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A Method of Applying Virtual Reality Converged Remote Platform Based on Crawfish Optimization Algorithm to Improve ESN Network

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Abstract

INTRODCTION: Immersive teaching and learning methods based on virtual reality-integrated remote platforms not only allow foreign language learners to learn in a vivid and intuitive learning environment, but also provide good conditions for multi-channel perceptual experiences of foreign language learners in terms of sight, sound and touch.
OBJECTIVES: To address the problems of insufficiently systematic analysis and quantification, poor robustness and low accuracy of analysis methods in current effect analysis methods.
METHODS: This paper proposes an effect analysis method of virtual reality fusion remote platform based on crawfish optimization algorithm to improve echo state network. First, the effect analysis system is constructed by analyzing the process of virtual reality fusion remote platform and extracting the effect analysis influencing elements; then, the echo state network is improved by the crayfish optimization algorithm and the effect analysis model is constructed; finally, the high accuracy of the proposed method is verified by the analysis of simulation experiments.
RESLUTS: The proposed method improves the accuracy of the virtual reality fusion remote platform effect analysis model, the analysis time is 0.002s, which meets the real-time requirements, and the number of optimization convergence iterations is 16, which is better than other algorithms.
CONCLUSION: The problems of insufficiently systematic analytical quantification of effect analysis methods, poor robustness of analytical methods, and low accuracy have been solved.

Keywords: virtual reality technology application, foreign language, teleplatform construction, effect analysis, crayfish optimization algorithm, backward state neural network

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1. Introduction

The development and application of artificial intelligence technology and virtual reality technology has accelerated the deepening reform in the field of distance education, accelerated the intelligent level of distance learning platform, improved the quality of intelligent remote platform construction, and enriched the means of distance education and learning [1]. Internet technology has accomplished distance education, making education and teaching no longer subject to site constraints, and no longer limited to a single means of teaching [2]. With the diversification of teaching content, the existing foreign language distance learning platform has been unable to meet the needs of students in the new era, the lack of virtual and real integration of distance teaching and learning environment, distance teaching or distance learning means a single remote classroom ignores the students or self-learner's personal experience [3]. With the development of teaching mode and learning strategy changes presenting informationization and intelligence, the integration of virtual reality technology has also attracted much attention [4]. Immersive teaching and learning methods based on virtual reality fusion remote platform, not only allows learners to learn in a vivid and intuitive learning environment, but also provides good conditions for learners to see, hear, touch and other multi-channel perceptual experience, enhances the sense of immersion in learning and physical and mental experience, and is conducive to promoting the traditional remote platform teaching mode and learning strategies to push forward the new [5]. Therefore, the study of virtual reality technology integration remote platform effect analysis method is an extremely urgent task [6].

Effective, scientific and systematic method of analyzing the effect of virtual reality technology fusion remote platform not only analyzes the process of fusion remote platform [6], but also builds a high-precision, high real-time virtual reality fusion remote platform effect analysis model [7]. The current application of virtual reality technology in the teaching platform mainly includes the fields of virtual campus, distance education, virtual experiment, game education, and virtual reality program development [8]. The integration effect analysis methods mainly include random forest, support vector machine, neural network, deep learning, intelligent optimization algorithm and other methods [9]. Literature [10] used various types of distance learning data, combined with the random forest algorithm, to build a fusion distance platform effect analysis model; literature [11] explored the impact of diversified virtual reality technology on the distance classroom, used the support vector regression algorithm to build the effect analysis model, verified the effectiveness of virtual reality technology teaching, and analyzed the effect value of the fusion of virtual reality technology in the distance classroom; literature [12] by exploring the combination of virtual reality and education on the modernization and intelligent promotion of teaching, designing a neural network-based effect analysis model, and verifying the effectiveness of the intelligent effect analysis method in the fusion remote platform; Literature [13] designed a cloud-based virtual operating platform, combined with the machine learning method, to develop the analysis program of virtual reality fusion remote platform, and verified the feasibility of quantifying the effect; Literature [14] proposed a remote teaching evaluation method based on decision tree algorithm, while combining virtual reality technology, analyzed the application integration effect, thus improving the quality of teaching; literature [15] extracted the virtual reality technology fusion remote platform effect analysis indexes by dividing and established the virtual reality technology fusion remote platform evaluation model based on the intelligent optimization algorithm optimization and improvement of machine learning, to provide a new analysis method for the effect analysis method ideas; Literature [16] combines integrated learning technology and deep learning technology to propose a virtual reality technology fusion intelligent remote platform effect analysis model based on virtual reality technology, which verifies the efficiency of integrated learning and deep learning technology. For the above literature analysis, the existing integration effect analysis methods have the following defects [18]:

1) There are fewer quantitative methods to analyze the effect of virtual reality technology integration remote platform, and they are not objective and systematic enough [19];

2) The effect analysis method lacks generalization and has poor robustness [20];

3) Effect analysis methods are less accurate and the sample size tends to overfit the training model [21].

Echo state network (ESN) is proposed by Jaeger, which has a big difference in model construction and learning algorithm compared with traditional recurrent neural network, and its corresponding learning algorithm opens a new era for the research of recurrent neural network by virtue of learning in the form of back propagation which is different from that of recurrent neural network [22]. Intelligent optimization algorithms are mainly divided into four categories: nature-like optimization algorithms, evolutionary algorithms, plant growth algorithms and group intelligent optimization algorithms, of which the group intelligent optimization algorithm is the most important category of algorithms. Intelligent optimization algorithms and image processing, fault detection, path planning, particle filtering, feature selection, production scheduling, intrusion detection, support vector machines, wireless sensors, neural networks and other technical areas of cross-fertilization, the application of a wider range of [23]. Echo state network method based on group intelligence optimization algorithm makes the accuracy of effect analysis increase, and its application in virtual reality technology fusion remote platform effect analysis and prediction problem has become a research hotspot for experts and scholars in the field.

Aiming at the problems existing in the current method of effect analysis of virtual reality technology fusion remote platform, this paper proposes a method of effect analysis of virtual reality technology fusion remote platform based on group intelligence optimization algorithm to improve echo state network. The main contributions of this paper are (1) to analyze the process of fusion remote platform by understanding the advantages of virtual reality technology, and to construct the effect analysis system; (2) to obtain the effect analysis data by using questionnaires, interviews, and online learning software, and to carry out the relevant data analysis; (3) to optimize the ESN hyper-parameters by using the group intelligence optimization algorithm, and to propose the effect analysis method based on the crayfish heuristic algorithm to optimize ESN network analysis method; (4) through virtual reality technology fusion remote platform data simulation verified the effectiveness of the effect analysis method proposed in this paper, while improving the analysis efficiency.

2. Virtual Reality Fusion Remote Platform Issues

By analyzing the advantages of virtual reality technology, researching the process of virtual reality fusion remote platform, and constructing the virtual reality fusion remote platform system.

2.1. Virtual Reality Technology Advantages

Virtual reality technology is through the use of computer technology and related high-tech science and technology, to create a design in a certain range in three-dimensional three-dimensional form, and through the use of the corresponding equipment, in the form of human-computer interaction to experience the interaction with the virtual character [24].

Teaching applications based on virtual reality have the following advantages: 1) virtual reality technology can effectively present specific learning scenes, experimental environments, instrumentation and the internal structure of the object; 2) virtual reality technology can meet the learning requirements of learners with different needs, in different locations, at different times, and at different levels; 3) virtual reality technology can enhance the teaching and learning interest and the ability of students to learn independently.

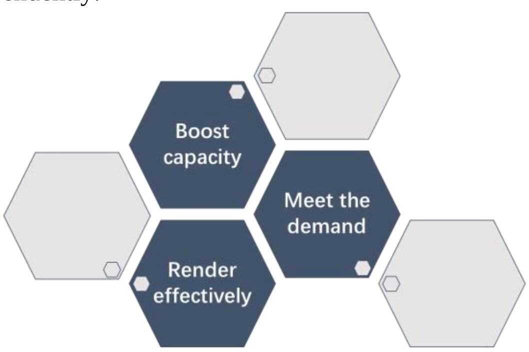


Figure 1. Advantages of virtual reality technology

2.2. Converged Remote Platform Process Analysis

According to the teaching resources, combined with virtual reality technology, the process of integrating remote platform mainly includes determining the selected topic, instructional design, scripting, development and production, system integration, evaluation and modification, and the process analysis diagram is shown in Figure 2 [25].

(1) Determination of the topic

Virtual reality technology integration distance learning platform process should first determine the selection of topics from the students' cognitive level, content characteristics, knowledge of the key points, etc., to follow the selection of a strong situational, picture-rich teaching content.

(2) Instructional design

Instructional design refers to the process of anticipating the conceptualization of the classroom before the teacher carries out the teaching content, and in the application of virtual reality technology should be considered in the course objectives, equipment resources, specific processes and post-course evaluation and other aspects.

(3) Scripting

Scripting is an important transitional stage in the process of virtual reality integration and is the main basis for the development of teaching resources, including the selection of scenes and virtual characters, the presentation of textual content and behavioral action settings.

(4) Development and production

The production of virtual reality technology integration platform resources is based on the script content production and development, the use of VR software development tools, carry out to carry out the production of text, audio, objects, behavioral actions and other aspects of the material.

(5) System Integration

System integration refers to the development and production is completed, the use of video editing software will be in accordance with the teaching design of the process of nuclear script synthesis of the material, through the system integration so that the combination of resources into a unified whole.

(6) Evaluation modifications

In order to effectively utilize the integration of virtual reality on a distance platform, improvements and modifications were made to the teaching resources, taking into account the opinions of teachers and students.

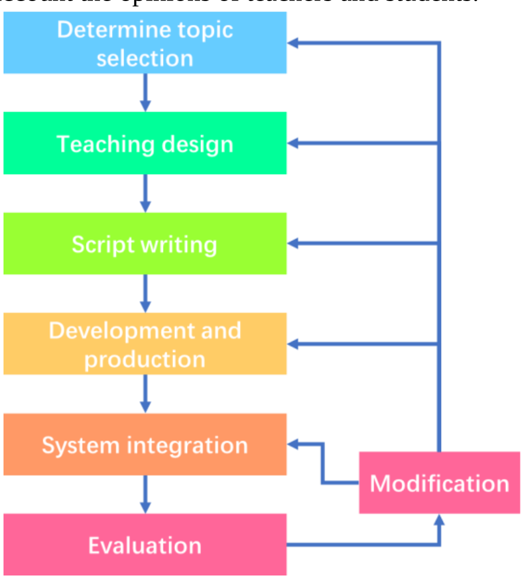


Figure 2. The process analysis of the converged remote platform

In order to better evaluate the advantages and disadvantages of the effect analysis algorithm, this paper takes the design of virtual reality integration remote platform as an example, carries out the construction of virtual reality integration remote platform system, and researches the application analysis model. The whole-process virtual reality integration remote platform system is constructed by taking the six influencing factors such as determining the topic selection, teaching design, script writing, development and production, system integration and evaluation and modification as indicators, and the specific schematic diagram is shown in Figure 3.

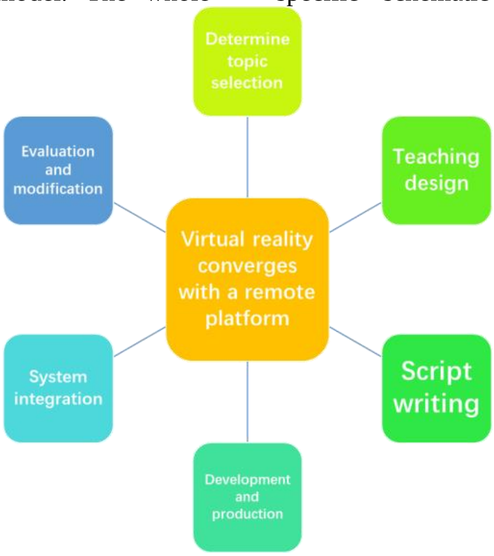


Figure 3. Virtual Reality Converged Remote Platform System

3. Data preprocessing and analysis

3.1. Data acquisition

In order to obtain reliable data of virtual reality fusion teleplatform, this paper adopts three ways to obtain data such as questionnaire survey, interview, and online learning software, and the schematic diagram of data acquisition methods is shown in Figure 4.

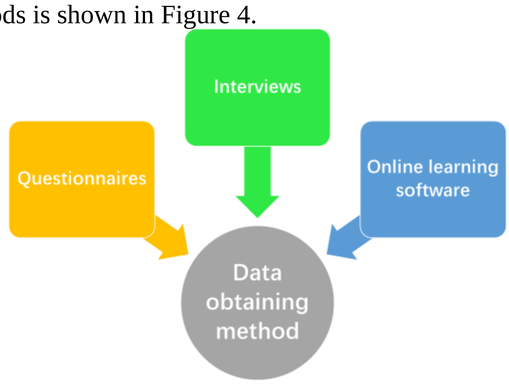


Figure 4. Data acquisition method

3.2. Data processing methods

(1) Correlation analysis

In order to analyze the redundancy of the input indicators, this paper investigates the correlation analysis of the influencing factors related to teaching effectiveness in higher education. The indicator parameter variables are all normal continuous variables, and the correlation coefficients can be calculated by Pearson with the range of $[-1,1]$. The calculation formula is as follows:

$$\rho(x,y)=\frac{\operatorname{cov}(x,y)}{\sigma(x)\cdot\sigma(y)}=\frac{E\left[(x-\mu_x)(y-\mu_y)\right]}{\sigma(x)\cdot\sigma(y)} \tag{1}$$

Where: $\operatorname{cov}(x,y)$ is the coefficient of variation, $\sigma(x)$ and $\sigma(y)$ are the standard deviations.

(2) Principal component analysis

In order to reduce the redundancy of input indicators, this paper chooses the principal component analysis method [26] for dimensionality reduction. In the process of dimensionality reduction feature extraction, the input indicators are usually transformed to generate comprehensive indicators, i.e., principal components, so that the principal components improve the precision of evaluation effect than the original variables. The steps for dimensionality reduction of the influencing factors of listening classroom effect analysis based on the principal component analysis method are as follows:

Step 1: Standardized processing of indicator characteristics. In order to eliminate the quantitative differences between the influencing factors of different elements, the original data matrix is standardized, and the standardized matrix Z is obtained by using the Z-Score method, where n is the number of samples, and d is the dimension of the characteristics of the sample indicators.

Step 2: Determine the matrix of correlation coefficients between indicators Σ :

$$\sigma_{ij} = \frac{\sum_{k=1}^{n}\left(z_{ki}-\bar{Z}_i\right)\left(z_{kj}-\bar{Z}_j\right)}{\sqrt{\sum_{k=1}^{n}\left(z_{ki}-\bar{Z}_i\right)^2\left(z_{kj}-\bar{Z}_j\right)^2}} \quad (2)$$

Where z_{ki} denotes the standardized value of the ith indicator for the kth sample; $\bar{Z}_i$ is the mean value of the ith indicator; σ_{ij} is the covariance of the vectors Z_i and Z_j .

Step 3: Determine the characteristic roots as well as the eigenvectors of the correlation coefficient matrix Σ . The symmetric positive definite matrix $\Sigma = \left[\sigma_{ij}\right]_{d\times d}$ is necessarily orthogonally similar to the diagonal matrix Λ , i.e:

$$U^T \Sigma U = \Lambda = \begin{bmatrix} \lambda_1 & & & \\ & \lambda_2 & & \\ & & \ddots & \\ & & & \lambda_d \end{bmatrix} \quad (3)$$

where, assuming $\lambda_1 \geq \lambda_2 \geq \cdots \geq \lambda_d$. U is an orthogonal matrix consisting of eigenvectors corresponding to the eigenroots.

Step 4: Calculate the contribution of the ith principal component ω_i :

$$\omega_i = 1 \Big/ \sum_{j=1}^{d} \lambda_j \quad (4)$$

Step 5: Sort the components one at a time according to the magnitude of the contribution rate, determine the information retention threshold after decoupling α , and if the cumulative contribution rate of the first k components ρ is greater than α , then the number of principal components is k.

$$\rho = \sum_{i=1}^{k} \omega_i \quad (5)$$

Step 6: Output the k indicator features associated with the principal components.

4. Echo state neural network

Echo state network (ESN) is a kind of recursive neural network, using the "reserve pool" method to construct the network hidden layer, usually used for the prediction of time series [27].ESN is mainly composed of the input layer, storage layer, output layer, the specific structure is shown in Figure 5. The connection weights $\boldsymbol{W}_{in}^{r\times n}$ from the input layer to the storage pool are untrained and do not change after random initialization. The reserve pool input comes from the output of the previous state of the input layer and the reserve pool respectively, and the state feedback weight $\boldsymbol{W}^{r\times r}$ is randomly initialized without training. Reserve pool to the output layer weights $\boldsymbol{W}_{out}^{m\times r}$ need to be trained, generally using Ridge regression (Ridge regression) method to train the connection weights, which is expressed as follows:

$$\boldsymbol{W}_{out} = \boldsymbol{Y}_{long}\boldsymbol{H}^T\left(\boldsymbol{H}\boldsymbol{H}^T + \lambda_r \boldsymbol{I}\right)^{-1} \quad (6)$$

Where $\boldsymbol{H}$ is the storage pool state and λ_r is the regularization factor. The state of the pool at $\boldsymbol{H}$ is shown below:

$$\boldsymbol{H}(t) = \tanh\left(\boldsymbol{W}_{in}\boldsymbol{X}_{long}(t) + \boldsymbol{W}\boldsymbol{H}(t-1)\right) \quad (7)$$

where tanh denotes the hyperbolic tangent activation function.

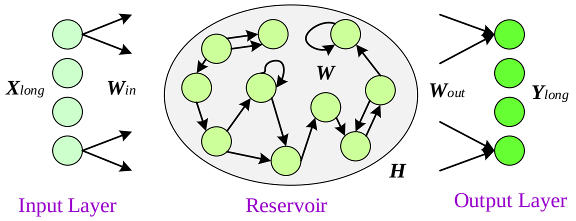


Figure 5. Echo state neural network

The process of ESN algorithm includes two phases of weight parameter initialization and training.ESN network contains relatively more neurons, and the connection weights between neurons in the storage pool are randomly generated and their connections are sparse.The hyperparameters of ESN affect the prediction effect, and adjusting the hyperparameters is very important, in which the ESN hyperparameters include the storage pool size N , the spectral radius SR , the input scaling factor IS , the sparseness of the storage pool degree SD .

5. Crayfish Optimization Algorithm

5.1. Inspiration mechanisms

Crayfish optimization algorithm (COA) [28] is inspired by crayfish foraging, heat avoidance and competition behaviors. Crayfish foraging and competitive behaviors belong to the exploitation phase of COA, and summering behavior belongs to the exploration phase of COA. In order to reflect the characteristics of swarm intelligence, the crayfish population X is defined as the initial stage of the algorithm, X_i is the position of the *ith crayfish*, which represents the candidate solution $X_i = \left\{X_{i,1}, X_{i,2}, \cdots, X_{i,\dim}\right\}$, and $\dim$ is the feature quantity (decision dimension) of the optimization problem. The crayfish candidate solution obtains the fitness value through the objective function $f(\cdot)$. The crayfish optimization algorithm (COA) should follow the following heuristic rules:

1) The COA algorithm development and exploration phase is regulated by the temperature of the environment where crayfish live. When the temperature is too high, COA enters into heat avoidance or competitive behavior; when the temperature is suitable, COA enters into foraging behavior;

(2) In summering behavior, crayfish populations update the solution by individual location and burrow location;

3) In foraging behavior, food as the optimal solution is obtained by the current fitness value and the optimal fitness value.COA uses sine and cosine to simulate the lobster's food delivery behavior. Food intake is determined by temperature.

5.2. Search Optimization Strategy

(1) Initialization of stocks

The COA algorithm is initialized with a random uniform distribution strategy and the data model is as follows:

$$X_{i,j} = lb_j + \left(ub_j - lb_j\right) \times rand \tag{8}$$

Where $X_{i,j}$ denotes the jth dimensional location information of the ith crayfish, lb_j and ub_j denote the lower and upper bounds of the jth dimension, respectively, and $rand$ denotes a random number in the range of $[0,1]$.

(2) Defining temperature and food intake

Temperature changes affect crayfish behavior, resulting in different behavioral stages. When the temperature is higher than 30 °C, crayfish will choose a cool residence in summer; in the right temperature, crayfish control to carry out foraging behavior and is affected by temperature. Crayfish feeding is best at 15 °C, 30 °C, and 25 °C. The mathematical model of COA intake was constructed as follows:

$$p = C_1 \times \left(\frac{1}{\sqrt{2 \times \pi} \times \sigma} \times \exp\left(-\frac{(temp - \mu)^2}{2\sigma^2} \right) \right) \tag{9}$$

$$temp = rand \times 15 + 20 \tag{10}$$

Among them, crayfish intake is approximately normally distributed, $temp$ represents the temperature of the environment where crayfish live, μ represents the most adapted temperature of crayfish, σ and C_1 are mainly used to control the intake of crayfish at different temperatures. The temperature influence of crayfish intake is shown in Figure 6.

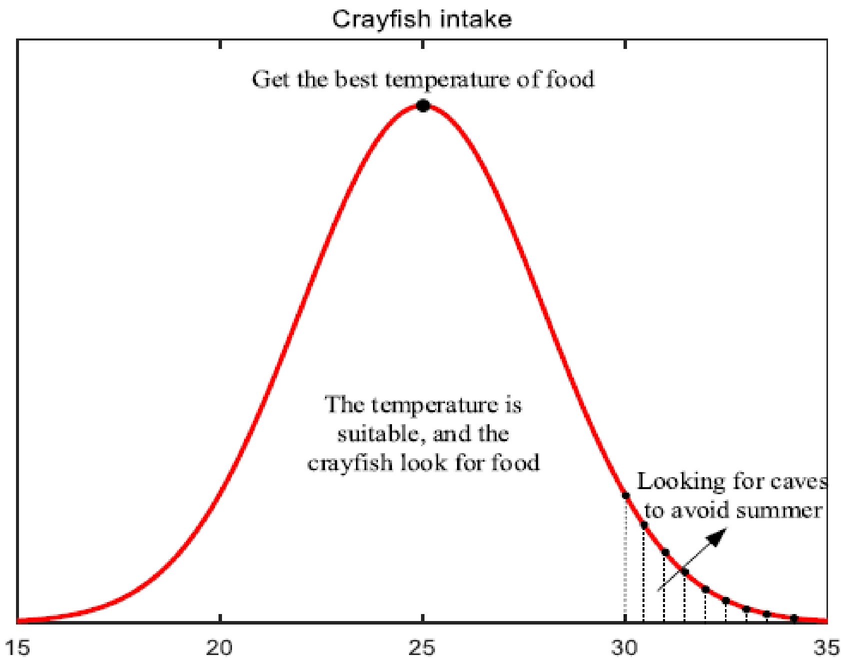
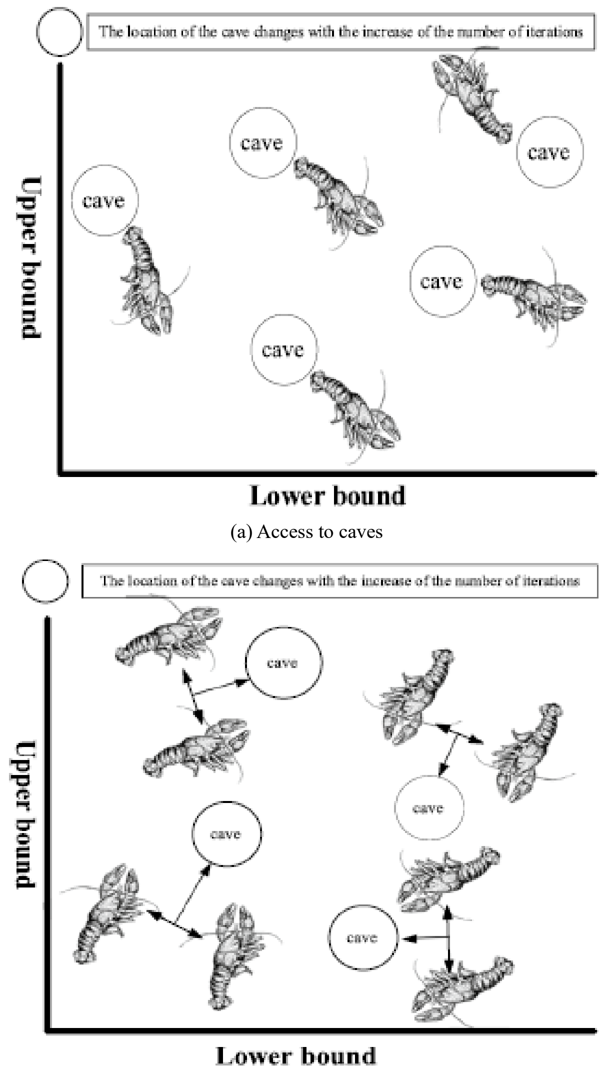


Figure 6. Temperature effect plot of crayfish intake

(3) Summer vacation behavior (exploration)

When temperatures are greater than 30°C, this results in crayfish choosing summering behavior. Crayfish burrow locations were defined as follows:

$$X_{shade} = \left(X_G + X_L\right)/2 \tag{11}$$



(a) Access to caves

(b) Competing caves

Figure 7. Crayfish summering behavior map

Where X_G denotes the optimal solution position for the current iteration number and X_L denotes the optimal position for the current population.

As shown in Figure. 7, the crayfish competition fight for shelter is a random event. When $rand < 0.5$, there is no crayfish burrow competition event, the crayfish can directly enter the burrow for summer vacation behavior, as modeled below:

$$X_{i,j}^{t+1} = X_{i,j}^{t} + C_2 \times rand \times \left(X_{shade} - X_{i,j}^{t} \right) \quad (12)$$

where t denotes the current iteration number, $t+1$ denotes the next iteration number, and C_2 is a reduced parameter:

$$C_2 = 2 - t/T \quad (13)$$

where T denotes the maximum number of iterations.

In the summering behavior phase, the purpose of the crayfish is to approach the cave, i.e., to approach the optimal solution and deposit the COA algorithm for fast convergence.

(4) Competitive behavior (exploration)

When $temp > 30$ and $rand \geq 0.5$, other crayfish are interested in the burrow, and by fighting with each other, they take the chance to approach the optimal solution, which is mathematically modeled as follows:

$$X_{i,j}^{t+1} = X_{i,j}^{t} - X_{z,j}^{t} + X_{shade} \quad (14)$$

where z denotes a random individual of crayfish, calculated as follows:

$$z = round\left(rand \times (N-1) \right) + 1 \quad (15)$$

In the competitive behavior phase, crayfish compete with each other to adjust their position information by randomizing lobster positions. Using the adjustment operation, the COA search range increases and exploration behavior is enhanced.

(5) Foraging behavior

When $temp \leq 30$, crayfish are fit to go foraging. In this stage, after discovering the food, the mode of foraging behavior operation is decided by judging the size of the food. The food X_{food} is generally defined as the optimal solution X_G . The food size is defined as follows:

$$Q = C_3 \times rand \times \left(fitness_i / fitness_{food} \right) \quad (16)$$

Where, C_3 denotes the food factor, which represents the largest food and generally takes the value of 3; $fitness_i$ and $fitness_{food}$ denote the adaptation value of the ith crayfish and the adaptation value of the location of the food, respectively.

When $Q > (C_3+1)/2$, the food is too large and the crayfish needs to use its first clawed foot to tear the food, the mathematical model is as follows:

$$X_{food} = \exp\left(-\frac{1}{Q} \right) \times X_{food} \quad (17)$$

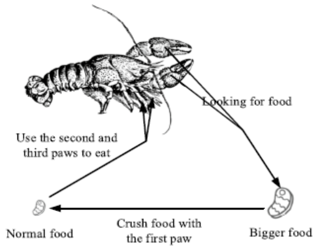
After the food is chopped and made smaller, the crayfish uses the second and third claws to pick up the food and put it into the mouth. In order to simulate the food selection process, COA uses sine function and cosine function to simulate the process, the specific foraging simulation is as follows:

$$X_{i,j}^{t+1} = X_{i,j}^{t} + X_{food} \times p \times \left(\cos(2 \times \pi \times rand) - \sin(2 \times \pi \times rand) \right) \quad (18)$$

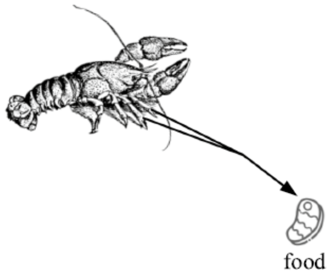
When $Q \leq (C_3+1)/2$, the crayfish needs to move to the food and eat it directly:

$$X_{i,j}^{t+1} = \left(X_{i,j}^{t} - X_{food} \right) \times p + p \times rand \times X_{i,j}^{t} \quad (19)$$

Crayfish foraging behavior is shown in Figure 8, during the foraging phase, crayfish feed using different feeding methods based on food size. When the size is suitable for crayfish to eat, they will choose to approach the food. When the size of the food is too large, the food will first be reduced to be closer to the food. Through the foraging behavior, the COA algorithm approaches the optimal solution, increasing the exploitation capacity and accelerating the convergence performance.



(a) Shredding of food



(b) Eating off food

Figure 8. Graph of crayfish foraging behavior

5.3. Algorithm Step Flow

According to the COA algorithm inspiration mechanism and optimization strategy, the pseudo-code of the algorithm is shown in Fig. 9, and the steps of the algorithm are as follows:

Step 1: Parameter definition and population initialization;

Step 2: Calculate temperature and crayfish intake using the temperature definition equation;

Step 3: Heat-seeking behavior and competitive behavior implementation. When $temp > 30$ and $rand < 0.5$, the COA enters the heat-seeking behavior stage; when $temp > 30$ and $rand \geq 0.5$, the COA enters the competitive behavior stage;

Step 4: Foraging behavior implementation. When $temp \leq 30$, the COA algorithm enters the foraging phase; calculates the food size size Q; if $Q > (C_3 + 1)/2$, tears the food and updates the lobster location information; otherwise, directly acquires the food and updates the lobster location information;

Step 5: Calculate the fitness value;

Step 6: Output the optimal solution and optimal value.

```
Algorithm 1: Pseudo code of the COA algorithm
Initialization iterations, population, dimension;
Randomly generate an initial population;
Calculate the fitness value of population to get global best position and local best position;
While t<T
    Defining temperature temp;
    If temp>30
        Defiine cave Xshade;
        If rand<0.5
            Crayfish conducts the summer resort stage;
        Else
            Crayfish compete for cave;
        End
    Else
        Obtain the food intake p and food size Q;
        If Q>2
            Crayfish shreds food and forage;
        Else
            Crayfish forage directly;
        End
    End
    Update fitness values, global best position and local best position;
    t=t+1;
End
```

Figure 9. Pseudo-code of COA algorithm

6. Methodological process for applying virtual reality converged remote platform based on COA improved ESN network

Combining COA and ESN networks, this section proposes a method for applying virtual reality fusion teleplatform based on crawfish optimization algorithm to improve the recurrent state neural network.

6.1. Decision Variables and Objective Functions

The fixed ESN network reserve pool parameters are not generalizable. In order to overcome the above problems, this paper uses crawfish optimization algorithm to optimize the ESN network reserve pool parameters.The optimization decision variable of COA algorithm is (SD, N, IS, SR) .

In order to improve the analysis accuracy of the COA algorithm for optimizing ESN network applications, the root mean square error function is used as the objective function of the COA-ESN algorithm and is calculated as follows:

$$\min f(\omega, a, b) = \sqrt{\frac{1}{K}\sum_{k=1}^{K}\left(y(k) - y_{predict}(k)\right)^2} \quad (20)$$

Where $y(k)$ is the actual value and $y_{predict}(k)$ is the analyzed value.

6.2. Main steps

The application analysis model of virtual reality fusion remote platform based on COA algorithm optimized ESN network is mainly based on the whole process of effect analysis factors as input and analysis value as output, and the mapping relationship between analysis factors and analysis value. The flowchart of the application analysis method of virtual reality fusion remote platform based on COA-ESN algorithm is shown in Figure 10. The specific steps are as follows:

Step 1: Acquire data based on three ways such as questionnaires, interviews, and online learning software; pre-process the acquired samples with sparse smoothing data processing method; normalize the raw data with Z-Score method and divide the data into testing set, validation set and training set;

Step 2: Use COA algorithm to encode the initial parameters of ESN, and also initialize the algorithm parameters such as population parameters and iteration number; initialize the population and calculate the value of the objective function;

Step 3: Update crayfish location information using heat avoidance behavior, competitive behavior, and foraging behavior based on defined temperature and food intake;

Step 4: In each iteration, it is necessary to compare the objective function value of each candidate solution with the objective function value of the current global optimal solution and update the global optimal solution;

Step 5: Judge whether the termination condition is satisfied. If satisfied, exit the iteration, output the optimal ESN network reserve pool parameters, and execute step 6, otherwise continue to execute step 3;

Step 6: Decode the parameters of the reserve pool for the COA-based optimized ESN network to obtain (SD, N, IS, SR) ;

Step 7: Construct the COA-ESN analysis model, train the analysis model using the training set, input the test set into the model, and obtain the analysis results and error results.

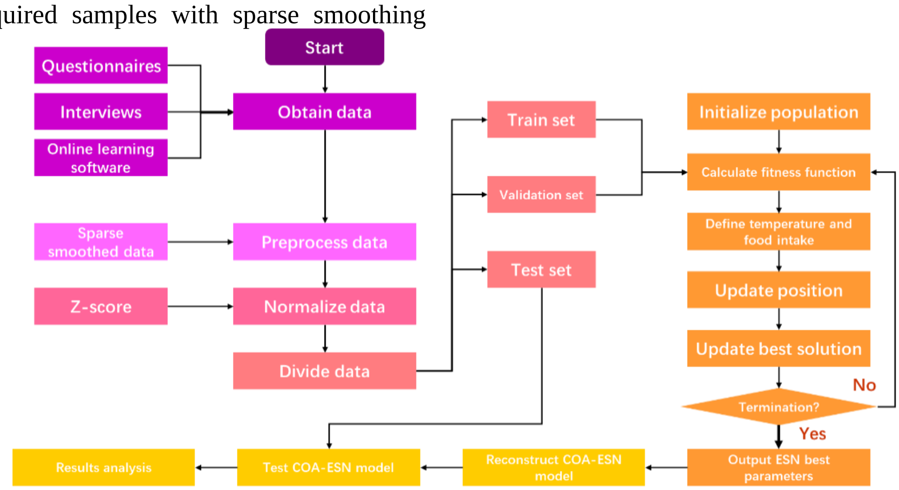


Figure 10. Flowchart of effect analysis of virtual reality converged remote platform based on COA algorithm optimizing ESN network

7. Experiments and analysis of results

In order to verify the accuracy and timeliness of the effect analysis model proposed in this paper, this paper takes the remote platform data based on virtual reality technology as simulation data, and selects five analysis algorithms for comparison, and the specific parameter settings of each algorithm are shown in Table 1.

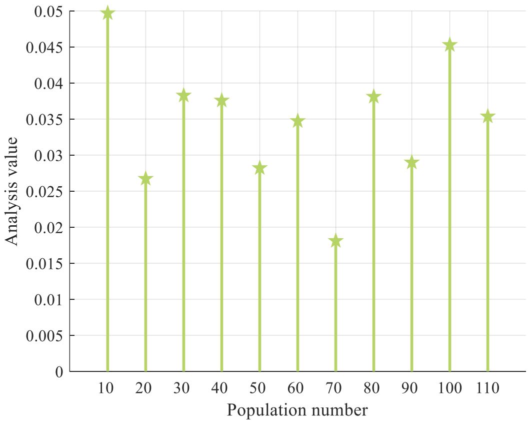
Table 1. Parameter settings for effect analysis methods

arithmetic	parameterization
ESN	SD=0.7, N=100, SR=0.2, IS=0.25, with 500 iterations
HLBO-ESN	Population and parameter settings refer to COA-ESN settings, with an iteration number of 500

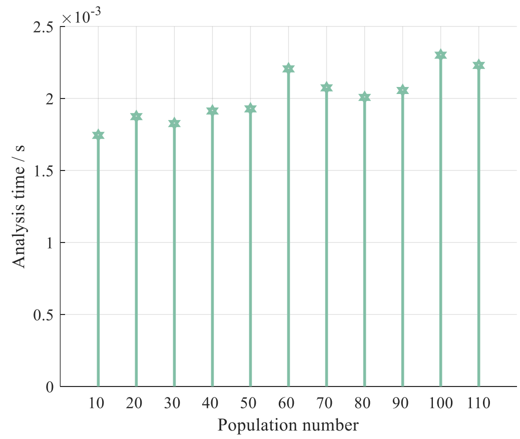
arithmetic	parameterization
DE-ESN	Population and parameter settings refer to COA-ESN settings, with an iteration number of 500
GWO-ESN	a=2-2×(iter/itermax), population and parameter settings refer to COA-ESN settings, number of iterations 500
PSO-ESN	Population and parameter settings refer to COA-ESN settings, with an iteration number of 500
COA-ESN	The number of populations is shown in Section 6.1, and the ESN hyperparameters are optimized as shown in Section 6.2, with an iteration number of 500

7.1. Parametric analysis

In order to obtain the optimal performance populations for the effect analysis method based on COA-ESN algorithm, the effect of different number of populations on the analysis value and analysis time is given in this section and the results are shown in Fig. 11. From Fig. 11(a), it can be seen that as the number of populations increases, the prediction accuracy of effect analysis increases. From Fig. 11(b), it can be seen that the time of effect analysis increased as the number of populations increased. In summary, the increase in the population number of the effect analysis model of the virtual reality fusion remote platform based on the COA-ESN algorithm is conducive to the increase in the accuracy of effect analysis, but the time of effect analysis increases. In order to balance the contradiction between time and accuracy, the population number should be selected as 70.



(a) Results of the impact on the precision of the effects analysis



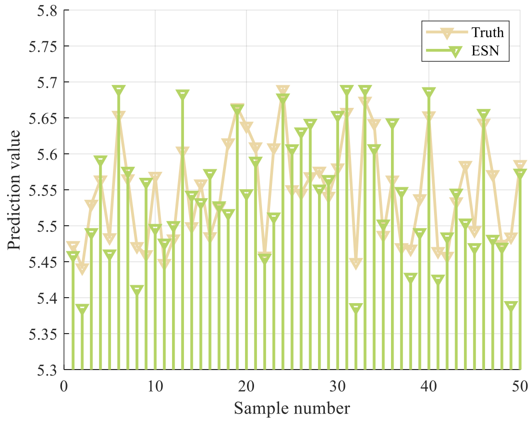
(b) Results of the impact on the timing of the effects analysis

Figure 11. Effect of different population sizes on analyzed values and analysis time

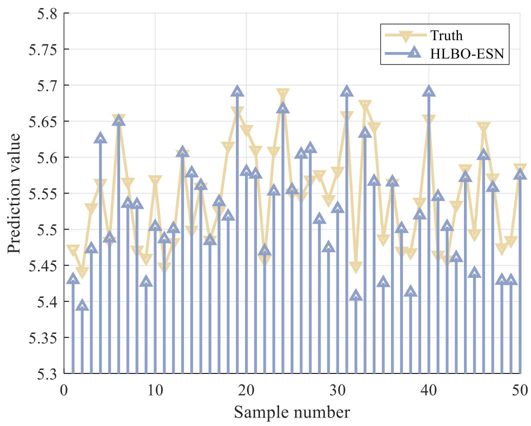
7.2. Performance analysis

In order to verify the effectiveness and superiority of the virtual reality fusion remote platform effect analysis method based on the COA-ESN algorithm, COA-ESN is compared with five other models, and the evaluation results of each model are shown in Figure 12, Figure 13, Figure 14, and Figure 15.

Figure 12 gives the analyzed values of the virtual reality fusion remote platform effect based on each algorithm. As can be seen from Figure 12, the results of the analysis accuracy based on the COA-ESN algorithm are closer to the real values, thus indicating that the accuracy of the virtual reality fusion remote platform effect analysis method based on the COA-ESN algorithm is better than the ESN, HLBO-ESN, DE-ESN, GWO-ESN, PSO-ESN algorithms; comparing the HLBO-ESN, DE-ESN, GWO-ESN, PSO-ESN algorithms analysis accuracy, COA algorithm improves the effect analysis accuracy.



(a) ESN



(b) HLBO-ESN

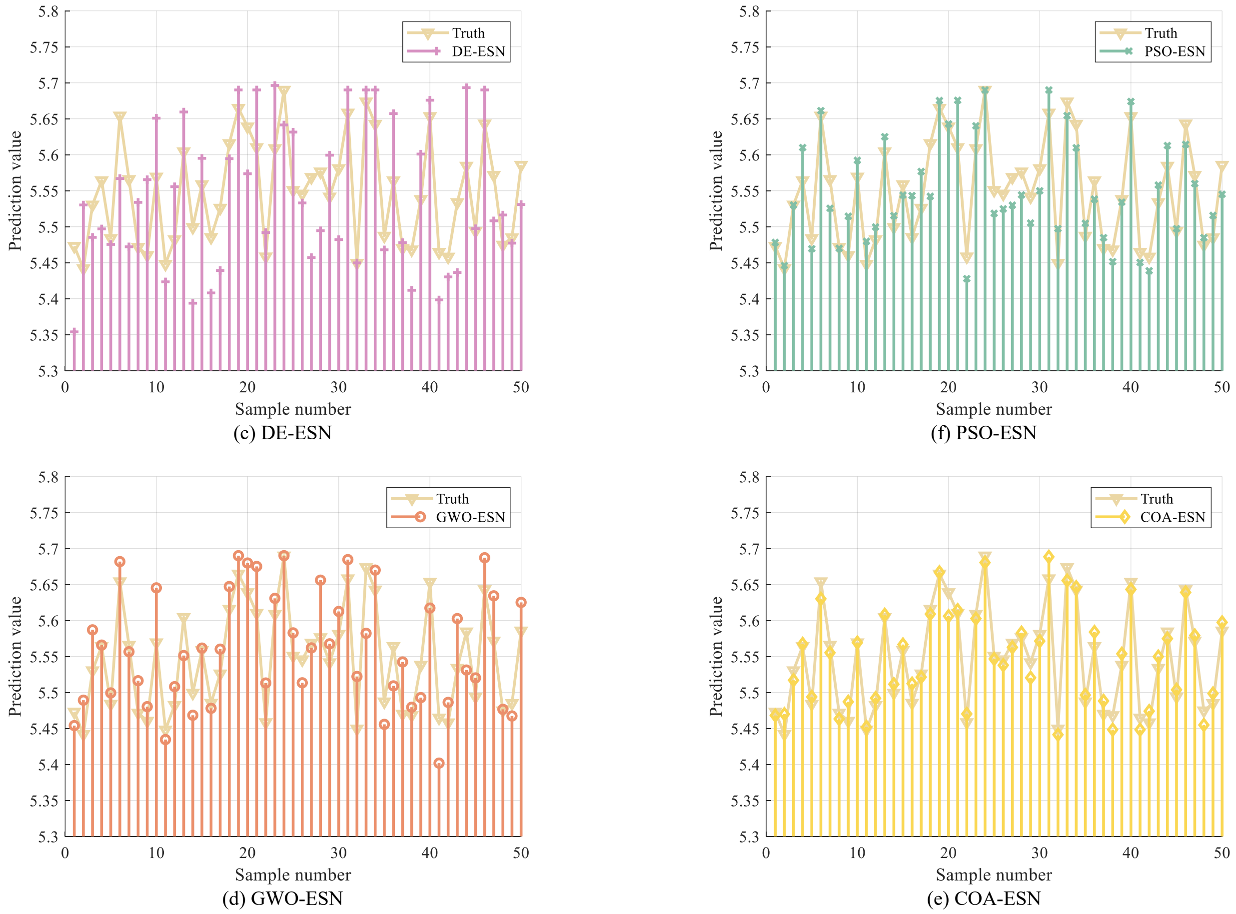


Figure 12. Analyzed values of the effect of virtual reality technology fusion remote platform based on each algorithm

Figure 13 gives the relative error between the analyzed value and the real value of the effect analysis value of the virtual reality technology integration remote platform based on each algorithm. As can be seen from Figure. 13, the absolute value of the relative error of the analyzed value of the effect analysis method based on the COA-ESN algorithm is controlled within the range of 0.04, the absolute value of the relative error of the analyzed value of the ESN algorithm is within the range of 0.1, the absolute value of the relative error of the analyzed value of the HLBO-ESN algorithm is within the range of 0.1, and the relative error of the analyzed value of the DE-ESN, GWO-ESN, and PSO-ESN algorithms absolute values are in the range of 0.12, 0.096, and 0.05, respectively. In summary, the error of the virtual reality technology integration remote platform effect analysis method based on the COA-ESN algorithm is the smallest overall.

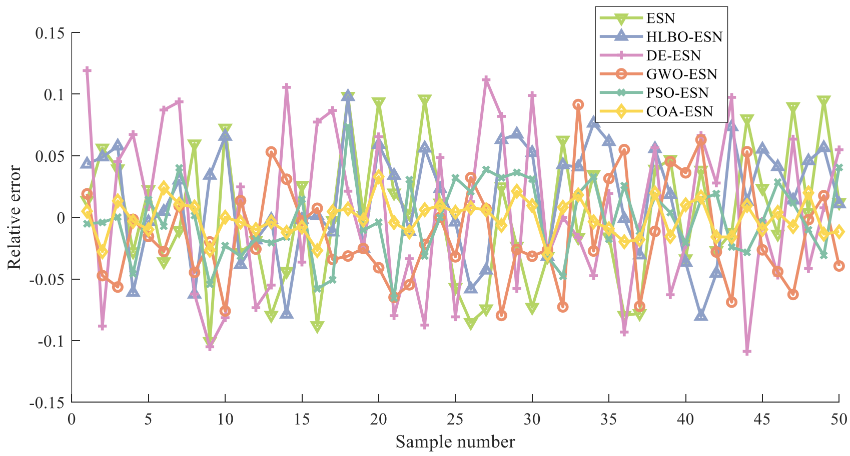


Figure 13. Relative error between the analyzed and real values of the effect of virtual reality technology integration remote platform based on each algorithm

Figure 14 gives the comparison of the time for analyzing the effect of virtual reality fusion remote platform based on each algorithm. From Figure. 14, it can be seen that the average time for analyzing the effect of virtual reality fusion remote platform based on COA-ES algorithm is less than the test analysis time of ESN, HLBO-ESN, DE-ESN, GWO-ESN, PSO-ESN algorithms, and the standard deviation of the time is less than that of ESN, HLBO-ESN, DE-ESN, GWO-ESN, PSO-ESN algorithms. This shows that the test analysis time takes the least time and has the best stability.

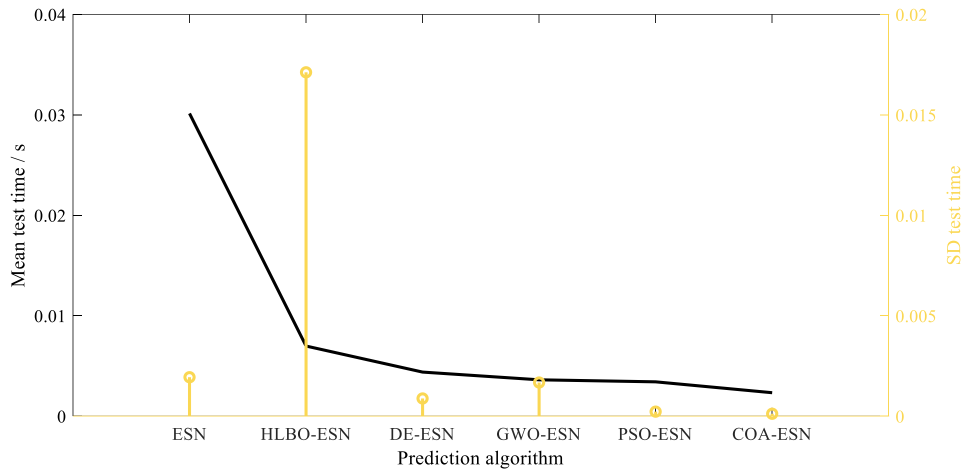


Figure 14. Comparison of time for analyzing the effect of virtual reality technology fusion remote platform based on each algorithm

Figure 15 gives the optimization results of the network parameters of the VRT converged teleplatform based on each algorithm. From Figure. 15, it can be seen that the number of iterations for ESN parameter optimization based on COA is less than that of HLBO, DE, GWO, and PSO algorithms. This shows that COA algorithm optimizes ESN hyperparameters with better convergence speed than other algorithms.

Algorithm	N	SR	IS	SD	Iteration
ESN	100	0.2	0.25	0.7	/
HLBO-ESN	152	0.26	0.8	0.78	20
DE-ESN	180	0.19	0.87	0.66	39
GWO-ESN	206	0.27	0.57	0.75	19
PSO-ESN	156	0.45	0.33	0.90	87
COA-ESN	170	0.34	0.66	0.73	16

Figure 15. Optimization results of network parameters of virtual reality technology converged remote platform based on each algorithm

8. Conlusion

In order to improve the accuracy and real-time performance of the effect analysis method, generalize the performance of the effect analysis method, and improve the quality of the effect analysis of the virtual reality fusion remote platform, this paper proposes an effect analysis method based on the COA to improve the ESN network. The method proposes the effect analysis method of virtual reality technology fusion remote platform by analyzing the process of virtual reality technology fusion remote platform and the extraction of influencing factors, combined with the CMA-ES algorithm to improve the DBN network prediction model. The proposed method is analyzed and compared using the data obtained in a multi-channel way, and the following conclusions are obtained:

(1) By comparing the analysis accuracy of COA-ESN algorithm with other algorithms, the virtual reality technology fusion remote platform effect analysis model based on COA-ESN algorithm improves the analysis accuracy;

2) The COA-ESN algorithm analysis time is less than 0.002s, and the real-time of COA-ESN algorithm analysis is improved;

(3) The optimization results of improving ESN parameters based on COA algorithm are better than HLBO, DE, GWO and PSO algorithms.

Since the COA-ESN algorithm has only been applied to the problem of analyzing the effects of virtual reality technology-integrated remote platforms, and has not been applied to other problems of analyzing the effects of education and teaching, the generalizability of the model based on the COA-ESN algorithm will be the next step.

References

[1] Nerys W .Occupational Health Issues for Workers Using

Virtual Reality Technology[J].

[2] Liu X , Pan H .The Path of Film and Television Animation Creation Using Virtual Reality Technology under the Artificial Intelligence[J].Scientific Programming, 2022, 2022:1-8.

[3] Tman U , Yildirim T G .The Effect of Gaining the Unit of Systems in Our Body by Using Virtual Reality Technology on Student Success.[J].i-manager's Journal on School Educational Technology, 2022.

[4] Liu L, Gong C, Li M, Wang R. RMSST Design Based on Virtual Reality[J].Acta Armamentarii, 2022, 43(S1):208-213.

[5] Lv Z , Guo J .Virtual Reality Neurorehabilitation[J]. International Journal of Mental Health Promotion (English), 2022, 24(3):287-310.

[6] Riner A , Hur J W , Kohlmeier J .Virtual Reality Integration in Social Studies Classroom: Impact on Student Knowledge, Classroom Engagement, and Historical Empathy Development[J].Journal of Educational Technology Systems, 2022.

[7] Cheng J Y , Gheisari M , Jeelani I .Using 360-Degree Virtual Reality Technology for Training Construction Workers about Safety Challenges of Drones[J].Journal of computing in civil engineering, 2023.

[8] Engineering M P I .Retracted: Virtual Reality Technology of Multi UAVEarthquake Disaster Path Optimization[J].Mathematical Problems in Engineering, 2023.

[9] Akdere M , Jiang Y , Lobo F D .Evaluation and assessment of virtual reality-based simulated training: exploring the human-technology frontier[J]. European Journal of Training and Development: a Journal for HRD Specialists, 2022(5/6):46.

[10] Mingliang L , Pc L .Interior Design Innovation Ability with Artificial Intelligence and Virtual Reality Technology[J].DS Journal of Digital Science and Technology, 2023.

[11] Yu Z , Xu W .A meta-analysis and systematic review of the effect of virtual reality technology on users' learning outcomes[J].Computer applications in engineering education, 2022.

[12] Ro J , Hong C W .Technology Trends of Virtual Augmented Reality and Application to Military Education and Training[J]. Institute of Information Technology, 2022.

[13] Haitao H , Ruijun D , Na H , JiangRong B, Yulong W, Ke L. Research on Stray Light Affecting the Imaging of Fresnel Lens in Virtual Reality Equipment[J]. SID International Symposium: Digest of Technology Papers, 2022(2):53.

[14] Lee S , Shetty A S , Cavuoto L .Modeling of Learning Processes using Continuous Time Markov Chain (CTMC) for Virtual Reality (VR)-based Surgical Training in Laparoscopic Surgery[J].IEEE Transactions on Learning Technologies, 2023.

[15] Cuckoo, D. Visual construction and practical application of Virtual Reality technology [J]. Wine and Steel Technology, 2023(4):26-30.

[16] Zaki H O , Fernandez D , Dastane O , Aman A, Sanusi S. Virtual reality in digital marketing: research agenda based on bibliometric reflection[J]. Marketing Intelligence & Planning, 2023, 41(4):505-524.

[17] Qian J .Research on Artificial Intelligence Technology of Virtual Reality Teaching Method in Digital Media Art Creation[J]. Technology, 2022(1):23.

[18] Liu Y , Luo D , Zhang H .Application of virtual reality technology and traditional cultural elements in landscape regeneration design[J]. computational methods in sciences and engineering, 2022.

[19] Shadiev R , Li D .A review study on eye-tracking technology usage in immersive virtual reality learning environments[J].Computers & education , 2023.

[20] He L , Zhu S .Virtual Reality Technology in Visual Design of Artistic Images: Analysis and Applications[J].Sci. Program. 2022, 2022:2527623:1- 2527623:6.

[21] Reer F , Wehden L O , Janzik R , Tang W Y, Quandt T. Virtual reality technology and game enjoyment: the contributions of natural mapping and need satisfaction[J].Computers in human behavior, 2022(7):132.

[22] HU Qinghui, SONG Jinling, HUANG Dahu Jiacheng, ZHAI Xiaoang. Water quality prediction model based on SSA-MIC-SMBO-ESN[J]. Industrial Water and Wastewater, 2023, 54(2):45-51.

[23] Gu Xiaofeng,Tang Yongli. Simulation of mixed-attribute big data clustering based on group intelligence algorithm[J]. Computer Simulation, 2023, 40(9):458-461.

[24] Loetscher T , Barrett A M , Billinghurst M ,Lange B. Immersive medical virtual reality: still a novelty or already a necessity?[J]. Neurology, Neurosurgery, and Psychiatry, 2023, 94:499 - 501.

[25] Jo S S .A Study on a Practical Model of Art Education Using Virtual Reality (VR) Technology[J].Journal of Basic Design & Art, 2023.

[26] WANG Taki-De, CAO Hui, WEI Lai. Research on online fault diagnosis of ship main engine under unbalanced data[J]. China Ship Research, 2023, 18(5):269-275.

[27] Ye D , Cao B , Zhou W .Echo State Network-Enabled Intelligent Smart Sensor Design for Creating a Robotic Nervous System[J]. Pattern Recognition and Artificial Intelligence, 2023, 37(07).

[28] Jia H, Rao H, Wen C, Mirjalili S. Crayfish optimization algorithm[J]. Artificial Intelligence Review, 2023, 56: 1919-1979.