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Research Article

Teaching Mode Design and Effect Evaluation Method of Visual Communication Design Course from the Perspective of Big Data

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Traditional visual communication design teaching courses only use books and courseware for teaching, which greatly limits students understanding and perception of visual communication design art courses. The visual communication design course is different from the teaching of other subjects; it requires students to have a deep understanding of the content of the video and the experience of emotion. Relying on courseware and book teaching methods will not only limit students' imagination, but also make students tired of learning psychological activities. The teaching of visual communication design technology is to transmit the images, colors, words, and emotions of artworks to students in the form of video, which is a relatively abstract course. With the development of big data technology, this brings new opportunities for the teaching of visual communication design technology courses. In this study, data mining technology will be used to evaluate the effect of visual communication design teaching. And CNN will be used to predict the content characteristics of visual communication design teaching, which is part of the visual communication design teaching system. The research results show that the big data method has better performance in the visual communication design technology course; both the classification and prediction errors are within the acceptable range for the artwork of the visual communication design course. Big data technology can well predict the relevant features in visual communication design; the largest prediction error is only 2.66%, and the smallest error is only 1.21%.

1. Introduction

The development of education is constantly improving with the advancement of science and technology, and the educational model has gone through book teaching and computer-assisted teaching [1, 2]. The teaching of visual communication design technology is a new type of subject in recent years, which is different from the teaching mode of traditional subjects, such as Chinese and mathematics. It shows the artwork to the students in the form of video, and the students will receive the visual impact brought by the artwork, which also allows the students to feel the artistic atmosphere and spiritual emotion of the artwork itself. Students will accept formulas, words, and equations in Chinese or mathematics subjects in a book-based teaching mode, which will not limit students' understanding and imagination of knowledge [3, 4]. This is because the knowledge is relatively fixed, and it does not require students to understand the spiritual emotion and artistic atmosphere. In other words, the color, image, and other information of Chinese or mathematics subjects will not bring a big deviation to students' understanding and learning. The visual communication design technology course is just the opposite [5, 6]. The color and pattern of the visual communication design technology course will have a greater impact on the students. The rapid development of visual communication design technology also benefits from the rapid development of computer performance and video technology. This technology can display artworks or objects in life to people in the form of video, which is a more intuitive way [7, 8]. In people's daily life, visual communication design technology is also a relatively important technology,

such as video advertising, 3D advertising design, and other forms [9].

The visual communication design technology course is a way for students to experience the connotation and emotion of works of art and living objects through video. In the visual communication design art course, if teachers still use a traditional teaching mode of books or PPT, this will limit students real experience of artworks [10, 11]. Even in the teaching of visual communication design, teachers teach artworks to students in the form of video, which still restricts students' interest in visual communication design art courses, which also lacks the interactivity of the courses [12, 13]. The real purpose of visual communication design art teaching is to let students tap into the emotional pigment and artistic experience contained in the art video itself [14, 15]. The visual communication design course will include information such as words, images, dimensions, and shapes, which are the basic properties of artworks. Students and teachers need to use these basic attributes to mine the emotional information and historical emotional information contained in the artwork itself. If this teaching course only allows students to watch videos, it will not allow students to truly understand the true meaning of visual communication design artworks [16]. With the improvement of people's living standards, people's pursuit of artworks and emotional information is getting higher and higher. The current teaching of visual communication design course is to let students learn to grasp people's psychological needs for visual communication design artworks. In order to improve the efficiency and interactivity of visual communication design technology teaching, it is necessary to combine new technology with visual communication design technology. Only by improving the interactivity and interest of the visual communication design technology course, students will have greater interest in learning this course [17, 18]. At the same time, it stimulates the comprehension of students for visual communication design artworks. Visual communication design is an important discipline for many fields, and it is also the foundation of some disciplines. Therefore, the teaching of visual communication design requires students to truly understand the theoretical knowledge and visual technology.

Big data technology is a new technology that developed rapidly in recent years. It can help every research object to find potential information [19]. It can also help professionals to find some information that cannot be found by professional knowledge. The main advantage of big data technology is to process high-dimensional and nonlinear data. The larger the amount of data, the more obvious the advantages of big data technology. If the amount of data is sufficient, the big data technology will learn more characteristics of the research object, which will make the big data technology reflect a greater ability in the data mining of the research object. Big data technology is more dependent on the processing power of computers and the capacity of hardware devices. The computing power of computers has greatly improved since the 21st century. This guarantee has promoted the rapid development of big data technology in various fields. Big data technology has achieved great success in the fields of transportation, finance, and medical care. It can help people process complex traffic flow data, financial data, and medical data. However, the application of big data in the teaching of visual communication design is relatively small; this is mainly due to the difficulty of data collection.

Big data technology can help the teaching of visual communication design to fully excavate the image, text, shape and other information of artworks. These data information will be used by big data technology to find strong linear correlation [20]. These linear correlations of visual communication design data are hard to be found by people who can rely on the professional knowledge or work experience. Big data technology has been applied in the teaching of many disciplines. It mainly improves the interaction of the teaching process and the initiative of students by collecting students' behavior information and courseware content. However, the visual communication design teaching classroom is different from the teaching of other subjects. It has many abstract features and many emotional information, which are different for different students. The different learning status and classroom performance of students will affect the understanding of visual communication design technology courses. If the big data technology is combined with the teaching of the visual communication design course, it will not only improve the students' understanding of the visual communication design course, but also show more characteristic information to the students. Big data technology is good at processing complex data, and visual communication will include features such as images and speech. Big data technology can extract image, speech, and temporal features of visual communication design.

This research mainly studies the feasibility of visual communication design courses from the perspective of big data and can formulate corresponding plans according to this system. This paper mainly presents the introduction from five aspects. The first part mainly introduces the significance of visual communication design technology teaching and the development status of big data technology. The second part mainly introduces the research status of visual communication design technology teaching. The third part mainly introduces the algorithm and system design of the combination of visual communication design technology teaching and big data. The fourth part mainly analyzes the feasibility of applying big data technology in visual traditional teaching. It contains statistical parameters, such as mean error, linear correlation plot, and error distribution cloud plot. The fifth part is the summary part of this paper, which summarizes the research content accordingly.

2. Related Work

The research of visual communication design teaching has been a research focus in the field of teaching today, and many researchers have done a lot of research on the visual communication design teaching mode using different methods. Ali [21] believed that the critical reflection method is an effective self-thinking tool that can improve teaching models and professional practice methods. He uses the

method of critical self-reflection to study the teaching process, experience, and key events in the teaching of visual communication design. The research results suggest that external factors will affect the teaching process of visual communication design, and this method plays a key role in the teaching of visual communication design. Saterbak et al. [14] incorporated visual communication design teaching into bioengineering teaching in a way that helps students communicate their knowledge and discoveries accurately. They used the Calibrated Peer Review™ (CPR) self-review tool to diagnose students' skills in visual poster design. They also devised a visual communication design method to measure students' changing skills based on an active learning intervention method. Ouyang [22] studied the content of visual communication design teaching based on the embedded development system and the detection combination algorithm, and he predicted the students' thinking measures with a visual animation as the research object. This teaching mode can promote students to memorize the teacher course content and it can more accurately memorize the teacher's teaching content. Maher [23] addressed the problems of the current voice teaching center in the teaching of deaf students, and his work explores the problem of nonverbal communication for future teachers through visual teaching methods. It correlates with qualitative data and shows that this visual teaching method attracts the attention and communication of scholars. Bian and Ji [24] believed that the rapid development of big data and information technology has promoted the rapid development of instructional design. Their work uses subject knowledge as well as statistics, communication subjects, and other knowledge to analyze many excellent cases. And it combines the interface design of APP technology to study the aesthetics of visual communication design, which increases the interest and satisfaction of reading. The conclusion shows that visual information visualization can facilitate the dissemination of visual communication design knowledge. Mills and Doyle [25] believed that visual communication design art and media communication are more important to the indigenous people. They analyzed the multidimensionality of aboriginal student paintings and also explained the language-related meanings of aboriginal legends. They concluded that the visual arts as an element of the English curriculum can help increase the cultural sensitivity of aboriginal students. Chen [26] believed that the development of the Internet has brought a new model for the teaching of visual communication design. He studied the teaching mode of visual communication design with the teaching communication mode of Internet + and cloud platform technology. And it analyzes the effect of visual communication design teaching mode based on big data analysis and recommendation engine technology of coding system. From the above research review, it can be seen that the current research on visual communication design teaching content rarely adopts data-driven methods. This may be due to the relatively high entry requirements of algorithms of big data technology. This research uses big data technology to classify and predict information such as images, colors, and texts of visual communication design teaching content. This has a certain reference value for the progress of visual communication design teaching. Even though current studies employ big data techniques to analyze the way of visual communication design, they rarely make sufficient predictions and analyses on the characteristics of teaching content of visual communication design. This kind of teaching system design will promote students' interest in learning, and it will also deepen students understanding of visual communication design teaching content.

3. An Application of Big Data Technology in Visual Communication Design

3.1. The Overview of Big Data Technology. The advantage of big data technology lies in the processing of nonlinear data and large amounts of data [27, 28]. It can find the relationship between input and output from a large amount of data, which is often not found by human beings by relying on empirical knowledge. Big data technology can not only effectively classify data sets, but also efficiently map data sets [29]. The big data approach is a time- and labor-saving method, but it requires stable and reliable data sets. It relies on the nonlinear relationship of the data set itself to effectively classify and predict the unknown data set. This also does not give good results if the training and test sets have large differences [30, 31]. Therefore, the key to big data technology is the selection and processing of data sets. With the development of big data technology, it can have many suitable algorithms for researchers to choose.

3.2. Visual Communication Design Teaching System Design and Classification Algorithm of Teaching Content Characteristics from the Perspective of Big Data. There are many kinds of features in the design of visual communication design teaching content. In this study, image features, color features, text features, and shape features are selected for classification and prediction. These four characteristics are important characteristics of visual communication design teaching content, which are also the key characteristics affecting students understanding and interest. Figure 1 shows the system design of the visual communication design teaching method from the perspective of big data. First, this research needs to collect information about the teaching content of visual communication design, which includes features such as images and colors. Then, these features will be efficiently classified using decision tree method. After the visual communication design teaching content is classified, these features will be predicted using neural network methods. This is a key component of this system. For the teaching of visual communication design, its four most important characteristics are image, color, shape, and text information. These four characteristics will be directly fed back to students and teachers, which is also the information they can directly receive through sight or hearing. When the training process of the visual communication design teaching system converges and reaches a stable state, the teacher can input the classroom content in real time, and it

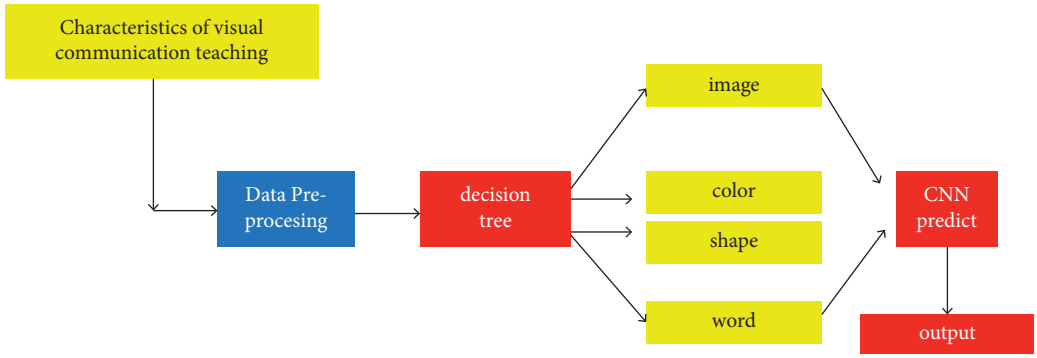

Figure 1: The design of visual communication design teaching system is aided by big data technology.

can quickly display the predicted content information to the students. The data of the CNN output layer will be the predicted content of the visual communication design teaching, and the actual value is the data output by the decision tree. Some of the output data of the decision tree will be used as labels.

There are many classification methods of big data technology, such as decision trees, clustering, Kalman filtering, and other methods. In this study, the decision tree was selected as the algorithm for the classification task of this study in combination with the form of visual communication design of teaching content. Figure 2 shows a schematic diagram of decision trees in the task of classifying teaching content in visual communication design, which is only a schematic approach to classification principles. The decision tree method will have many branches, which are continuously adjusted during the operation of the algorithm. The number of branches of the decision tree in this study will be selected as 4, which represents the 4 features of the visual transmission teaching content. Each branch also has different classification criteria, and this study will choose 3 as the number of criteria for each branch. Decision tree has a variety of evaluation indicators; this research will be introduced in the following equation. The more important parameters of decision trees are the number of branches and the learning rate. This study chooses 4 as the number of branches of the decision tree, which represents the four characteristics of visual communication design teaching, and the learning rate is set to 0.0001.

The most used loss function in the back-propagation method is the mean square error function. In the classification task of decision tree, it also needs the mean square error function to adjust the gradient descent. The following equation shows how the mean square error function is calculated.

$$J = \frac{1}{2}\sum_{k=1}^{l}\sum_{r=1}^{o}\left(x_k - \chi_r\right)^2. \tag{1}$$

The decision tree needs an evaluation index to evaluate the results of each iteration step in the classification process, and it will further adjust the operation process of the next iteration step. Entropy is one of the most important evaluation indicators for decision trees, and the following equation shows the calculation method of entropy:

$$H(D) = -\sum_{l=1}^{L}\frac{|C_l|}{|D|}\log_2\frac{|C_l|}{|D|}. \tag{2}$$

In the classification task of visually conveying teaching content, multiple features will be involved, and there is a strong correlation between these features. Conditional entropy is a classification evaluation index between multiple features, which can take into account the correlation between different features. The following equation shows the operation rule of conditional entropy:

$$H\left(\frac{D}{A}\right) = \sum_{J=1}^{n}\frac{|C_j|}{|D|}H\left(D_j\right). \tag{3}$$

In the classification task of visually conveying teaching content, it is often necessary to understand the source of uncertainty in classification, which requires the evaluation index of information gain. The following equation shows the calculation process of the information gain:

$$g_r(D, A) = \frac{g(D, A)}{H_A(D)}. \tag{4}$$

3.3. The Application of Neural Network Method in the Prediction of Visual Communication Design Teaching Content. This research mainly involves two processes of visual communication design of teaching content and classification and prediction. The prediction of neural network method in visual communication design teaching is an important process of system design. It will use the data set to effectively predict the unknown teaching content, and it can improve the interaction and intelligence of the visual communication design teaching classroom. In this study, convolutional neural network was selected as the basic algorithm for visual communication design teaching content prediction. Figure 3 shows the operation flow of convolutional neural network in the prediction of visual communication design teaching content. First of all, this study uses the classification data of the decision tree as the input layer data of the convolutional neural network. These four types of feature data will sequentially pass through the input layer, convolutional layer, pooling layer, fully connected layer, and activation function of the neural network, and finally the predicted value of

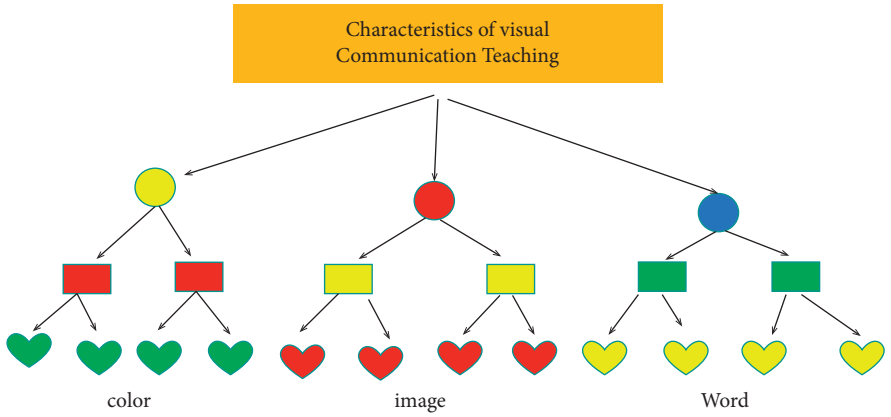

Figure 2: Application of decision tree in visual communication design teaching system.

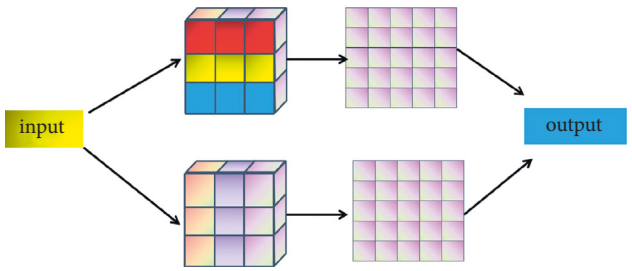

Figure 3: The operation process of convolutional neural network in predicting the teaching content of visual communication design.

visually conveying the teaching content will be output in the output layer of the neural network. The data set will be transformed into the form required by the neural networks. The parameters of CNN are critical to the training of the algorithm. The number of filters 64 and the step size 1 were chosen in this study. Meanwhile, the learning rate 0.001 is chosen to improve the training convergence and training speed.

In the operation of the convolutional neural network, hyperparameters such as the number of filters, step size, and number of layers will be involved. The following equation shows the operation rules of these hyperparameters:

$$w' = \frac{(w + 2p - k)}{s} + 1. \tag{5}$$

The main computational form of the neural network method is the derivation of weights and biases, which is the main source of the gradient descent method. The following equations show the process of derivation of the bias and weight of the convolutional neural network:

$$\Delta\omega_{ji} = -\eta \frac{\partial E}{\partial \omega_{ji}}, \tag{6}$$

$$\Delta u_{ij} = -\eta \frac{\partial E}{\partial u_{ij}} \frac{\partial}{}. \tag{7}$$

Activation function is an indispensable calculation process for neural network operations, and it is a function of nonlinear processing of data. Only after the activation function calculates the weights and biases will they change continuously. The following equation shows how the activation function operates:

$$f(x) = \text{sign}(\omega \cdot x + b). \tag{8}$$

The convolutional layer is an important layer of the convolutional neural network. It will effectively extract features according to the step size and the number of filters and only retain important features. The following equation shows the computation rules for convolutional layers:

$$\delta_j^{\zeta} = f'\left(u_j^{\zeta}\right) \circ conv2\left(\delta_j^{\zeta+1}, rot180\left(k_j^{\zeta+1}\right)\right). \tag{9}$$

The pooling layer is to further reduce the number of parameters of the network; it mainly includes two methods of upsampling and downsampling. The following equations show the calculation rules for downsampling and upsampling, respectively:

$$x_j = f\left(\sum_{u,v} \beta_j^{\zeta} \text{down}\left(x_i^{\zeta-1}\right) + b_j^{\zeta}\right), \tag{10}$$

$$\delta_j^{\zeta} = \beta_j^{\zeta+1}\left(f'(u)_l^{\zeta} \circ up\left(\delta_j^{\zeta+1}\right)\right). \tag{11}$$

3.4. The Processing Process of Visual Communication Design Teaching Content Feature Data. The data set of this study comes from the artwork appreciation data of a visual communication design class in a university in Beijing. The image, color, and shape feature data are all derived from the classroom camera system and courseware content. This research is mainly to realize the effective classification and efficient prediction task of visual communication design teaching content. The teaching content of visual communication design mainly includes image features, word features, shape features, and color features. It can be clearly seen that these characteristics are very different. The image features are mainly between 0 and 255, but the word information features are between 0 and 1, so the data preprocessing process is more important for the prediction of visual communication design teaching content. First, the

image characteristics of the visual communication design need to be matrixed into the form of data, and then these data will be normalized. The processed data will be in the interval −1 to 1. This will ensure that all features are within an interval. A good data set will affect the accuracy of training and the convergence of training. First of all, in this study, the text features and shape features are converted into numerical form by using the rectangle processing. Then, these four characteristics of the visual communication design teaching content will be normalized. Ultimately, this study treats the four characteristics data into data values with the same magnitude and the same characteristics.

4. Result Analysis and Discussion

Big data technology is used in the teaching of visual communication design technology. In this paper, four factors involved in the course of visual communication design are classified by decision tree method; then, neural network technology is used in the prediction of four factors in visual communication design teaching. Reasonable classification is the key to the success of visual communication design teaching content prediction. In the data collection stage, there will be some differences in the four characteristics of visual communication design teaching, whether in quantity or magnitude. In order to ensure the accuracy of big data technology, data preprocessing is used in the feature processing of visual communication design, which will cause the phenomenon of uneven feature distribution. Figure 4 shows the classification of the four elements of the visual communication design teaching method. It can be seen from Figure 4 that the decision tree method is more average in classifying the four factors in the visual communication design teaching method. According to the need and actual situation of visual communication design teaching, the content of visual communication design teaching will be divided into four kinds of information: image feature, character feature, shape feature, and color feature. The proportion of four kinds of video teaching content is about 25%; the largest proportion is 27.1%; this part is the image feature information. The minimum feature ratio is 22.9%, which is the shape information of video teaching content.

Error is one of the most important evaluation indexes of big data technology. Figure 5 shows the classification error of decision tree method in visual communication design teaching content. Through Figure 5, it can be clearly seen that the decision tree has good performance for the information of image feature, character feature, shape feature, and color feature of visual communication design teaching content, and the prediction error is less than 3%, this is a good error range for the teaching mode of visual communication design. The biggest classification error comes from the image information of the teaching content, which is also an understandable error, this part of the error is only 2.66%. This part of the classification error is large because the image features are the main features of the video content; this part of the features is relatively large changes compared to other features. The small error of image feature shows that the decision tree has great credibility in the teaching content of

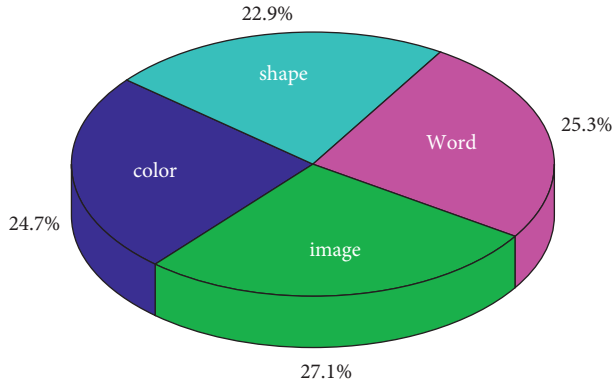

Figure 4: The distribution of the classification of visual communication design teaching content.

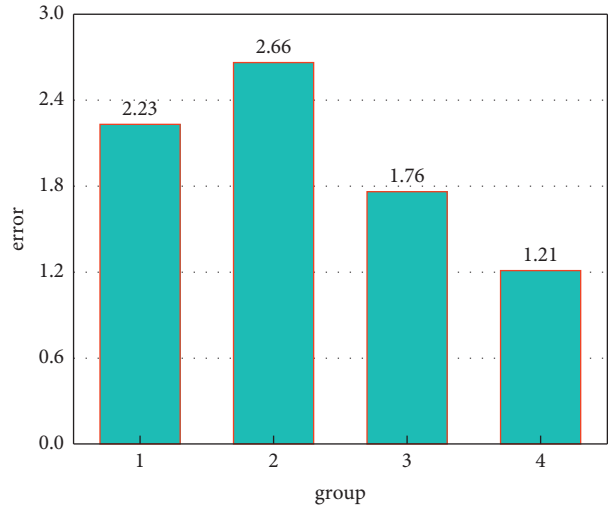

Figure 5: The classification error of video transmission teaching content.

classified visual communication design. Color information is also an important feature of video teaching content; its classification error is only 2.23%. Other video transmission teaching content classification error is less than 2%.

In the following discussion and analysis, this paper mainly analyzes the prediction error and prediction accuracy of the neural network method in the visual communication design teaching content. Figure 6 shows the error distribution of image features for visually conveying teaching content. Image feature is the most important feature of video conveying teaching content. It can directly feed back the visual teaching content to students, and it requires students to experience the emotional information of the visual teaching content. It can be seen from Figure 6 that the gradient of the error distribution of the image features is relatively small, and the errors are all concentrated within 3%. The main error of image features is distributed in the middle of the image, which is the area where the visual communication design course content has a large gradient, and the errors around the image are relatively small. In the follow-up research, the data set needs to add more image features to improve the reliability

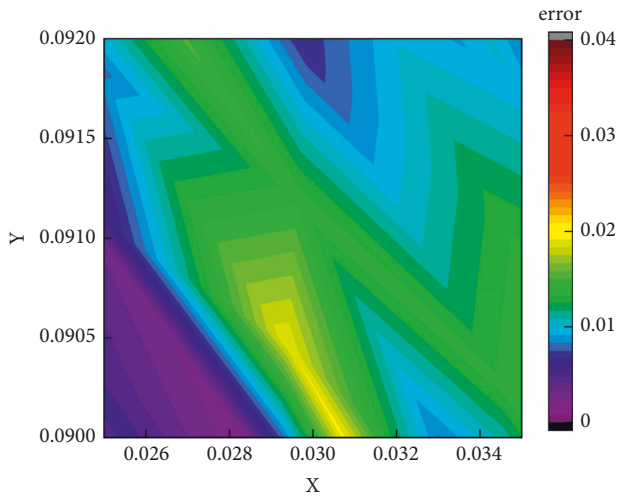

Figure 6: The error distribution of image feature in teaching content of visual communication design.

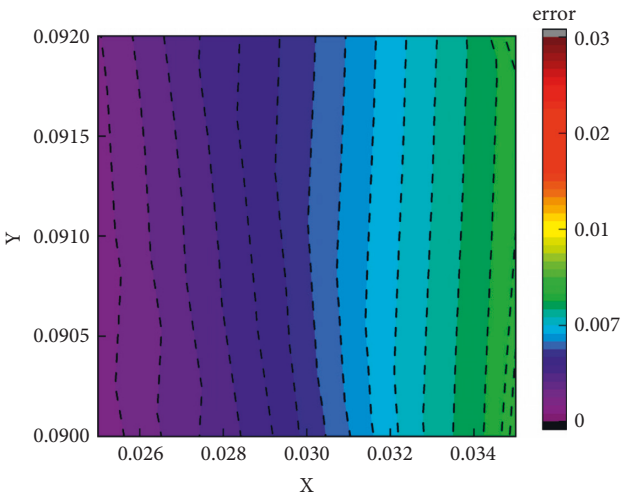

Figure 7: The color error distribution of visual communication design teaching content.

of the neural network method in video conveying image content prediction.

Color distribution is an important feature of video conveying the characteristics of teaching content, and it is mainly for the prediction of the three primary colors of color. Color information can directly let students experience the impact of visual communication design of teaching content. Figure 7 shows the distribution of color prediction errors for visual communication design teaching content. It can be seen intuitively from Figure 7 that the distribution of color errors has a certain regularity, which is not like the distribution of image feature errors. Color errors have smaller prediction errors on the left side of the picture, and larger errors are distributed in the right region of the image. The largest color error is mainly distributed on the right side of the image, which may be due to the continuity of the teaching content of visual communication design, which will cause the color information to have certain temporal

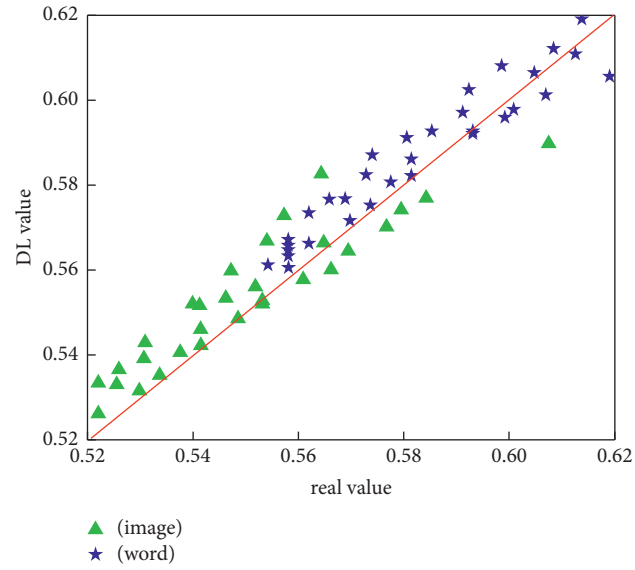

Figure 8: Linear correlation graph of word and image feature prediction for visual communication design teaching content.

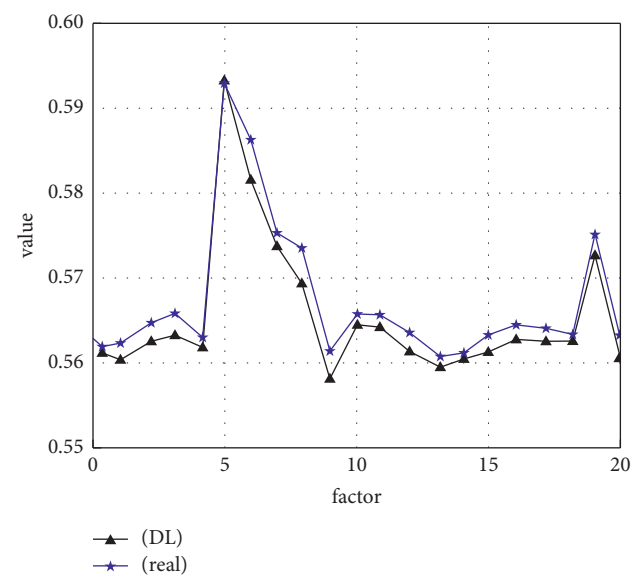

Figure 9: Distribution of predicted value and actual value of the shape of visual communication design teaching content.

characteristics. It leads to a large color prediction error in the right area of the image.

"Word error" refers to the word prediction error of visually conveying teaching content. Generally speaking, the data points are closer the linear function $y = x$; linear correlation of the data points is better. This can also reflect the high accuracy of CNN in predicting visual communication design features. Figure 8 shows the linear correlation plot of the predicted values for word and images. It can be seen from Figure 8 that the neural network method has a good linear correlation in predicting the predicted value of the word and image of the visual communication design teaching content. The predicted values for word and images are basically distributed on both sides of the linear function.

A good linear correlation indicates that the visual communication design teaching content prediction has a high accuracy. The shape information of visual communication design teaching content mainly includes plane, three-dimensional, and various shape information, which is relatively easy to predict. This is because the shape features have relatively stable features. Figure 9 shows the distribution of predicted values for visually conveying instructional shape content. It is also relatively easy to see from Figure 9 that the predicted value of the shape is in good agreement with the actual shape information, whether it is a region with large variation in shape feature gradient or peak information of shape.

5. Conclusions

Visual communication design technology is an emerging technology in recent years, which is of great significance to people's production and life. Visual communication design teaching is also a relatively new subject, which is different from traditional subjects such as Chinese and mathematics. Its teaching methods and teaching modes are quite different from traditional subjects. Traditional books and computer-aided teaching modes can only effectively transmit text information to students, but visual communication design teaching not only involves text information, but also images and color information are more important teaching contents. It requires students to experience the emotional information and historical information contained in the artwork itself through visual content. This research mainly uses big data technology to effectively classify the teaching content of visual communication design, and it makes efficient prediction of these classified data. The combination of big data technology and visual communication design teaching will not only improve students' interest in learning, but also allow students to truly appreciate the content of visual communication design teaching. For the application of decision tree in the classification of visual communication design teaching content, it can effectively classify the image features, color features, shape features, and text features of visual communication design teaching content, and the distribution of these four types of features is relatively uniform, which is also conducive to CNN neural network model in the prediction of teaching content in visual communication design. Image features and color features are the most important two-side features of visual communication design teaching content, and the classification errors of decision tree method in image and color features are 2.66% and 2.33%, respectively. Since the information of image features is mainly distributed in the central area of the image, this results in a larger error distribution in the central area of the image compared to the surrounding areas of the image. For the color features prediction of CNN model, the color errors are mainly distributed on the right side of the image, which may be related to the strong correlation between the teaching content and time of visual communication design. For the text features prediction of CNN model, CNN methods have achieved good performance. The text prediction values of visual communication design teaching are mostly distributed on both sides of the linear correlation function. Overall, the CNN model and decision tree method proposed in this study have important value in the research of visual communication design teaching.

Data Availability

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

Conflicts of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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