Students' Health Emotions Management Driven English Teaching Quality Evaluation

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Abstract:Teachers are unable to timely and effectively perceive the emotional states of many students in the learning process due to the large number of classes, which leads to that these learners with cognitive impairment of new knowledge keep at the negative emotional state and has no high-learning efficiency. In particular, English is an international language, of which these students are very subjected to the health emotion management. Therefore, it is very necessary to investigate the students' health emotions and promote the improvement of English teaching quality, where the basis idea is to collect the facial expressions of students during the teaching process due to the fact that the facial expressions can reflect students' psychological state and emotional changes. Consider that the whole collection process is dynamic and the involve data on the facial expressions is large-scale, and thus it needs an intelligent methods to analyze such large-scale heath management data. This paper proposes a facial expression analysis strategy based on deep multi-kernel learning, and the experimental results show that the recognition accuracy basic facial expressions can reach 94.75%. In other words, the students' health emotions can be managed efficiently and the proposed health analysis method can provide a significant and universal reference for the English teaching in future.
Keywords: Health Management Data; English Teaching Evaluation; Deep Learning; Data Analysis

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1. INTRODUCTION

Information technology curriculum integration refers to the full integration and utilization of modern information technology into the learning of subjects to complete the task of learning objectives [1-2]. In this process, all kinds of resources and contents of all kinds of courses are organically combined, resulting in a new teaching method [3]. Due to the openness of the network and the richness of resources, this learning method represented by modern information technology has been used by more and more colleges and learners, and plays an increasingly important role [4]. The application of this technology can enrich the English teaching environment, and penetrate all kinds of advanced educational ideas into all aspects of teaching, influencing and integrating each other, thus affecting the whole [5]. Teachers' enthusiasm and students' creativity are gradually stimulated inspired and teaching objectives are achieved.

As a new way which is different from the traditional education mode, flipped classroom with the rapid development of modern information technology subverts the traditional education mode of "teaching by teachers and listening by students", realizes the transformation of students from passive acceptance of knowledge to self-exploration of knowledge, and has become one of the most popular education modes in today's education field [6-8]. Flipped classroom education mode integrates openness, flexibility and autonomy, which is quite different from traditional education and teaching mode in terms of teaching form of education. The "flipped" of English flipped classroom mainly refers to the gradual transformation of the roles between teachers and students in English learning classes, that is, the classroom becomes an English learning platform for communication and learning between English teachers and students, and the teacher is not the teacher of English knowledge, but the guide of students' language learning [9-10]. To help students improve their ability to solve difficulties, learn independently and flexibly in English learning.

In traditional classroom teaching, teachers always stand on a platform to explain the key points of knowledge and make demands on the students, while students can only passively accept knowledge. They are often "subordinate" in the process of getting along with the students and face the students as "managers" in many aspects. Under this teaching mode, teachers hold the initiative of students, the learning progress and the learning time of students. The teachers and students are in an unequal position. In this teaching mode, teachers hold the initiative of students' learning, grasp the learning progress and control the students' learning time, so teachers and students are in an unequal position. However, in the flipped classroom teaching mode, teachers and students are in an equal position, so teachers need to become good partners of students in learning, instead of managing students blindly, they need to actively communicate with them to realize "personalized" teaching. Through the interaction between students and teachers, teachers can change the original serious and inaccessible image, close the distance with students, become a good partner of students in learning, so that students can remove the disguise in front of teachers, put forward questions to teachers without reservation, and dare to argue with teachers on their own views [11-12]. Therefore, teachers have a better understanding of students' characteristics, learning styles and learning difficulties, and help students improve their English ability.

The popularization of Internet and the application of computer technology in the field of education make the application of flipped classroom teaching concept in the actual teaching process become a reality. At the same time, it also provides technical support and power source for the innovation of traditional teaching, learning mode and teacher-student relationship. Professionals have conducted such questionnaires and the results show that students can only remember about 20% of the knowledge by listening, and only by looking can reach a quarter. If listening and watching are combined, students can basically remember 70% of the relevant knowledge [13]. Such teaching and learning atmosphere is conducive to the creative development of students and the improvement and change of their practical English ability [14-15].

The significance of this study is that deep multiple-kernel learning is proposed to classify learners' facial expressions in flipped classroom based on deep learning and multiple-kernel learning.

The rest of the paper is organized as follows. Section 2 reviews related works. In Section 3, deep multiple-kernel learning is proposed to classify learners' facial expressions in flipped classroom. Experimental results are presented in Section 4. Section 5 concludes this paper.

2. RELATED WORKS

A. *Application of flipped classroom in English teaching.*

As a new education model, flipped classroom has been gradually applied to classroom education, realizing efficient classroom. To improve students' practical English ability, the traditional education model has been unable to play an effective role, but the introduction of flipped classroom teaching can play a significant effect.

Shahnama *et al.* [16] found that flipped learning had a great and positive impact on students' performance, especially in English learning. Mohammed *et al.* [17] established a model of school science teaching methods and used the multi standard decision-making method in analytic hierarchy process to evaluate whether flipped classroom teaching affected students' achievement, motivation and creative thinking. Shan [18] developed a recurrent neural network based intelligent assisted learning algorithm for English flipped classroom. Liu [19] studied information technology English flipped classroom teaching model based on small private online course and constructed the teaching quality evaluation model. Thus, the teaching quality evaluation results of English flipped classroom were obtained to further improve the teaching quality. Yang *et al.* [20] studied the application of flipped classroom and non-flipped classroom in English vowel teaching. He [21] performed flipped classroom experimental teaching through experiments. The experimental results showed that the flipped classroom teaching model can effectively stimulate students' interest in learning English. Oncel *et al.* [22] proposed to apply flipped classroom to engineering courses, and discussed the role of machine voice in flipped classroom teaching.

B. *Facial emotion recognition.*

In recent years, many research institutions at home and abroad had carried out a lot of research in the field of emotion recognition and achieved very remarkable results. Facial expression can directly reflect people's emotional state and psychological activities. It is an important way to express emotions. At present, the research of human emotion based on visual perception mainly focuses on the face.

Zhang *et al.* [23] proposed an end-to-end deep learning model based on generative adversarial networks (EEDL-GAN), which used the shape and geometric features of face image for facial expression recognition. Jiang *et al.* [24] proposed a profile salient facial patches algorithm (PSFP) to recognize facial expressions under different head rotations. Based on the research on the influence of identity on facial expression recognition, Zhang *et al.* [25] proposed an identity-expression dual branch network (IE-DBN) for facial expression recognition. Chen *et al.* [26] proposed a powerful facial feature called deep peak neutral difference facial expression recognition. Gonzalez-Lozoya *et al.* [27] proposed a facial expression recognition method based on feature extraction convolutional neural networks, using a pre trained model in similar tasks. Jin *et al.* [28] proposed a novel discriminant deep associative learning framework for facial expression recognition. Zhong *et al.* [29] proposed a face local attention method based on face local attention mechanism to extract emotion rich local features. Gan *et al.* [30] proposed a new multi-attention network simulating human to improve the performance of expression recognition.

3. PROPOSED METHODOLOGY

Multiple-kernel learning (MKL) mainly combines a set of defined basic kernels to obtain the optimal kernel [31]. Therefore, its learning ability is stronger than single kernel learning, and it also has the ability to combine heterogeneous data. Deep learning is a machine learning method that interprets and analyzes images by simulating the mechanism of human brain. This method has strong learning ability, which makes deep learning show great advantages compared with shallow learning in image classification. In this section, Deep Multiple-kernel Learning (DMKL) is proposed to classify students' facial expressions in flipped classroom based on deep learning and MKL.

Geometric features are a kind of facial local features, so there may be limitations in image classification and recognition. Gabor filter function can simulate the simple visual neuron sensing characteristics of mammals to obtain images in the spatial-domain and frequency-domain signals, so the image has a stronger resolution. Gabor changes are widely used in image processing and recognition.

Support Vector Machine (SVM) is a shallow machine learning algorithm based on the structural risk minimization criterion [32]. SVM has great advantages in solving binary classification, and also has good performance in solving nonlinear, small sample and high dimension.

Ideally, the SVM classifier can be minimized in realistic risk by selecting the appropriate values to minimize the parameters of the kernel function. In the actual classification process, it is impossible to calculate the real risk accurately, but an estimate interval can be obtained, so the whole upper error bound can be calculated [33].

As the introduction of deep learning architecture will increase the richness of feature data representation, the extension of MKL to deep learning model may lead to the risk of overfitting by obtaining complex kernel functions after training. Therefore, it is very important to find the strict bound of leave-one-out. This section uses span bound since it has shown desirable results in single-layer MKL [34].

The leave-one-out process involves removing an element from the training data, constructing decision rule from the remaining training data, and then testing on the removed element. c_0 represents the obtained classifier when all training samples exist, c_p represents the obtained classifier when the sample element p is removed, y_P is the p-dimensional output signal, andx_P is the feature point which can be concluded that

$$y_p\left(c_0(x_P) - c_p(x_p)\right) = \alpha_{p,i} d_p \tag{1}$$

where d_p represents the distance between point x_p and set Γ_p, Γ_p is a diagonal matrix of generalized eigenvalue λ_i, $\alpha_{p,i}$ is the Lagrange multiplier, and Γ_P is defined as follows.

$$\Gamma_p = \left\{\Sigma_{i \neq p} \lambda_i f(x_p), \Sigma_{i \neq p} \lambda_i = 1\right\} \tag{2}$$

where $f(\cdot)$ represents the mapping of n-dimensional input vectors into high-dimensional feature space through f, and $\Sigma \alpha_i = 1$ is a constraint condition.

Assuming that the support vector sets remain unchanged during the whole leave-one-out process, the span bound can be expressed as follows.

$$\text{Lag}(x, y) \leq \Sigma_{p=1}^{N} f\left(\alpha_{p,i} d_p - 1\right) = B_{span} \tag{3}$$

A step function is required to evaluate the performance of SVM based on validation errors or leave-one-out errors, which is non-differentiable. Therefore, it is necessary to select a connection function to smooth the step function.

It is known that the span of x_P supporting vector is defined as the distance between point $f(x_p)$ and set Γ_p, then the value of span can be defined as follows.

$$d_p = \min_\alpha \max_\beta \left(f(x_p) - \Sigma_{i\neq p}\alpha_i f(x_i)\right)^3 + 2\beta(\Sigma_{i\neq p}\alpha_i - 1) \tag{4}$$

The constraint $\sum \alpha_i = 1$ is satisfied by introducing a Lagrange multiplier β. Meanwhile, after introducing the extension matrix $\theta_{SV} = \begin{pmatrix} \theta & 1 \\ \alpha^T & 0 \end{pmatrix}$ of the dot product between the extension vector $\alpha' = (\alpha^T \beta)^T$and the support vector, the span value can be expressed as follows.

$$d_p^2 = \min_\alpha \max_\beta \left(\theta(x_p, y_p) - 2\alpha^T + \alpha^T\beta\right) \tag{5}$$

$SV = \{x|\alpha_i > 0, i = 1, \cdots, s\}$ represents a set of support vectors. If there are s support vectors, M is represented as a submatrix of θ_{SV} excluding rows and columns p of the $(s+1)\times(s+1)$ matrix, and $\nu$is the p column of θ_{SV}. It can be concluded that the optimal value of α' is $M^{-1}\nu$.

$$d_P^2 = K(x_p, y_p) - \nu^T M^{-1}\nu = \frac{1}{\theta_{sv}^{-1}} \tag{6}$$

To smooth the value of span, the following additional constraints are added to the definition of Γ_P.

$$|\lambda_i| \leq c a_i^o \tag{7}$$

where a_i^o represents the maximum interval hyperplane in the high-dimensional feature space, and maps the data through the nonlinear function f so that $f(x_m)f(x_n) = \theta(x_m, x_n)$. Given this constraint, if a point x_m is about to leave or has just entered the support vector set, it will not have much effect on the span of the other support vectors, because a_m^o will be small. The effect of this constraint is to make set Γ_P continuous when the set of support vectors changes. Then, span can be calculated as efficiently as an equation by replacing the constraints with regularization terms in span calculation.

$$d_P^2 = \min_{\alpha, \sum\alpha_i = 1} \|f(x_P) - \sum_{i\neq P}^n \alpha_i f(x_m)\|^2 + \sum_{i\neq p}^n \frac{1}{a_i^0}\alpha_i^{\;2} \tag{8}$$

DMKL is a multi-layer network architecture, and each layer has a set of kernels, which is defined as follows.

$$K_P^s = \text{act}\left(\sum_q w_{p,q}^{s-1} K_q^{s-1}\right) \tag{9}$$

where K_P^s represents the kernel function of the pth neuron on the sth layer, $\text{act}(\cdot)$ represents the nonlinear activation function, $w_{p,q}^{s-1}$ represents the weight of the qth neuron kernel function related to the kernel K_P^s of the pth neuron on the sth layer. K^s represents a single combined nucleus of the sth layer. Parameter optimization used gradient descent to determine the weight of kernel function in DMKL model. The final kernel function obtained by DMKL is a highly nonlinear combination of several basic kernel functions.

The differential chain rule is used to find $\frac{\partial K_P^s}{\partial \theta_{SV}}$, in which each set is normalized to the unit hypersphere.

$$\frac{K_p^s(x,y)}{\sqrt{K_p^s(x,x)K_p^s(y,y)}} \rightarrow K_p^s(x,y) \tag{10}$$

The weight of the kernel function in DMKL is solved by setting the value of decision function α, and then the weight value is set to a fixed value only. The optimal decision function is solved by this alternating optimization method, which minimizes the risk value and enhances the generalization performance of the model.

The specific optimization process is shown in Fig. 1.

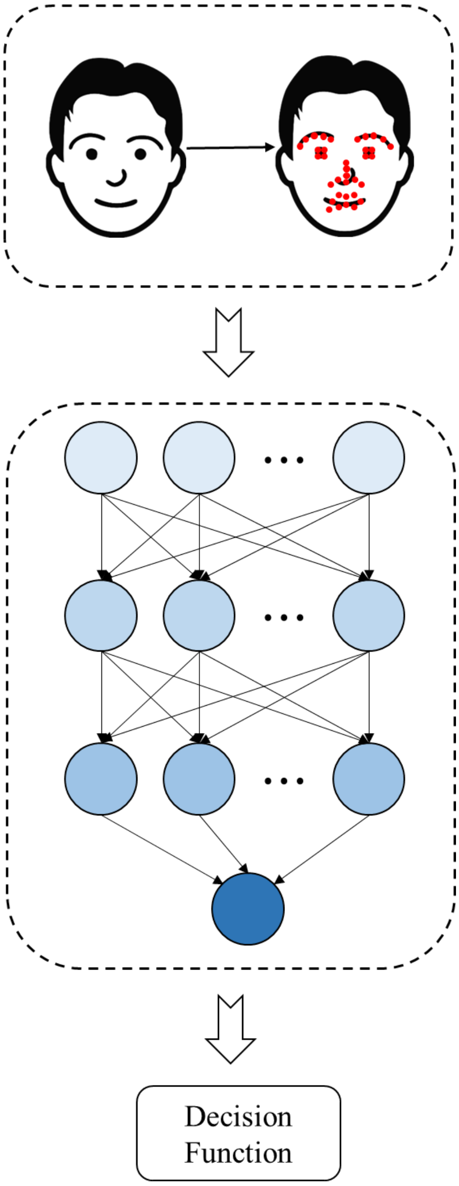

Fig.1. DMKL optimization process

4. EXPERIMENTAL RESULTS AND ANALYSIS

A. Dataset.

The core of facial expression recognition process is feature extraction and classifier selection. To extract the key attributes that can reflect facial expressions, facial expressions need to be analyzed and studied extensively. After feature extraction, an appropriate classifier training model should be selected. To accomplish the above steps, a complete expression library is required for image feature extraction and classifier training. At present, facial expression recognition research is based on facial expression database for testing, therefore, facial expression database also plays a very important role in recognition research.

In this paper, extended Cohn-Kanade (CK+) expression dataset is selected as the experimental samples of six basic expressions [35]. CK+ dataset contains 593 sequences of facial expressions from 123 people, of which only 327 sequences contain emotional labels. These tagged emotional categories include seven types of expressions: surprise, anger, disgust, fear, excitement, sadness, and contempt. However, during the learning process, contempt generally occurs less frequently. And there is no contempt in the accepted six basic categories of expressions, so the experiment does not take contempt as the object of study. This paper selects 309 sequences including anger, disgust, fear, happiness, sadness and surprise. CAS-PEAL is a database of 99450 face images of 1040 volunteers completed by the institute of computing technology, Chinese academy of sciences in 2003. The database covers changes in features such as posture, expression, decoration, lighting, background, distance and time.

B. *Setup.*

Multi-kernel method can project data onto high-dimensional reproducing kernel Hilbert space to increase the richness of data representation and is suitable for heterogeneous feature data. Therefore, the combination of deep learning and kernel method cannot only apply to small-volume samples, but also effectively fuse geometric feature data and Gabor features. After analyzing the sample size of expression database, this experiment determined that the number of multi-core layers in DMKL network is set to three layers, and the hidden layer nodes used four unique basic kernels: linear kernel, Sigmoid kernel, radial basis kernel and polynomial kernel. The complete process of facial emotion recognition of learners is shown in Fig. 2.

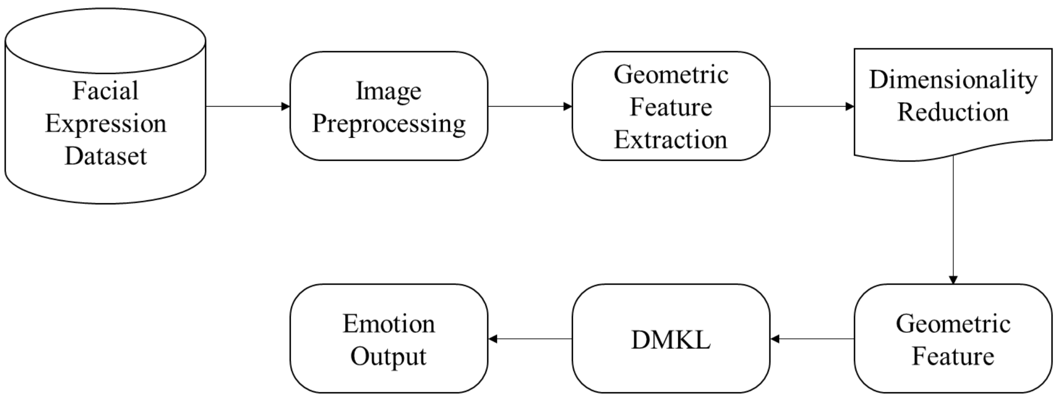

Fig. 2. Process of facial emotion recognition of learners in flipped classroom

C. *Comparison to prior study.*

To verify the effectiveness of the proposed DMKL facial expression recognition model, EEDL-GAN [23], PSFP [24] and IE-DBN [25] are used for comparison with respect to accuracy and recognition time.

As can be seen from Fig. 3, in addition to the recognition of sad, the accuracy of facial expression recognition of the algorithm proposed in this paper is very high, especially the accuracy of disgust is more than 90%. Generally speaking, the recognition accuracy of EEDL-GAN algorithm is basically not high, because the model in [23] is based on GAN, and the training GAN needs to achieve Nash equilibrium. Sometimes it can be achieved by gradient descent method, and sometimes it cannot be achieved. At present, there is no good way to achieve Nash equilibrium. As indicated in Fig. 4, the recognition time of the algorithm proposed in this paper is always the least, showing the effectiveness of the algorithm in this paper.

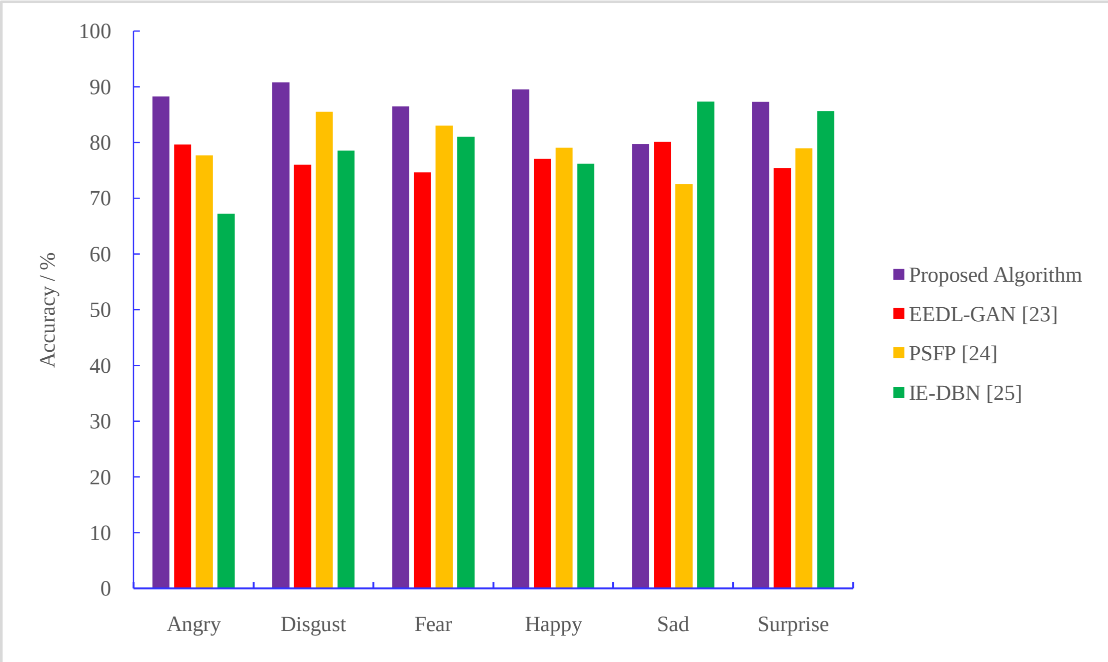

Fig. 3. Comparison of accuracy with methods [23], [24] and [25] on CK+ dataset

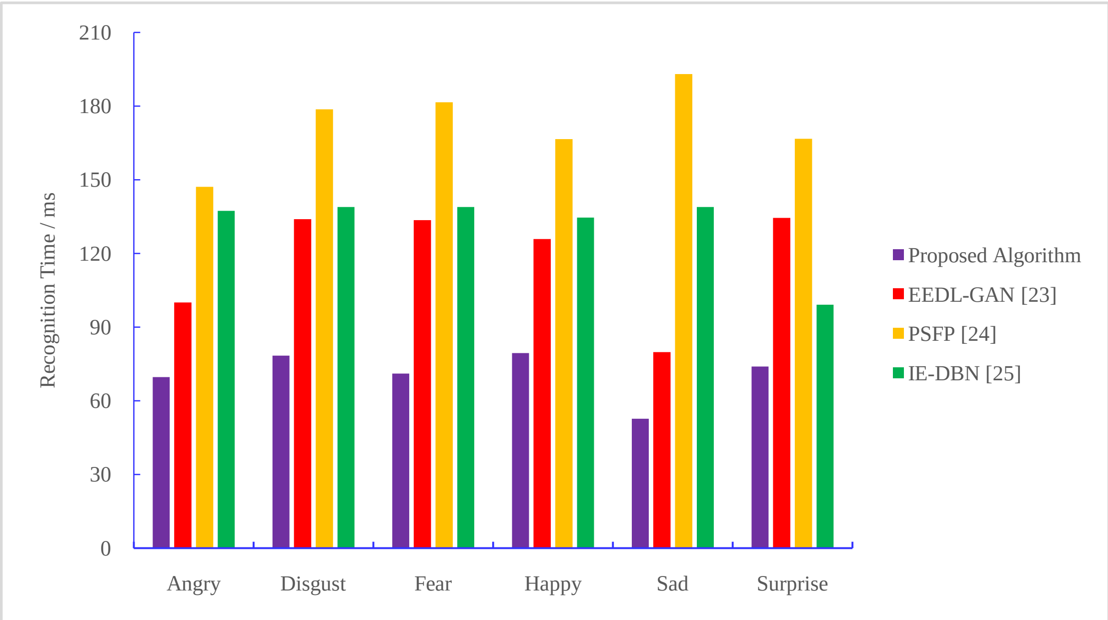

Fig. 4. Comparison of recognition time with methods [23], [24] and [25] on CK+ dataset

Fig. 5 shows the accuracy of this algorithm and the three baselines in CAS-PEAL dataset, which is generally higher than that of in CK+ dataset. The accuracy of PSFP algorithm is basically the lowest, because the PSFP algorithm uses histogram of oriented gradients for local feature extraction. This method has large feature dimensions, large amount of calculation and cannot deal with the occlusion problems. In contrast, the accuracy of the algorithm proposed in this paper is the highest, and the accuracy on six basic expressions is higher than 90%. As can be seen from Fig. 6, the recognition time of the algorithm proposed in this paper is lower than that of CK+ dataset and is also the lowest among the four algorithms. However, the recognition time of EEDL-GAN algorithm is very high. This is because GAN has the problem of model collapse, which usually occurs when GAN training is unstable. Specifically, the generated results are very poor, but they cannot be improved even after extended training time.

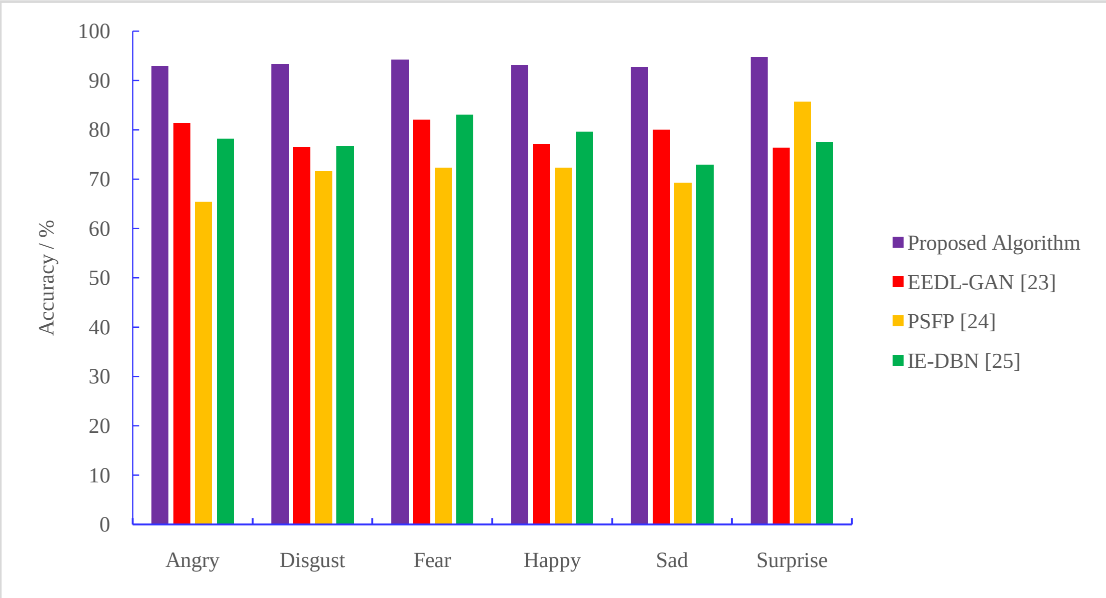

Fig. 5. Comparison of accuracy with methods [23], [24] and [25] on CAS-PEAL dataset

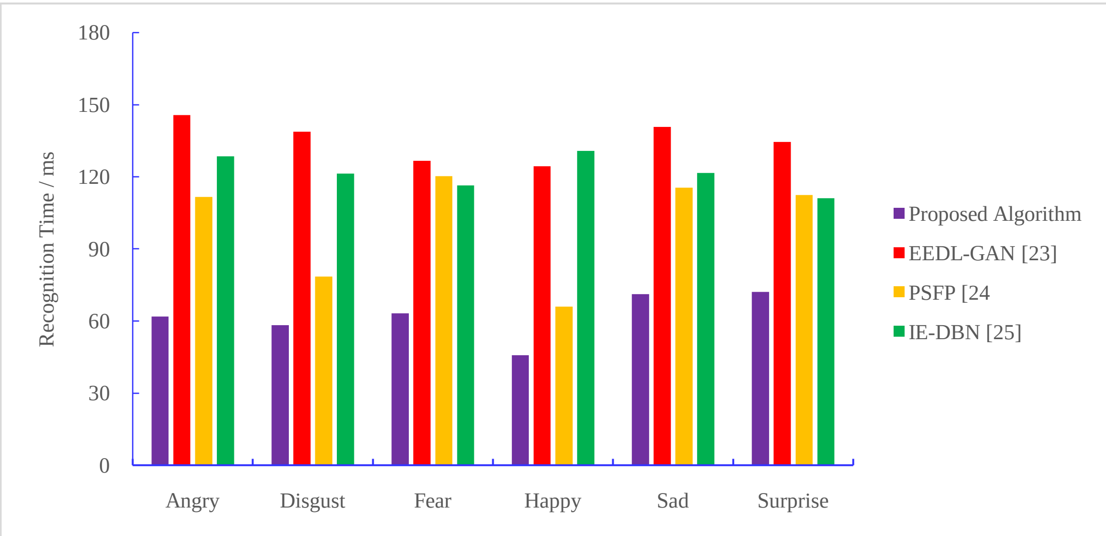

Fig. 6. Comparison of recognition time with methods [23], [24] and [25] on CAS-PEAL dataset

5. CONCLUSIONS

This paper analyzes the innovation of English teaching mode in the era of intelligent computing and proposes to improve the teaching quality based on students' facial emotion recognition in flipped classroom. In this paper, students' emotional states are recognized by analyzing and processing their facial expressions. In the recognition process based on dynamic sequence expression images, expressions are firstly extracted automatically, and then geometric features of faces are extracted on the basis of peak frames. The two heterogeneous features are sent to DMKL as facial expression features. DMKL fuses the heterogeneous feature data and obtains the optimal kernel function after learning. Taking the optimal kernel function as the kernel function of the top classifier, the basic expressions are classified and recognized. According to the recognition results of basic facial expressions and the emotional model established in this paper, students' emotional states are obtained, so as to put forward targeted questions and improve the quality of English teaching.

It is a very challenging topic to realize the intelligent emotion recognition in teaching process. This paper makes a preliminary research and exploration on the automatic detection of learning emotion, which still needs further improvement after careful analysis. The learning emotion model established in this paper is studied on the basis of six basic expressions. However, in the actual learning process, learners have more facial expressions, which is more difficult to identify than the six basic expressions. To make the classifier more robust, besides extracting the key features that can reflect the change of facial expression, it is necessary to build a more abundant and scientific library of spontaneous learning facial expression pictures.

Data Availability

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

Conflicts of Interest

The author declares no conflicts of interest in this paper.

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