly affect the quality of classroom teaching.

In this paper, we analyze the application experience of 5G and VR technology in situational English immersion teaching. The main contributions of this paper are summarized as follows: (1) we design the overall framework of teaching around teaching goals, learner characteristics, teaching resources, and teaching evaluation, where the virtual classroom is divided into three different teaching processes: before, during, and after class. (2) We form a virtual classroom teaching system, which includes a cloud system, communication equipment, and a VR classroom applet. (3) We design the interaction scheme between teachers and students in situational English teaching.

The rest of this paper is organized as follows: Section 2 introduces the teaching method designed for situational English teaching based on 5G+ VR technology, including the teaching process, presentation in class, and interaction design. Section 3 presents experimental studies and results to compare and demonstrate the performance of the designed teaching method under two English teaching methods. Section 4 concludes the paper.

2. Immersive Teaching Design based on 5G+ VR

In recent years, the development of VR technology has received considerable attention, and with the further popularization of 5G networks, online teaching has emerged as one of the most popular teaching methods besides school teaching [16, 17]. Based on this feature and the needs of the current teaching content, we attempt to develop and explore the course mode and resources and apply 5G+ VR technology to the English teaching scenario.

Instructional design is a process of systematically designing and realizing learning objectives. It follows the principle of optimal learning effect and is the key to the quality of courseware development. First, we design the overall framework of teaching around teaching goals, learner characteristics, teaching resources, and teaching evaluation. The virtual classroom solves various problems of traditional education through different task-based teaching of "before class, during class, and after class," to optimize the learning effect. Second, based on the characteristics of the existing 5G+ VR technology, we design a virtual classroom teaching system, which includes a cloud system, communication equipment, and a VR classroom applet. The combination of each subsystem and teaching design is introduced as follows.

2.1. Teaching Process. As mentioned above, the virtual classroom can be divided into three different teaching processes: before class, during class, and after class. The overall design of the teaching process is illustrated in Figure 1.

In the "before class" stage, the microlecture videos and preview test questions corresponding to the courses that students will learn are extracted from the cloud system through the platform and pushed. The system can select auxiliary materials and videos to be used in the classroom according to the teaching content. Teachers constantly adjust the teaching content according to students' test scores and feedback to move it closer to students' actual level, which can greatly improve their learning enthusiasm.

In class, interactive platform software is used to build a simulated environment with foreign locales for students, such as vacations abroad, pick-up at international airports, cafes, cafeterias, and lawns, to improve students' practical application and oral English abilities. Teachers and students realize voice communication and barrage interaction through the communication system in the virtual classroom. The data transmission network built based on the 5G system meets the needs of the VR port for cloud data uploading and data sharing with high speed, a large amount of time, large delay, and small delay.

After class, according to the students' test feedback before class and the interaction in the virtual classroom, teachers arrange personalized games for students in the WeChat applet and set up small game rewards. Through various means such as virtual character upgrades, virtual equipment rewards, and side quest promotion, the interest of learners is further stimulated and the learning results are consolidated. These teaching processes fully utilize 3D modeling and visualization techniques to provide real or near-real environments and situations, creating a strong sense of immersion and motivating learners. Authenticity improves environment fidelity, control reliability, and user experience. Authenticity not only means that the created environment and the objects it contains have a high sense of reality but also implies that the problems created originate from real life and have real meaning.

2.2. Presentation in Class. For students to learn efficiently in virtual classrooms, practical, economical, and convenient VR equipment is indispensable. These devices include both headsets and virtual desktop environments.

The VR devices in the market today are mainly of three types with a wide range of applications: mobile headsets,

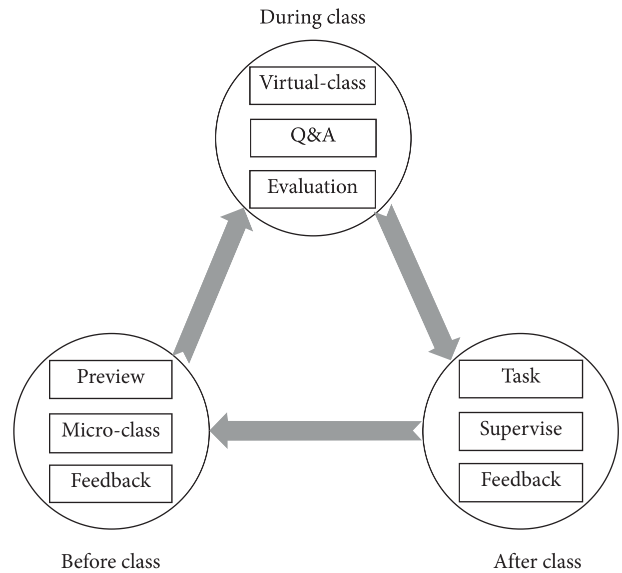

Figure 1: Overall design of the teaching process.

external wearable devices, and all-in-one headsets. Among them, the mobile head-mounted display has the simplest structure and the lowest price, although the user experience is poor and cannot adequately achieve the purpose of virtual classroom learning. The external wearable device has an independent processor and is equipped with a special operating system, which simplifies its use. The all-in-one head-mounted display has the best imaging effect and is free from the shackles of external data cables.

Desktop VR (WebVR) [18, 19] uses personal computers and low-level workstations for simulation and the computer's display screen serves as a window for learners to experience VR. Desktop virtualization technology can enable the terminal desktop application environment to exist independently without relying on the hardware environment [20, 21]. Therefore, the cost of VR on the desktop is relatively low and it compensates for the need for the healthy development of students' eyesight. Therefore, this technology has a wide range of applications and is the best medium for the current fantasy English learning. The implementation of desktop VR application software relies on the development of WebGL technology [22, 23]. WebGL creates and runs 3D images on the browser. It follows the OpenGL ES specification and writes shader code through the GLSL language, including vertex and fragment shaders. The code written in GLSL is compiled to the GPU, then mapped to the OpenGL API for calling, and finally returned to WebGL rendering. The development process can include VR data initialization, WebGL initialization, and animation rendering as shown in Figure 2.

In addition to self-developed desktop VR software, we also consider using products that have been developed in the market, such as the video player of play2VR, which supports multiterminal use, is convenient, and low-cost. Using it only entails registering an account, uploading the premade media (course video or picture), and then copying the integrated code to the port of the WeChat applet [24], after which

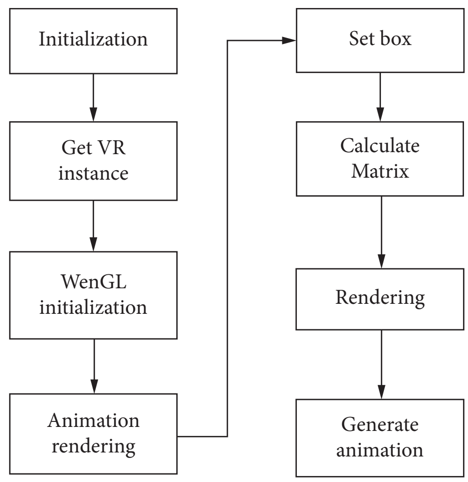

Figure 2: Development process of WebVR.

students can participate in the virtual classroom online learning on the student side.

2.3. Interaction Design. Interaction is an indispensable link in the learning process and has the functions of communicating information, diagnosing learning situations, emotional exchange, and promoting reflection. Interaction is a psychological need and self-actualization whose main purpose is to provide help and guidance to the learner to obtain timely learning feedback. Interaction design includes two parts: student interaction and teacher interaction.

In the English teaching situation, students' activities are mainly based on exploration, learning, and experience. Students appear in the virtual space in the form of avatars, can roam in the virtual space, interact with virtual objects to perceive information, and observe objects from various angles. The first-person perspective can be used in the design. At this time, the scene that students view is consistent with the scene that the avatar views. This perspective has a good sense of substitution and can produce a strong immersive psychological experience. A third-person perspective can also be used, where students can observe not only the scene but also their avatars. In the "reflective situation" and "concept forming situation," students' activities are mainly based on reflection, observation, discussion, sharing, dialogue, operation, and practice and can be designed into competitions, entertainment, and other forms. For example, if students answer the question correctly, some words of praise or sounds can appear in the virtual space, or they can be rewarded with virtual items. In the "verified situation," students' activities are to solve similar problems, test the acquired knowledge, and consolidate the learned concepts through activities such as tests, operations, decision-making, and exploration.

The role of teachers in the experiential teaching environment is mainly to assist learners to experience the situation, guide and communicate timely, and help learners to reflect and summarize. Instructors design corresponding activities according to different roles. As students are the main body of experiential learning in a virtual environment, the role of teachers in the design should be weakened to the maximum possible extent, and students' learning subjectivity should be highlighted. The design of experiential learning activities should play the role of the learner's main body.

The interactive form of a VR-based experiential learning environment can be designed either explicitly or implicitly. Explicit interaction means that learners can always view interactive elements, such as highlighting colors, flashing displays, and indicating arrows of interactive elements in the scene, so that learners can use them at any time. Implicit interaction implies that the elements interacting in the scene do not always exist, and only appear when the learner reaches an area, and the interactive elements disappear automatically when they leave this area. The purpose is to provide temporary prompts to enable barrier-free learning. From the perspective of interactive subjects and objects, it is divided into two situations: human-virtual object interaction and human-human interaction. In virtual space, both interaction situations are very important. The interaction between humans and virtual objects can promote the learner's experience, while human-to-human interaction can enhance learners' reflection. It should also fully consider VR-specific interaction technologies and devices, such as the use of "motion capture," "haptic feedback," "voice interaction," "eye tracking," and other interactive technologies to achieve natural interaction, which helps to increase the sense of immersion.

According to the interaction between the virtual and real classrooms, we divide classroom teaching into three stages, continuously implement feedback and exploration of classroom teaching activities, and plan to develop a teaching design that integrates virtual and real formats. The design map of the 5G+ VR-based classroom teaching method employed in this study is shown in Figure 3.

3. Analysis of Immersive Teaching Implementation based on 5G+ VR

In this section, we experimentally verify the designed method based on the 5G+ VR in the situational English teaching analysis proposed in this study.

Aiming at the situational English teaching analysis method based on 5G and VR technology designed in this study, we conduct some experiments to verify the effect of the designed method in English teaching. In the experiment, we select 20 students in the English classroom to conduct classroom tests. The effectiveness of the method is verified from the following three experiments:

(1) whether the concentration time in English learning is improved
(2) whether the learning efficiency is improved
(3) whether the learning interest is improved

In the first experiment, we continue to monitor the English learning focus time of 20 students. Specifically, in the experiment, we continuously examine each student's attention at the beginning of learning and record their concentration

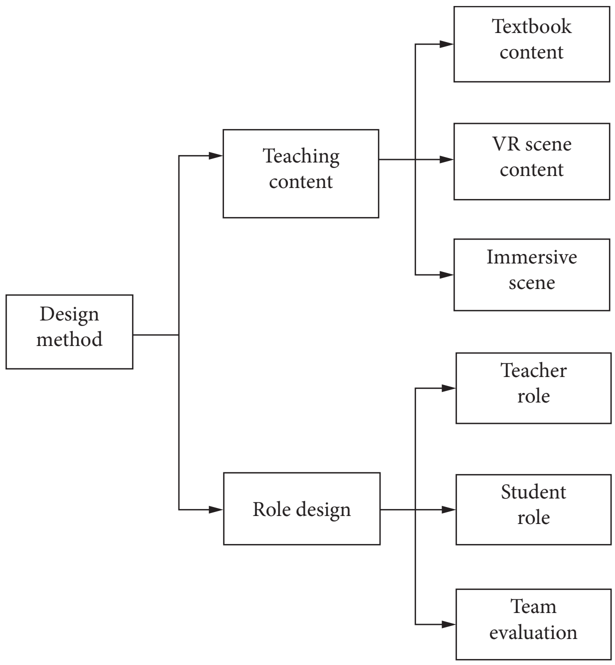

Figure 3: Design map of the 5G+ VR-based classroom teaching method.

Table 1: The results of the concentration time of students in the two groups of experiments.

No.	Normal	5G+ VR	Improvement
1	15	28	13
2	16	30	14
3	13	24	11
4	18	28	10
5	19	29	10
6	14	26	12
7	16	34	18
8	18	31	13
9	20	28	8
10	13	24	11
11	21	30	9
12	18	31	13
13	17	32	15
14	13	34	21
15	24	31	7
16	16	27	11
17	20	29	9
18	17	24	7
19	18	28	10
20	19	31	12

time in real-time. Notably, the duration of each lesson in the experiment is 40 minutes. To compare the role of 5G+ VR technology in situational English teaching, we compare two groups of experimental data. One group used the 5G+ VR technology in the situational English teaching method designed in this study, whereas the other group used the common teaching mode. Table 1 presents the results of the concentration time of students in the two groups of experiments, where "normal" represents the normal teaching model, and 5G+ VR represents the 5G+ VR technology in the

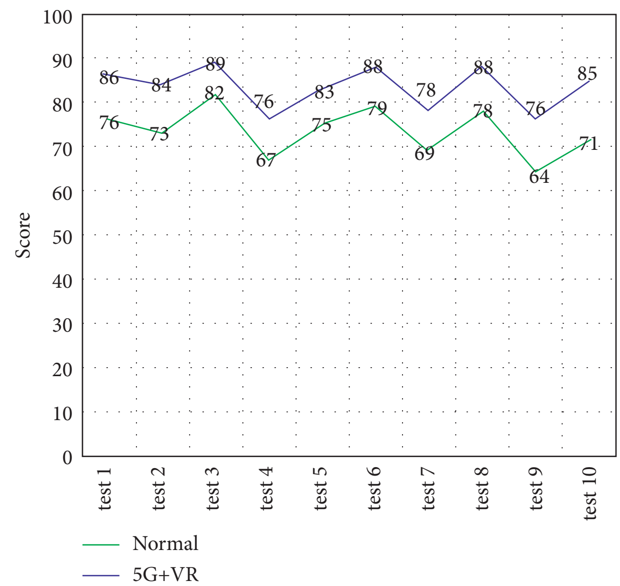

Figure 4: The average scores achieved by students in the 10 tests under the two teaching schemes.

situational English teaching method designed in this study. As evident from Table 1, in the second teaching mode, that is, the 5G+ VR model, students' concentration time in the classroom is greatly improved compared to the ordinary teaching mode.

In the second experiment, we design 10 test scenarios to test whether students' learning efficiency improved. In other words, we compare the learning efficiency of students in the situational English teaching scheme using 5G+ VR technology and the ordinary teaching scheme. Figure 4 depicts the average scores achieved by students in the 10 tests under the 2 teaching schemes. As evident from Figure 4, the average scores of students in the situational English teaching plan using 5G+ VR technology are higher than those of ordinary teaching methods, which demonstrates that students' learning efficiency is improved in the situational English teaching plan using 5G+ VR technology.

In the third experiment, we test whether students' interest in learning improved by recording the number of student-teacher interactions. Thus, we compare the number of interactions between students and teachers in the situational English teaching plan using 5G+ VR technology and the general teaching plan. Table 2 describes the number of 20 student-teacher interactions in both tests under the two teaching scenarios.

Table 2 illustrates that in the situational English teaching plan using 5G+ VR technology, the number of interactions among students is significantly higher than that in the ordinary teaching method, which indicates that students' interest in learning improves by using the 5G+ VR technology in the situational English teaching.

We can draw the following conclusions from the above-given experiments. First, compared with traditional education methods, 5G+ VR teaching can achieve maximum utilization of resources without being limited by time and region. Simultaneously, the immersive scene can fully

Table 2: The interactions times under the two teaching methods.

No.	Normal	5G+ VR
1	1	2
2	1	3
3	0	1
4	1	2
5	1	1
6	2	2
7	0	3
8	0	2
9	2	2
10	1	2
11	1	3
12	1	2
13	1	3
14	1	2
15	2	4
16	1	2
17	0	2
18	2	4
19	1	3
20	1	1

transmit the teacher's teaching content to students, effectively communicate and interact between teachers and students, and answer questions timely. This mode can restore the vivid learning mode to the maximum possible extent and can also improve the learning experience of students. Second, two major problems still exist in the realization of virtual classrooms: (1) too few VR course resources have been developed and the production process is relatively slow; (2) the equipment for realizing virtual classrooms still cannot fully realize comprehensive immersive learning, and learners could be disturbed by the outside world while studying. The application of VR in English teaching can indeed increase the learner's ability to use language and promote the all-around development of the learner. To ensure the popularity of VR English teaching, and considering the characteristics of students' physical development, WebVR is the most reasonable method to realize this teaching mode. With instant synchronization of data from a computer, mobile phone, or tablet, students can seamlessly switch learning devices, thereby increasing learning flexibility.

4. Conclusion

In this study, we analyzed a teaching scene-based 5G+ VR technology for situational English teaching. We first designed the overall framework of teaching around teaching goals, learner characteristics, teaching resources, and teaching evaluation. We divided the virtual classroom into three different teaching processes: before class, during class, and after class. Second, based on the characteristics of the existing 5G+ VR technology, we designed a virtual classroom teaching system, which included a cloud system, communication equipment, and a VR classroom applet. Finally, we designed the interaction scheme between teachers and students in situational English teaching. The experimental results proved that the method designed in this study improved performance in teaching effectiveness, which has great significance for English teaching.

Data Availability

The data used to support the findings of this study is available from the corresponding author upon request.

Conflicts of Interest

The authors declare that there are no conflicts of interest in this article.

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