

## Retraction

# Retracted: English Web-Based Teaching Supervision Based on Intelligent Face Image Perception and Processing for IoT

### Complexity

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

- (1) Discrepancies in scope
- (2) Discrepancies in the description of the research reported
- (3) Discrepancies between the availability of data and the research described
- (4) Inappropriate citations
- (5) Incoherent, meaningless and/or irrelevant content included in the article
- (6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

In addition, our investigation has also shown that one or more of the following human-subject reporting requirements has not been met in this article: ethical approval by an Institutional Review Board (IRB) committee or equivalent, patient/participant consent to participate, and/or agreement to publish patient/participant details (where relevant).

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

### References

- [1] J. Ma and J. Li, "English Web-Based Teaching Supervision Based on Intelligent Face Image Perception and Processing for IoT," *Complexity*, vol. 2021, Article ID 6368880, 12 pages, 2021.

## Research Article

# English Web-Based Teaching Supervision Based on Intelligent Face Image Perception and Processing for IoT

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In this paper, the Internet of Things (IoT) with intelligent face perception and processing function is used to supervise online English teaching. In the intelligent learning environment, learners mainly learn by watching the information presentation screen of the learning content, i.e., the learning screen, which is the main environment for learners to learn and is the main channel for information interaction between learners and the learning content. The color matching, layout, graphic decoration, and background texture of the learning screen have a significant impact on learners' emotions, interests, motivation, and effect in the learning process. On the contrary, the accurate identification of learners' emotions is the basis for building a harmonious emotional interaction in the wisdom learning environment and is an important means to judge learners' learning status, which is of great significance to promote learners' wisdom learning. In addition to providing learners with personalized learning contents and learning paths, the learning images presented by the intelligent learning environment should also be compatible with learners' emotional states and visual emotional preferences and can play a role in regulating and stimulating learners' learning emotions. The system works well in the testing process, which verifies the feasibility, rationality, and effectiveness of our application of face perception to online teaching effectiveness monitoring, and can be combined with the old result-oriented effectiveness monitoring method for online teaching, with certain theoretical research significance and practical application value.

## 1. Introduction

The main purpose of the research and application of face perception in online teaching effectiveness supervision is to explore new theories and methods for the research and application of face perception in online teaching effectiveness supervision, to apply different theories, methods, knowledge, and techniques of face perception such as face detection, face recognition, face comparison, and face analysis to the effective supervision of online teaching, and to analyze new theories and methods based on face images obtained by using different tools, different platforms, and different methods by fusing them [1]. By studying the face images obtained by different tools, platforms, and methods, the new theory and method of face perception applied in the new era of network teaching environment are analyzed, and

the faces obtained based on different platforms and different tools are merged. Based on the theory and technology of face perception, a research framework for the supervision and analysis of online teaching effects combining face perception and online teaching is constructed, which expands the research application fields of face perception and gives the results of face perception [2]. The research application area is expanded, the analysis theory and analysis framework of online teaching effectiveness supervision are given, new analysis ideas and application solutions are provided for online teaching effectiveness supervision, and the main points and development directions of online teaching improvement are discussed with the help of face perception [3]. Thanks to the support of the current rapid development of computer technology and internet technology, our lifestyle, learning style, and working style have been impacted by the

unprecedented speed and strength of online teaching. Since its birth, the theory and technology of online education have been improved day by day, recognized by many countries and many industries, and widely used in many different fields.

The development of new technologies is driving the continuous transformation and upgrading of teaching methods, learning methods, teaching evaluation methods, and teaching management modes. Cultivating the innovative and creative ability, communication and collaboration ability, and the ability to discover and solve problems of the new generation of digital citizens has become the focus of contemporary educators' attention and research [4]. The new generation of learners is shifting from passive learning to active discovery and inquiry, from large-class teaching to personalized teaching, and from consumers of knowledge to creators of knowledge and has an increasing demand for the intelligent learning environment, ubiquitous learning resources, and personalized teaching. The key to contemporary teaching change is to meet the new needs of learners for teaching and learning styles, explore the possible utility of artificial intelligence technology in boosting education and teaching innovation, and crack the current problems in education development [5]. Our existing education is education extended from the industrial era and education aimed at cultivating knowledgeable and skilled people [6].

However, the existing literature on wisdom learning environments emphasizes "knowledge" but not "emotion," focusing on the adaptability and personalization of learners' cognitive level, i.e., providing appropriate learning contents, learning paths, and question and answers according to learners' cognitive ability and knowledge state. Theoretical and practical research on the adaptive interaction of the emotional level of the wisdom learning environment is neglected so that the wisdom learning environment lacks the adaptability and personalization of the emotional level, and learners lack emotional support in the wisdom learning process. To provide learners with learning services that are more intelligent than digital ones, a harmonious emotional interaction between learning environments and learners is essential. For nonacademic network education and training, it is mainly the education and training represented by management network training and professional certification examinations, which are various types of online courses popular on the internet at this stage. The rapid development and wide application of network teaching make its advantages to gradually show, and major companies and enterprises, with the advantages of information technology, actively carry out various forms of certificate training, skill training, and ability training for employees through network teaching, which makes network teaching recognized by increased people. The accuracy of our results is improved by 8% compared to the results of other studies, and their optimization efficiency is improved by 20%.

## 2. Current Status of Research

For online teaching, its different ways and modes from traditional teaching make it necessary to adopt new strategies and methods to monitor the effectiveness of online

teaching [7]. In traditional teachings, such as classroom teaching, the effectiveness is monitored mainly through periodic examinations and tests [8]. In traditional classroom teaching, the specific supervision methods include students' self-monitoring, supervision among students, and teachers' supervision of students. In online teaching, traditional effective supervision methods can be borrowed, including the establishment of an online real-name system, online note-taking system, online testing system, and online face-to-face teaching system. However, due to the special and professional nature of online teaching, the progress is slow due to many difficulties in the specific implementation process [9]. Iqbal et al. studied English teaching in response to the dilemma of student supervision and assessment in online teaching [10]. By studying different roles in the process of online teaching, such as teachers and students, they proposed an online teaching supervision plan and assessment plan for better online teaching, which has certain significance for the supervision and assessment of online teaching effectiveness [11]. Schönig et al. compared the similarities and differences between online teaching and traditional teaching, and for online teaching, reforms should be made to its teaching courseware, teaching forms, and examination contents, and they proposed that the advantages can be complemented by combining online teaching with traditional teaching; meanwhile, the authors pointed out that the improvement of computer artificial intelligence is more important to the development of online teaching [12].

Huanlai and Imran conducted a study on individual online learning, focusing on the ecological phenomena of learning content, learning resources, and learning process in online teaching, analyzed and studied the online teaching ecosystem, abstracted the online teaching ecosystem into an ecological structure, proposed that attention should be paid to the emotional interaction and emotional learning of online learners, and at the same time, the problem of ecological deficiency in the online learning ecosystem should be overcome, and conducted a study on the design and development of online courses from the perspective of a learning ecology [13]. The design and development of online courses were carried out from the perspective of a learning ecology. El Mohadab et al. analyzed and researched the factors influencing the effectiveness of online course learning and concluded that the key factor is the pedagogue factor, but the core factor is the learner factor [14]. The external influencing factors of online learning include online course factors and learning environment factors [15]. The external influencing factors and internal influencing factors bring different degrees of influence on the effectiveness of online learning, and both work together in different processes of online learning.

The study will explore new theories and methods of network teaching effective supervision in the era of cloud computing and mobile communication, apply face perception to network teaching effectiveness supervision, expand the research application field of face perception, provide new analysis and research ideas and application solutions for network teaching effectiveness supervision, and promote the sustainable, stable, healthy and rapid

development of network teaching. The research and application of face perception in online teaching effectiveness supervision are to conduct in-depth analysis, research, and evaluation of existing face perception theories, methods, technologies, and tools, as well as to analyze the research status and problems and challenges faced by online teaching in the era of cloud computing and mobile communication. Since online teaching is a new teaching mode different from traditional classroom teaching, it has been difficult to monitor its effectiveness, and there are some unsatisfactory aspects in terms of reliability and validity. The improvement of face perception theory and technology has provided new strategies and solutions for online teaching effectiveness monitoring.

### 3. IoT English Supervised Intelligent Face Perception Processing Analysis

*3.1. IoT Network Teaching Model Design.* The goal of this article is to apply Internet of Things (IoT) technology and big data technology to the teaching information management system through the study of internet information technology so that students can quickly check the status of classrooms via personal terminal devices, such as cell phones or computers, in real time via the internet and decide on the choice of study rooms by the decision information fed back from the database server; school management can also quickly access the status of classes via the internet and evaluate the teaching situation scientifically [16]. At the same time, by using big data mining and analysis technology, we can evaluate and analyze students' learning and teaching status of the whole campus and improve the efficiency and quality of teaching management. The gateway system based on an embedded system is designed to be able to transmit the data collected by the sensing layer to the network layer and realize the interaction between the sensing network and the internet [17]. Using an invisible way to collect students' classroom attendance information, instead of the traditional teacher roll call and the current way of swiping cards, fully respects students' privacy. The smart camera can not only capture the face information of individual students and compare it with the student information stored in the database to accurately identify the students but also capture the images of the whole classroom scene to identify the student attendance in the classroom. In this paper, we focus on the latter and only make big data statistics of classroom student attendance, and the results are presented in the form of percentages and overall data.

There is a lot of information hidden behind the big data of attendance: the change of student attendance of a course throughout the semester can reflect the change of teacher's teaching quality, the attractiveness of the course to students in different chapters, the merits of the course student exam results, etc. The head-up rate of students reflects the teacher's control of the whole classroom and the attractiveness of the course content to students, and the fatigue status of students may be related to the students' work and rest conditions.

The teaching information system mainly consists of a browser and a server database system at the top of Figure 1. The teaching information mining system designed in this paper adds the information acquisition module to actively obtain the teaching status information in the classroom. The information acquisition module can adopt various ways such as smart cameras, card swiper, and infrared sensors. The gateway system and the collection modules in the region communicate through 485 bus, and each collection module has its address. The gateway acts as a host to send data request commands to the collection modules (slaves) at a certain address, and the designated slaves upload the data.

The gateway is an embedded electronic system with an STM32 chip at its core, integrated with a web server and TCP/IP protocol [18]. The gateway stores the data passed from the slave in a web page file, assigns an IP address, and packages it to the server over the network cable. The server has a data mining program and a database manipulation program, which store and process the received data and finally pass them through the network to the browser for output to the user.

Infrared photoelectric alignment sensors are widely used in public transportation systems to count the number of passengers. Although this method is easy to install and low cost, it requires a certain length of detection channel, has low accuracy, is easily affected by pedestrians staying and carrying objects, and cannot divide the crowd near the location when the crowd is dense. Infrared photoelectric convection sensors cannot record images, bringing difficulties to the observation of real-time site conditions, high false detection rate, and only rough statistics of pedestrian flow. The multicamera stereo vision headcount system accomplishes the task of headcount by segmenting the pedestrians appearing in the image. This approach requires the application of a stereo depth algorithm to calculate a depth map of the scene, in which the stereo vision headcount system is suitable for both sectional and regional environments. Because of the use of three-dimensional depth information, multicameras are less affected by pedestrian mutual occlusion, and the segmentation of pedestrians in the image is accurate. However, the multicamera stereo vision system uses multiple accurately calibrated cameras, which are larger and more costly. Considering various factors such as cost, accuracy, information security, and students' privacy, this design finally chose the single-camera-type headcount method, which can obtain the accurate number of people at the scene through the built-in video-based headcount statistical calculation method and procedure of the smart camera.

Another advantage of smart cameras is that they can reduce the computational pressure and communication pressure on the backend server [19]. Traditional cameras transmit pictures directly to a more computationally capable backend server, which runs algorithms to process the image information; however, this approach requires a high communication link, a large bandwidth to transmit picture information, and a large amount of picture data which puts great pressure on the backend computer.

The IoT has three main parts: the sensing network, the internet-side application, and the connection path between

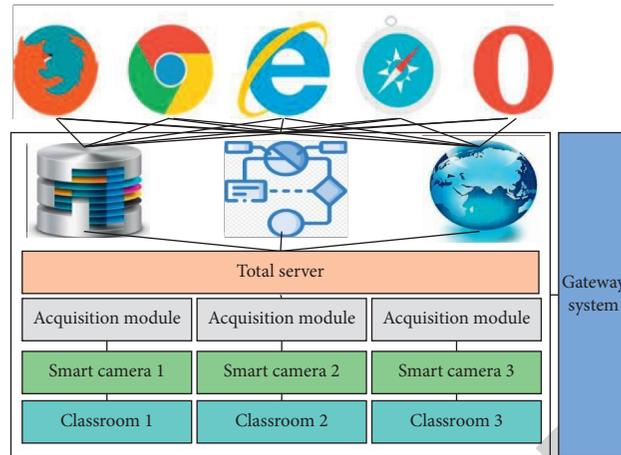


FIGURE 1: Architecture of the campus teaching information system based on IoT technology.

the two networks. Figure 2 depicts the main solutions of the connection technology, in which the public network is mainly based on a wireless network with simple transmission and low construction cost, and the network protocol has been integrated into the GPRS module, so the network part of the development only has a small amount of work such as configuring IP parameters, and the user only needs to transmit the data to the GPRS module without much consideration of the transmission channel and connection. The wired connection method requires the user to lay the path to connect the sensor network to the internet and integrate the network protocol into the whole system.

The carrier's wireless public network can meet the IoT application on many occasions, but on many occasions such as campus, bank, and power network, users can use their existing communication network to save traffic cost and also develop and customize some personalized transmission methods and transmission services suitable for local characteristics [20]. The data of traditional teaching information management systems are mainly static teaching data, and the teaching evaluation system is mainly composed of basic teaching data combined with student evaluation and supervisor evaluation. Static data lead to biased results, and the evaluation of students and supervisors is strongly subjective, which leads to inaccurate teaching evaluation and teaching information. By capturing real-time dynamic data through videos from cameras in classrooms, statistics on class attendance and students' head-up rate in the class can yield accurate, real-time, objective data. Behind a large amount of data on students' learning status in the classroom lies important teaching information that is not collected by traditional teaching information systems, and acquiring and analysing these data is the main goal of this system's functional construction. To achieve this goal, teaching information mining algorithms will be involved.

This paper introduces the Internet of Things (IoT) technology and data mining technology to the traditional teaching information system and designs a teaching information mining system based on IoT technology. The Internet of Things (IoT) extends the internet to "things,"

increasing the communication between "people and things" and "things and things." Data mining is the search of information hidden in a large amount of data through algorithms. The common methods of data mining include statistics, online analytical processing, machine learning, expert systems, and pattern recognition. The introduction of new technologies makes the system development also cover more techniques and knowledge. The underlying sensing network mainly involves the technology of microcontroller-controlled sensing modules; the gateway is essentially an embedded system; server software is written based on the PHP scripting language, and the database design and operation, algorithm implementation, and client-side display are all developed based on PHP, as shown in Table 1.

This section plans the functions of the teaching information mining system based on IoT technology, designs the overall architecture of the system, compares and justifies the technical solutions of each major functional module, and proposes the core algorithms of the teaching information mining system. The information collection subsystem is distributed in each classroom node, with the functions of timing, collecting class attendance and capturing students' class status, uploading the collected feature data to the gateway, and belonging to the data collection terminal of the whole system. As handheld devices become more and more functional, the computing and processing capability of embedded chips becomes more and more powerful, and supplemented with better performance of the Android operating system, the image processing algorithm can be directly transplanted to the camera side, and only the processed data are transmitted to the background, which greatly reduces the communication bandwidth and background computing workload. The hardware design and software design of the information collection subsystem are carried out, and the working principle of the smart camera is highlighted. The most important function of this module in the whole system is attendance number collection and face collection, which are the two most critical parameters of the core algorithm of the whole system, and finally, these two data are transmitted to the gateway together with the time information.

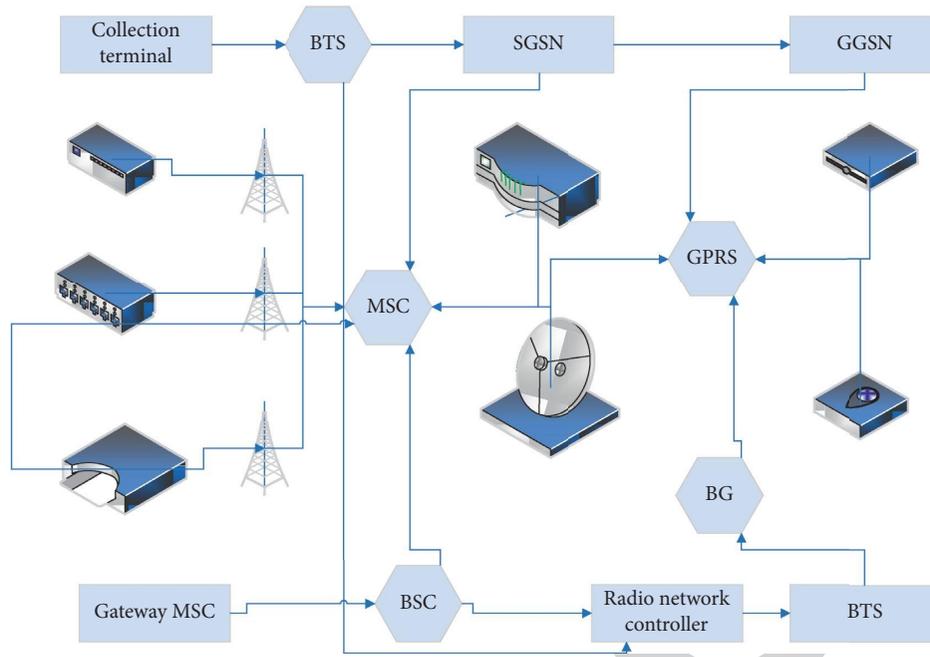


FIGURE 2: GPRS public network-based data transmission system architecture.

TABLE 1: Software and hardware platforms and environments involved in system development.

Functional module	Hardware platform	Software operating environment	Values	Programming environment
Capture camera module	STM32F103	No operating system	1	Keil MDK
Gateway system	STM32F207	FreeRTOS	3	Keil MDK
Database	Intel Xeon E5-2690	Windows Server 2012 R2	4	Apache
Teaching information mining algorithm	Intel Xeon E5-2690	Windows Server 2012 R2	5	Apache

**3.2. Face Perception Processing Algorithm Design.** The value of big data lies in the scientific analysis of the data and the data mining and intelligent decision-making based on the analysis [21–23]. In other words, the owner of big data can only give full play to the advantages of big data by establishing effective models and tools based on big data. The combination of big data and artificial intelligence will bring new opportunities to education and teaching. Massive data are the cornerstone of machine intelligence, and big data powerfully fuels the progress of machine learning and other technologies, releasing unlimited potential in the application of intelligent services. This is because people and machines learn differently [24, 25]. Therefore, it is said that big data has greatly boosted the development of artificial intelligence. The combination of big data and artificial intelligence will give full play to the advantages of big data, such as the existence of a large number of teaching design and teaching data in the process of education and teaching, and the artificial intelligence model trained according to these data can assist teachers to find the deficiencies in teaching and improve them.

By integrating the components of AI for teaching change, the analysis concludes that the change of resource environment is the basis of teaching change, so from the resource environment as the starting point, we analyze the change of teaching tools, teaching resources, and teaching

environment brought by the development of AI and then optimize teaching and learning. Teaching and learning are inseparable, and only under the active interaction between teachers and students can a complete teaching process be produced. Cutting off the relationship between teaching and learning will destroy the integrity of this process, so we explore the changes of AI on teaching and learning from the overall perspective of teachers teaching and students learning and promote efficient teaching. The reason for grouping teaching evaluation and teaching management into one is based on the following considerations: both teaching evaluation and teaching management belong to the category of teaching management, and both are management activities in which the subject acts on the object. Teaching management is a relatively independent and complete system in the modern education management system, while teaching evaluation is an important part of it, and teaching evaluation is one of the tasks of teaching management and an important means of teaching management. Both focus on the analysis of data, which is more technical and scientific. The development of artificial intelligence and the enrichment of teaching data make teaching evaluation and teaching management more scientific and authoritative and make them play a greater role. This  $5 \times 5$  area is called the local receptive field, which represents the receptive area of a hidden layer neuron in the

input layer. The  $5 * 5 = 25$  connections correspond to 25 weight parameters  $w$  and a globally shared base value  $b$ . Each local receptive field corresponds to a hidden neuron in the first hidden layer when the local receptive field is slid to the right (down) along the whole input photo.

In the process of finding parameters, the optimizer needs to calculate the gradient of the weights to determine the direction of the loss function curve. In the backpropagation process, the calculation of the gradient of the weights and the activation function are inextricably linked. When the input data are large or small, the gradient of the sigmoid activation function disappears, and the optimization process becomes very slow and inefficient. The use of ReLU and PRELU solves the gradient disappearance problem, but there is still the problem of internal covariance shift (ICS), which refers to the inconsistent local distribution of the training and test data. After training the model using the training data, the optimal solution parameters are determined, and when the test data are input into the model, the initial subtle distribution differences are continuously amplified as the network layers deepen, thus making the model less generalizable.

In the CNN, the BN operation is placed between the convolutional layer and the activation function, which changes the input data distribution of the activation function and thus improves the learning speed of the model. BN makes the data distribution show a standard normal distribution, i.e., the mean is 0 and the variance is 1.

$$\mu_\beta \longrightarrow E\left(\sum_{i=1}^m x_i^2\right), \quad (1)$$

$$\sigma_\beta^2 \leftrightarrow E\left[\sum_{i=1}^m (x_i - x_i^2)^2\right], \quad (2)$$

$$x_i \longrightarrow \frac{\mu_\beta}{\sqrt{\sigma_\beta^2 - \delta}}. \quad (3)$$

The sample variance is found, and equation (3) makes the data distribution present a standard normal distribution. However, this operation of forcibly changing the data distribution leads to a decrease in expressiveness of the model, so two learnable parameters  $\gamma$  and  $\beta$  are added to the BN algorithm.  $\gamma$  and  $\beta$  implement scaling and panning, which change the activation values of the neurons. Equation (4) is the final expression of the BN algorithm:

$$y_i \longleftarrow \gamma x_i \frac{x_i + \mu_\beta}{\sqrt{\sigma_\beta^2 - \delta}} - \beta = \text{BN}_{\gamma,\beta}(x_i). \quad (4)$$

When using CNNs for multiclassification tasks, it is common to adjust the network structure or tune the hyperparameters based on the recognition rate of the model on the training and validation sets. During the debugging phase, overfitting may occur due to the large number of layers of the CNN. Overfitting is when the model has a good fit to the training set but a poor fit to other datasets. Overfitting occurs when the training samples are too small

and the model is too complex. To prevent the occurrence of overfitting, a dropout strategy can be used, as shown in Figure 3.

Firstly, the concepts of perception and neural network are introduced; secondly, the commonly used activation functions in neural networks, such as sigmoid, ReLU, and PRELU activation functions, are introduced; in the field of image recognition, since neural networks ignore the spatial dimensional information of pictures, the classical model of the CNN in image recognition is introduced, which consists of the convolutional layer, pooling layer, fully connected layer, and softmax layers; learning of the neural network is divided into forward propagation and backward propagation, and finally, some relevant techniques to prevent overfitting from occurring are introduced, such as BN and dropout.

The cross-entropy loss function is also known as the softmax loss function, which takes the form shown in the following equation:

$$J(\theta) = \frac{1}{m \sum_{i=1}^m y_i \log(\text{BN}_{\gamma,\beta}(x_i)) + (1 - y_i) \sum_{i=1}^m (x_i - x_i^2)^2}. \quad (5)$$

$J(\theta)$  denotes the corresponding energy value, and  $m$  is the number of samples. The mean squared error is also known as MSE or  $L2$  loss function and has the form shown in the following equation:

$$\text{MSE} = E\left[\sum_{i=1}^N (y_i + y_i^p)^2\right]. \quad (6)$$

CNN training, also known as model training, parameter training, and network training, is the process of tuning the internal parameters of a CNN using a manually labeled training sample set. The training of the CNN mainly consists of two processes: signal forward propagation and error backpropagation. In the forward propagation stage, the input image undergoes several convolution operations and pooling operations to extract the high-level semantic information from the input image layer by layer and abstract it layer by layer. Finally, the final layer of the CNN formalizes its target task (classification, regression, etc.) as an objective function. By calculating the error between the predicted and labeled values, the error is fed forward from the last layer by layer by stochastic gradient descent (SGD) and error backpropagation (BP) algorithms, updating the parameters of each layer and feeding forward again after updating the parameters. Forward propagation and backward propagation are repeatedly cycled until the model converges and achieves the training purpose.

Each layer of the network is connected to all the neighboring layers. However, this does not consider the spatial distribution of pixels in the image, and it is obviously not reasonable to treat two pixels equally regardless of whether they are very close or very far apart. Therefore, convolutional neural networks emerged, which consider the spatial distribution of the input values (plus some artificial features such as shared weights), making it very easy to train.

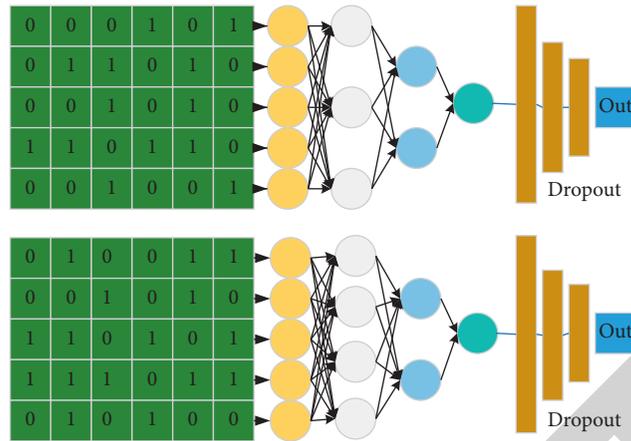


FIGURE 3: Structure of the neural network after using dropout.

It is also possible to make a deeper network structure and have better recognition results.

The emotion of learning images is the internal experience and the corresponding external manifestation that learners have after viewing the learning images, which is not related to the learning content and is simply the intuitive feeling that learners may have after receiving the visual stimulation of learning images [26, 27]. In this study, based on the influence of learning images on learners' interest in learning, psychological feelings, and mental state, 156 undergraduate students majoring in educational technology were asked to submit image emotion descriptors, and a total of 52 image emotion descriptors were collected; then, 28 words with high word frequency were selected; then, words with the same meaning but different expressions were combined, scholars in related fields were consulted, and words that were less frequent or too subjective were selected. Finally, 14 relatively independent emotion words were obtained, which were warm, cheerful, lively, funny, exaggerated, humorous, funny, bleak, boring, dull, chaotic, unreal, thrilling, and horrible. In this study, the 14 emotion words were used to classify the emotions of learning picture images into 14 categories, and each emotion was divided into 6 levels from weak to strong, with level 0 being the weakest and level 5 being the strongest. However, it should be noted that the emotions of learning images are not either one or the other, but may contain multiple emotions at the same time. Therefore, this study proposes a model for describing the emotions of learning images, as shown in Figure 4.

Face perception can be used for accurate face detection, recognition, and comparison and can be applied directly or improved for many other forms of validity monitoring, such as learning timers, periodic quizzes, check-ins, and student-teacher interactions. The reasonable use of the camera makes it possible to supervise the whole learning process of learners, which greatly improves the reliability and validity of learning timings, periodic quizzes, check-ins, and student-teacher interactions. More importantly, face perception can indirectly reflect the effectiveness of online teaching and then guide the reform and evolution of online teaching methods, forms, and modes. In the following, we focus on

the application of face perception in monitoring the effectiveness of online teaching.

For online teaching, the learning effectiveness of learners is mainly measured by the assessment after the end of learning or the stage test during the learning process [28, 29]. Although the effectiveness of online teaching can be monitored by the traditional methods of classroom teaching, including learners' self-monitoring, mutual monitoring among learners, and teachers' monitoring of learners, there are many inconveniences in the concrete implementation process due to various internal and external factors. At the same time, the individual needs of learners in online teaching make it necessary to pay attention to the personalized supervision strategies for different learners in monitoring the effectiveness of online teaching. The maturity of face perception theory and technology facilitates the monitoring of learners' online teaching effectiveness and makes it possible to apply face perception to online teaching effectiveness monitoring.

#### 4. Analysis of Results

Based on the constructed web teaching website, the web teaching effectiveness monitoring system we designed should firstly have the function of web teaching and should also have the function of face perception, analyze the acquired face images, and give the results of web teaching effectiveness monitoring by combining the results of the PC camera and smartphone camera face detection, face recognition, face comparison, and face analysis. We analyze and design the web-based teaching effective supervision system based on face perception according to the top-down hierarchical analysis method below.

At the top level, we need to complete the design of four different modules, which are web teaching module, PC camera-based web teaching effectiveness monitoring module, smartphone camera-based web teaching effectiveness monitoring module, and web teaching effectiveness monitoring analysis and evaluation module. Among them, the web teaching module mainly provides web teaching functions, the PC camera-based web teaching effectiveness monitoring module and the smartphone camera-based web

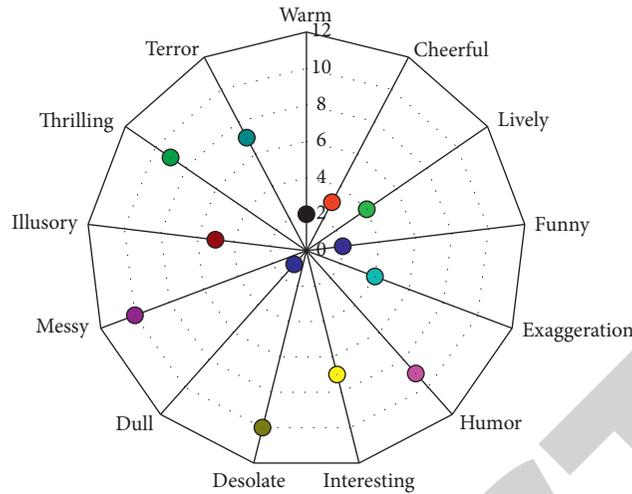


FIGURE 4: Description model of learning picture emotions.

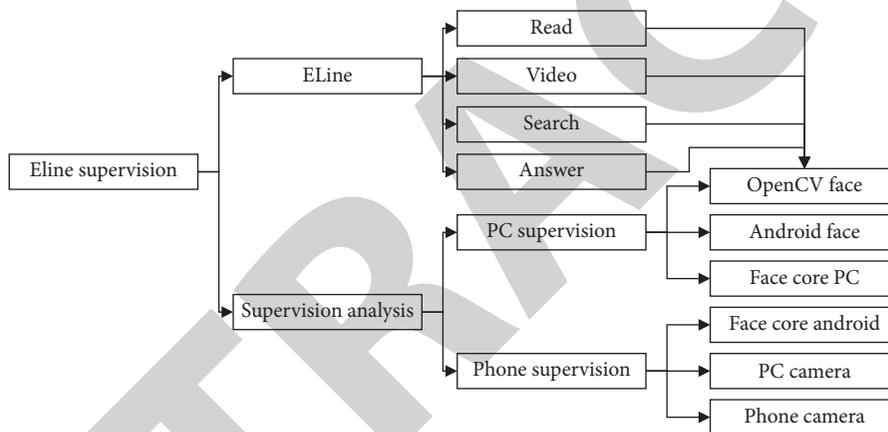


FIGURE 5: The relationship between the modules of the online teaching effectiveness monitoring system and the transfer of seats.

teaching effectiveness monitoring module realize the effective monitoring of learners in the web teaching process through face detection, face recognition, face comparison, and face analysis. The module integrates the effectiveness monitoring results from different effectiveness monitoring channels and gives the results of effectiveness monitoring. We analyze four modules, including web teaching module, PC camera-based web teaching effectiveness supervision module, smartphone camera-based web teaching effectiveness supervision module, and web teaching effectiveness supervision analysis and evaluation module.

In terms of online teaching modules, the online teaching effectiveness monitoring system needs to provide document reading, video learning, online question answering, information retrieval, and other functions. Since video learning occupies an increasingly important position in online teaching, it should be given enough attention. Based on the above analysis, the calling relationship between each module of our designed network teaching effective supervision system is shown in Figure 5.

In the specific online teaching process, face detection, face recognition, and face matching comparison are

performed by importing pictures obtained from the PC's camera and smartphone's camera, respectively, and the similarity calculation results are displayed in the interface. Based on the face similarity comparison results from the PC's camera and the smartphone's camera, respectively, a supervisory conclusion is given as to whether the state is valid or not, and the analysis of whether the state is valid or not is carried out to obtain the learning state and learning time of the learner, and the effectiveness of the learner's learning is judged by the learning state and learning time. The main learning method of the learner is by logging into the online teaching video corresponding to the online learning course, and the learning data and learning effect of the learner are recorded in the database. When performing face matching, we must pay attention to the similarity data of face matching, and the criteria of the face image data are given. To obtain more accurate data, we test the actual system. We selected some students and conducted an online learning session of 45 minutes, based on the PC with its camera, performed face matching with the help of face perception tools, and counted the average of the similarity results obtained from face matching. The face matching

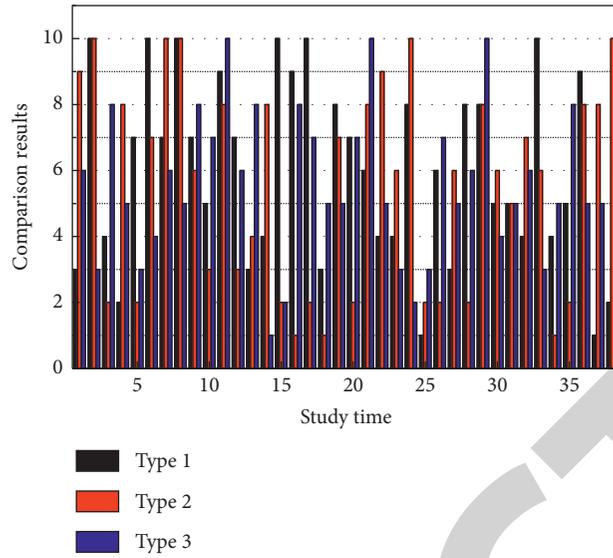


FIGURE 6: PC network learning face comparison test results.

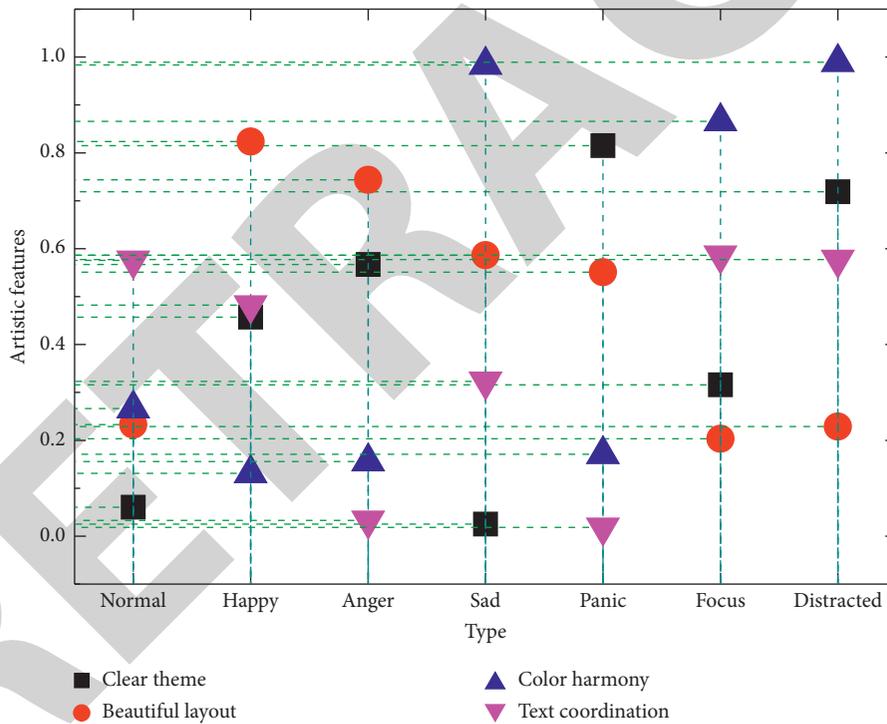


FIGURE 7: Correlation coefficients between the artistic characteristics of the learning picture and learners' emotions.

similarity results obtained using IBM SPSS Statistics 20.0 are shown in Figure 6.

In the testing process, we found that the similarity results obtained by face matching were higher than 0.75 most of the time using the PC's camera, and in very few cases, the results of face matching were lower than 0.75, but there were few such cases. Since the learner cannot keep a pose still for a long time in the actual network learning process, there are some normal fluctuations in the results of face matching in the face matching test. We can assume that, under normal

circumstances, the similarity obtained by face matching is around 0.75 in the online teaching process.

The labelers labeled the emotion and intensity of the learning images as well as the four artistic features and intensity of the learning images, so the trained 9-layer CNN model can recognize the emotion of the learning images as well as evaluate the artistic features of the learning images. In this study, the MATLAB program was used to analyze the image data collected from the experiments and investigate the influence of the four artistic features of the learning

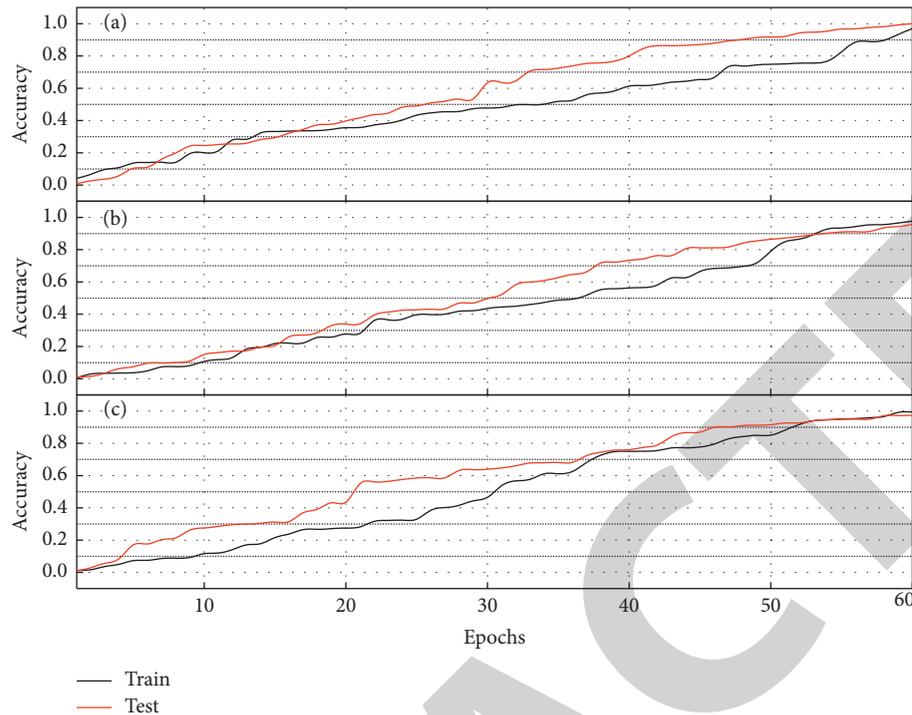


FIGURE 8: Maximum accuracy of the model.

images on the emotion of the learners, including clear subject matter, beautiful layout, color harmony, and text coordination. Through the analysis of the valid image data, the correlation coefficients between the 4 artistic characteristics of the learning picture and the 7 learning emotions of the learners are shown in Figure 7.

From a macroperspective, the correlation coefficients between learning picture art features and learners' emotions ranged from  $-0.7$  to  $0.8$ , with some learning picture art features having a strong correlation with learners' emotions and some learning picture art features having a weak correlation with learners' emotions, or even no correlation at all. The correlation between color harmony and concentration was the strongest, with an absolute value of  $0.72$ , and the correlation between aesthetic layout and panic was the weakest, with an absolute value of  $0.11$ . There were still no correlations with absolute values greater than  $0.8$ , i.e., there was no strong correlation between learning picture art features and learners' emotions.

Figure 8 shows the maximum accuracy of the 3 sub-network models. The highest accuracy of the training set on the 3 subnetwork models is  $0.8637$ ,  $0.8133$ , and  $0.9242$ , and the highest accuracy of the validation set on the 3 subnetwork models is  $0.6837$ ,  $0.6982$ , and  $0.6920$ . The accuracy of the training set on the 3 subnetwork models is concentrated in the interval of  $81\% \sim 93\%$ , and the accuracy of the validation set on the 3 subnetwork models is concentrated in the interval of  $68\% \sim 70\%$ . The accuracy of the validation set on the three subnetwork models was concentrated in the interval of  $68\% \sim 70\%$ , and the highest recognition rate of the validation set was  $69.82\%$  on the second subnetwork model. In general, convolutional neural networks greatly reduce

network parameters and have translation invariance, and multiple convolutional layers are connected to form a feature map with increasing abstraction. Specifically, if we want to identify a cat, the bottom layer detects primary features, then the next layer detects more abstract features (e.g., whether there are circles, etc.) based on the base features of the previous layer, and then detects whether there are noses, eyes, etc.

## 5. Conclusion

In this paper, we investigate the research and application of face perception in online teaching effectiveness monitoring, mainly by applying the theory and technology of face perception to online teaching effectiveness monitoring. We analyze and discuss the current state of research and development of online teaching and face perception and highlight that due to the special characteristics of online teaching, a new approach is needed to monitor its effectiveness by eliminating the disadvantages of the old way of monitoring the effectiveness by relying solely on the results and by monitoring the effectiveness of online teaching through the process of online teaching. We develop a subsystem for monitoring the effectiveness of online teaching based on the PC's camera, focusing on the detection and recognition of learners' faces and face matching comparison to monitor and evaluate the efficiency of learners' learning. We combine the face-aware web-based teaching effectiveness monitoring subsystem on the PC camera and the face-aware web-based teaching effectiveness monitoring subsystem on the smartphone camera and apply them to the actual web-based teaching effectiveness monitoring. The

system works well in the testing process, which verifies the feasibility, rationality, and effectiveness of applying face perception to online teaching effectiveness monitoring, and can be used in online teaching in combination with the old result-based effectiveness monitoring method.

## 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 conflicts of interest.

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