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DESIGN AND IMPLEMENTATION OF INTELLIGENT EVALUATION SYSTEM BASED ON PATTERN RECOGNITION FOR MICROTEACHING SKILLS TRAINING

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Abstract. *Pedagogical competence of normal students and young teachers can be improved effectively by microteaching skills training. However, the training evaluation results mainly given by instructors and several trained partners are greatly affected by human factors for decades. With the rapid development of artificial intelligence technology, deep learning based on convolutional neural network algorithm has achieved amazing performance in image recognition, face recognition, speech recognition, limb movement recognition and so on. Intelligent judgement applied those artificial intelligence technologies to microteaching skills training can implement intelligent evaluation for trainees in the application of teaching skills, pronunciation accuracy, teaching fluency, teaching posture, teacher-student interaction, multi-media application and so on. The experimental results show that the intelligent evaluation system can effectively reduce human misjudgment and missed judgment, and man-machine collaborative guidance can guide the trainees more accurately.*

Keywords: Pattern recognition, Microteaching skills training, Voice recognition, Face recognition, Intelligent evaluation system

1. **Introduction.** Microteaching was proposed by professor Allen of Stanford University in the 1960s [1]. It is a professional training method for normal students and young teachers to improve their teaching skills in the microteaching environment. For decades, the evaluation of the training effect of microteaching teaching skills is mainly given by instructors playing back the videos one by one. In addition, the training team members also give their own opinions after training. Some teachers and team members cannot make a comprehensive, professional and accurate evaluation due to the limitations of knowledge, teaching and guidance experience and competence. In order to solve such problems, some technologies (e.g., artificial intelligence and big data) are used to improve teaching quality and prowess.

Since the 21st century, scholars have conducted in-depth research in speech recognition and image recognition, and have applied the research results to classroom teaching at home and abroad. The accuracy and robustness of recognition are improved by using Recurrent Neural Network (RNN) [2] and Convolutional Neural Network (CNN) [3] in

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acoustic modeling. 3D convolutional neural network was proposed by Chen et al. for human behavior recognition [4], which can learn time-domain features better, for time dimension is added to two-dimensional convolutional neural network. Dual stream CNN algorithm was proposed by Qin and Shi for human behavior recognition [5]. The algorithm trains two CNN classifiers. One CNN classifier mainly extracts optical flow features, and the other one extracts RGB information of the image. Finally, the features of the two classifiers are fused. RNN is replaced with transformer in RNN-T model by Zhang et al. [6]. Thus, not only is the calculation efficiency improved, but also the width of context time slice of attention module is controlled. Based on capturing long-distance interaction in the transformer model, the local feature extraction that CNN was good at was added by Peng et al. to obtain the Conformer model to achieve better accuracy with fewer parameters [7]. CNN deep learning model was applied to the detection and recognition of students' classroom behavior by Zuo et al. with good recognition effect, so as to complete the classification of whether students focus on classroom learning [8]. Computer vision technology developed by Zhao et al. automatically observes, measures and diagnoses students' attendance and behavior engagement in classroom learning, and teachers will know students' classroom learning investment better with the help of computer vision technology [9]. A student behavior recognition algorithm based on Res Net network was proposed by Qin [10]. In the algorithm, Res Net is trained on the Image Net data set firstly, and then is applied to recognizing student behavior of looking left and right, raising hands, standing and sleeping by using transfer learning. The recognition of students' behavior state in classroom is realized [11] by Zhu. At first the behaviors of students' heads down and heads up in class are identified through Fast R-CNN, then the behavior sequence of students is extracted by using YOLOV3 algorithm, and finally the students' behaviors are classified through Res Net network. The characteristics of students' head and shoulder position are fused through gradient histogram and equivalent local binary pattern histogram by Ding, and the classifier is trained by support vector machine to realize the target detection on the experimental data set; furthermore, the algorithm based on sparse matrix reconstruction was proposed to realize the detection of abnormal behavior in the examination room [12].

In terms of practical application, the Cold Fusion system proposed by Baidu in 2017 realizes speech recognition of English and Mandarin in different noise environments. Deep Full-Sequence Revolution Neural Networks (DFCNN) proposed by IFLYTEK in 2018 is directly used to model speech signals, and good recognition result was achieved. Low Frame Rate-Deep Feed Forward Sequential Memory Networks (LFR-DFSMN) proposed by Alibaba combines the low frame rate algorithm and DFSMN algorithm in the same year, with the error rate reduced by 20% while the decoding speed improved by nearly three times. Edu-Brain classroom teaching analysis system designed by Beijing QingFan Technology Co., Ltd. in 2018 uses face recognition and expression recognition to identify and analyze students' learning situation in class, so as to reflect the fit between students' emotion and classroom activity level.

For the fact that the evaluation of microteaching skills training is greatly affected by human factors, and there is no in-depth research report and mature application of intelligent evaluation system for microteaching and training, the intelligent evaluation system model of microteaching skills training by using the theory and technology of pattern recognition is designed in this paper. By evaluating the speech, semantics, face, expression and teaching posture of the trainee's, the accurate intelligent evaluation and guidance of the trainee in teaching skills training will be given. And the trainee's pedagogical competence will be improved with the evaluation and guidance.

2. **Microteaching Skills Training and Teaching Behaviors Analysis.**

(1) The training process of microteaching skills

The training tasks should be clarified before training. Students independently learn the relevant teaching resources online, design the instruction of each skill-item, and constantly improve the instructional design under the guidance after teachers carry out centralized case teaching one by one for teaching skills. The first stage of single teaching-skill training is composed of three segments: group-collaborative training, individual independent training and class-centralized training. During the training process, it will help the trainees find problems, retrain and improve continuously by watching the playback of training video, carrying out mutual evaluation within the group and combining with teachers' comments. The second stage is the comprehensive application training, including the design of teaching-skills comprehensive application, group-collaborative training, individual independent training, mutual evaluation and selecting excellent students from the group, recommending excellent students in each group to participate in the centralized display of the class, mutual evaluation of each group, and all trainees improve teaching design and training video. Finally, the trainees submit the instructional design and training video, and the teachers judge and give the final training results.

(2) Analysis of classroom teaching behaviors in the microteaching skills training

It is necessary for normal students lacking of teaching experience to comprehensively improve their teaching competence in microteaching skills training. It mainly includes basic teaching posture, language of instruction, teaching skills, instructional design, etc., and the instructional design module is usually set as a course for special learning.

i. Teaching posture. It mainly includes facial expression, body orientation, classroom teaching gestures and standing posture during teaching, positioning such as occlusion when presenting PPT, wall chart and playing video, posture when writing blackboard, presentation of body language during teacher-student interaction, walking track of tutoring students and guiding group activities, etc.
ii. Language of instruction. It mainly includes the accuracy of Mandarin pronunciation, the rationality of speech speed, the coherence of teaching statements, as well as the integrity of hierarchy and logical expression.
iii. Teaching skills. It is the core of microteaching skills training. It mainly applies the flexible application of teaching skills according to the teaching content, and organizes and carries out teaching correctly and efficiently.

(3) Common evaluation indexes of microteaching skills training

Microteaching skills training, which is based on modern educational theory, can systematically train normal students or young teachers' teaching skills in stages by using advanced media information technology according to the feedback principle and teaching evaluation theory. Microteaching skills training can comprehensively improve the pedagogical competence of the trainees. Generally, the training evaluation for the trainees was given by instructors and training group members. The evaluation contents mainly include instructional design, teaching skills (semantics), pronunciation (Mandarin), sentence logic (turning, hierarchy, etc.), speech speed, teaching posture, body language, teacher-student interaction, multi-media application, etc. The contents of man-machine evaluation in the evaluation are shown in Table 1.

(4) The path of pattern recognition in classroom teaching behaviors in microteaching skills training

The pattern recognition of classroom teaching behavior in microteaching skills training is mainly implemented in two ways (as shown in Figure 1): one is speech recognition, and

TABLE 1. List of man-machine evaluation contents of microteaching skills training

Evaluation content	Instructor & group member	Computer intelligent evaluation	Evaluation subject	Basis for setting evaluation subject
Instructional design (includes semantics)	√	√	Teachers' evaluation is the main part, supplemented by group and intelligent evaluation	(1) Human judgment depends on experience (2) Intelligent evaluation depends on learning library
Teaching skills	√	√	Teachers' evaluation is the main part, supplemented by group and intelligent evaluation	(1) Human judgment depends on experience (2) Intelligent evaluation depends on learning library
*** Pronunciation (Mandarin)**	√	√	Intelligent evaluation is the main part, supplemented by human judgment	(1) The rate of human misjudgment and missed judgment is high (2) The accuracy of intelligent evaluation is very high
Statement logic (includes semantics)	√	√	Intelligent evaluation is the main part, supplemented by human judgment	(1) The rate of human missed judgment is high (2) Intelligent evaluation depends on learning library (3) The accuracy of intelligent evaluation is very high
Speech speed	√	√	Intelligent evaluation is the main part, supplemented by human judgment	(1) Human judgment depends on sensation (2) Intelligent evaluation is 100% accurate
Teaching posture	√	√	Intelligent evaluation is the main part, supplemented by human judgment	(1) Human judgment depends on experience (2) Intelligent evaluation depends on learning library
Body language	√	√	Intelligent evaluation is the main part, supplemented by human judgment	(1) Human judgment depends on experience (2) Intelligent evaluation depends on learning library
Emotional expression	√	√	Teachers' evaluation is the main part, supplemented by group and intelligent evaluation	(1) Human judgment depends on experience (2) Intelligent evaluation depends on learning library
Teacher-student interaction	√	√	Intelligent evaluation is the main part, supplemented by human judgment	(1) Human judgment depends on experience (2) Statistics of intelligent evaluation and recognition (3) Judging effective interaction depends on learning library
Multi-media application	√	√	Intelligent evaluation is the main part, supplemented by human judgment	(1) Human judgment depends on experience (2) Automatic statistics of intelligent system
**** Emergency situation**	√	√	Intelligent evaluation is the main part, supplemented by group members' judgment	(1) The instructor was not present (2) The intelligent system will alarm immediately

*: Due to the large number of Chinese dialects, teaching will not be carried out normally without using the official language. Therefore, Mandarin standard is one of the basic conditions for qualified Chinese teachers.
**: Quasi-teacher's fainting and squatting in teaching emergencies do not belong to the evaluation content of microteaching skills training, but are only used to prompt the instructor to respond urgently.

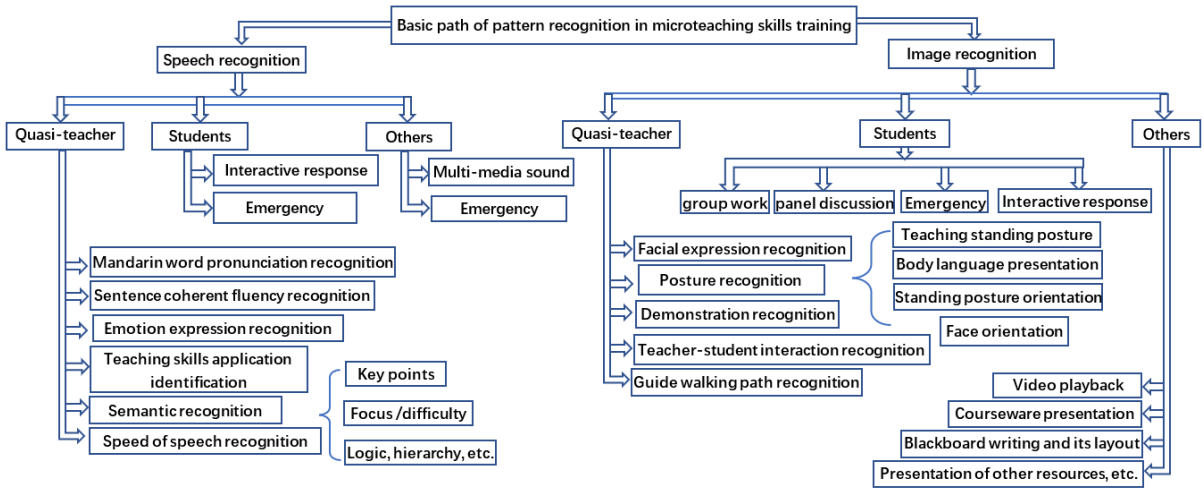

FIGURE 1. Basic path of pattern recognition in microteaching skills training

the other is image recognition. Considering the specificity of microteaching skills training function, the identification key points mainly are quasi-teachers and the training contents (teaching skills).

It is different from common classroom teaching that several trainees as quasi-teachers teach on stage one by one (for certain skill-item training) during group training and class centralized training in the microteaching skills training. It will lead character recognition to be more complex because a quasi-teacher teaches on stage for only 5 to 8 minutes during training, and then change the role to be a student. At this time, another student becomes a quasi-teacher and begins his own teaching skills training. Therefore, the identity of quasi-teacher should be determined with the help of image recognition and speech recognition before classroom teaching behavior recognition.

3. **Analysis of Identified Elements in Microteaching Skills Training.**

(1) The speech recognition in microteaching skills training

1) The basic tasks of the speech recognition in microteaching skills training

The basic tasks of the speech recognition mainly include the following nine points:

i. Distinguish the trainee's voiceprint and recognize the role of quasi-teacher;
ii. Recognize the accuracy of the quasi-teacher's pronunciation of words, and thus judge the pronunciation accuracy;
iii. Identify the speed of the quasi-teacher's speech, so as to judge the students' tolerance of receiving knowledge;
iv. Identify the quasi-teacher's fluency and coherence in teaching, and thus judge the quasi-teacher's familiarity of the teaching content;
v. Identify the structure of logic and hierarchy when the quasi-teacher teaches, so as to judge the correctness of logic and hierarchy in teaching;
vi. Identify the teaching skills applied by the quasi-teacher, and thus judge whether the quasi-teacher's teaching is carried out around the training content;
vii. Identify the communication between the trainee and quasi-students, so as to judge whether the teacher-student interaction is implemented while teaching;
viii. Perform speech recognition on videos and animations played by quasi-teacher, so as to determine whether multi-media teaching is carried out in teaching;
ix. Identify whether the trainee speeds up speech speed, louder voice or higher tone, so as to judge the trainee's passionate in teaching.

2) The basic principle of voiceprint recognition of quasi-teacher

Voiceprint recognition is used to identify the quasi-teacher from the group or class collective display in microteaching skills training, as shown in Figure 2. Five team members' (i.e., students A to E) voiceprint features will be extracted before training, and the features will be put into the model library after model training. During the training, the identity of quasi-teacher can be determined by picking up the voiceprint features of the speaker. The voiceprint features will be compared with the features in the model library, and the one the most matching which is also over the matching threshold will be selected. If two or more exceed the matching threshold, it will be determined by other auxiliary means (such as face recognition).

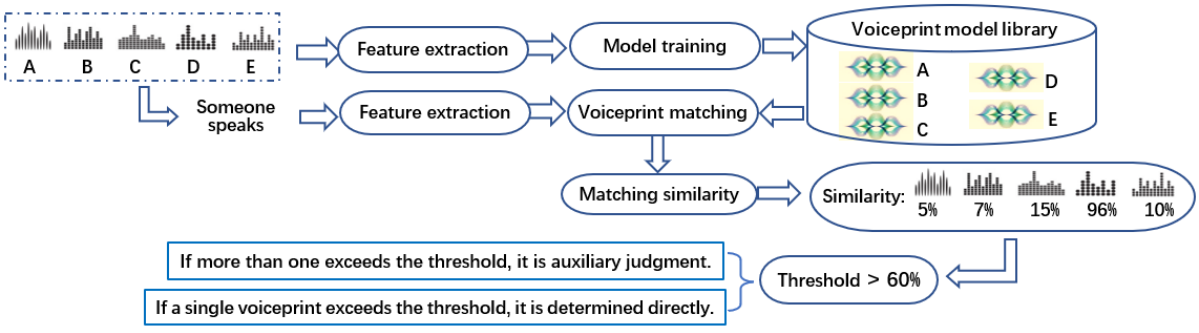

FIGURE 2. Schematic diagram of the basic principle of voiceprint recognition

After determining the identity of quasi-teacher, the corresponding name, class, number, training date and time will be given, and the header information of subsequent teaching skills training records is automatically generated.

3) The diagnosis of quasi-teacher's pronunciation, speech speed, semantic and interpretation fluency

The speech recognition of quasi-teacher's continuous speech mainly includes the accuracy of word pronunciation, the speed of speech, the fluency of speech, the rationality of logical phrase application and hierarchical expression in lectures, the application of teaching skills, etc.

Taking advantages of speech recognition based on Deep Full-Sequence Convolution Neural Network (DFCNN), a sentence of speech can be used as an input, and the whole sentence speech signal can be modeled directly by using a large number of convolution layers. By adding pooling layers after multiple convolutional layers, not only can the expression ability of convolution neural network be greatly enhanced, but also the long-term correlation of speech can be better reflected, and the output unit directly corresponds to the syllable or Chinese character of the final recognition result.

The training rate can be doubled by using Batch Normalization algorithm (BN algorithm [13]), but the number of iterations required to achieve the same accuracy is only 1/14 of the original, and the training time is greatly shortened. BN algorithm proposed by Google in 2015 is a deep neural network training algorithm. It can not only accelerate the convergence speed of the model, but also alleviate "gradient dispersion (scattered characteristic distribution)" in the deep network in certain extent, therefore BN algorithm makes it easier and more stable to train the deep network model, and it has become the standard algorithm of almost all convolutional neural networks at present. The algorithm is as follows:

Input: Values of x over a min-batch: $\mathfrak{B} = \{x_{1,\ldots,m}\}$; Parameters to be learned: γ, β

Output: $\{y_i = BN_{\gamma,\beta}(x_i)\}$

$$\mu_{\mathfrak{B}} \leftarrow \frac{1}{m}\sum_{i=1}^{m} x_i \quad \text{//min-batch mean} \qquad \sigma_{\mathfrak{B}}^2 \leftarrow \frac{1}{m}\sum_{i=1}^{m}(x_i - \mu_{\mathfrak{B}})^2 \quad \text{//min-batch variance}$$

$$\hat{x_i} \leftarrow \frac{x_i - \mu_{\mathfrak{B}}}{\sqrt{\sigma_{\mathfrak{B}}^2 + \epsilon}} \quad \text{//normalize} \qquad y_i \leftarrow \gamma\hat{x_i} + \beta \equiv BN_{\gamma,\beta}(x_i) \quad \text{//scale and shift}$$

where $x_1, \ldots, x_m$ are input data, γ and β for training parameters, m is the training sample size, $\mu_{\mathfrak{B}}$ is the average output of the upper layer, $\sigma_{\mathfrak{B}}$ is the standard deviation of upper output data, ϵ is a small value close to 0 added to avoid denominator being 0, y is output data: the new value obtained by linear transformation of γ and β.

(2) The image recognition in microteaching skills training

1) The basic tasks of image recognition in microteaching skills training

The basic tasks of image recognition mainly include the following seven aspects:

i. Identify quasi-teacher. Through feature extraction and matching identification, the corresponding identity of quasi-teacher who teaches on stage is determined to ensure that the evaluation result corresponds to the trainee;
ii. Identify the teaching posture of quasi-teacher, and judge the rationality of quasi-teachers' expression, standing posture and body language;
iii. Identify the interaction and path of quasi-teacher when guiding students in order to judge the rationality of the guiding process;
iv. Identify the blackboard writing, and evaluate the aesthetics of the design and writing of blackboard writing;
v. Recognize the multimedia means used by the quasi-teachers, and evaluate their application of multimedia teaching;
vi. Recognize quasi-teacher's demonstration and explanation with teaching aids, so as to identify the demonstration teaching process;

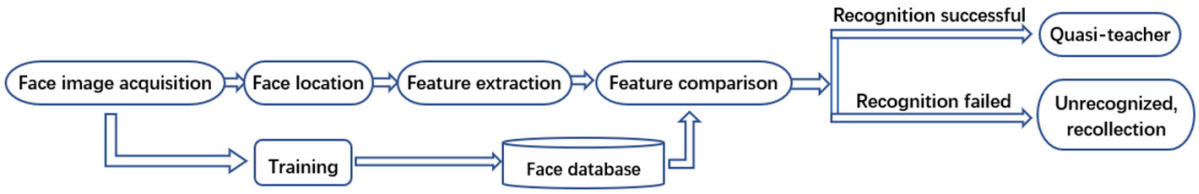

FIGURE 3. Flow chart of face recognition

vii. Identify the abnormal teaching posture, such as suddenly squatting, and falling. Identify the teaching out of control, for example, and most students do not look up or move around.

2) The image recognition principle of quasi-teacher

It is very important to confirm the identity of quasi-teacher in microteaching skills training. Therefore, the dual recognition of speech recognition and face recognition is used to confirm the identity of quasi-teacher in the system in order to ensure that the result of intelligent evaluation belongs to the judged person. The basic process of face recognition is shown in Figure 3.

3) Identification of teaching posture, teacher-student interaction and emergencies of quasi-teacher

Quasi-teacher as the main role of classroom teaching behavior in microteaching skills training, his teaching posture, facial expression, body language and teacher-student interaction are the key contents to be judged in the training. The main elements judged include:

Face orientation recognition: analyze and evaluate face orientation time proportion;

Teaching posture recognition: analyze and evaluate standing posture, gesture amplitude and movement speed;

Recognition of body covered up: if quasi-teacher is blocked by the podium for a long time, or the hands are blocked in the pockets, etc.;

Recognition of teacher-student interaction: if quasi-teacher interacts with students, or walks off the podium to students, etc.;

Emergency identification: quasi-teacher squats down or faints suddenly, or loses control of teaching.

4. **System Design and Function Realization.** The software and hardware modules such as speech recognition module, face recognition module and human posture recognition module based on convolutional neural network algorithm are integrated, and designed to form an intelligent evaluation system for microteaching skills training (as shown in Figure 4) to practice the intelligent evaluation in microteaching skills training. After testing, the results of each module are shown in Table 2 and Table 3. In the speech recognition module, the emotional expression recognition will not be enabled temporarily for the recognition accuracy does not meet the expected value 85%. Meanwhile, the art design effect of blackboard writing was tried to evaluate in the image recognition module, and it is regrettable that it has not been put into the evaluation system for the recognition rate does not meet the requirements. Except the two indexes, the others' results all meet the expected requirements. Furthermore, because the recognition response speed is paid special attention in the recognition algorithm design, the system can generate the trainee's teaching skills training effect analysis report immediately after the training is completed.

It can be seen from Table 2 and Table 3 that the intelligent system can give very accurate judgment on speech speed, Mandarin pronunciation, teaching posture which were judged

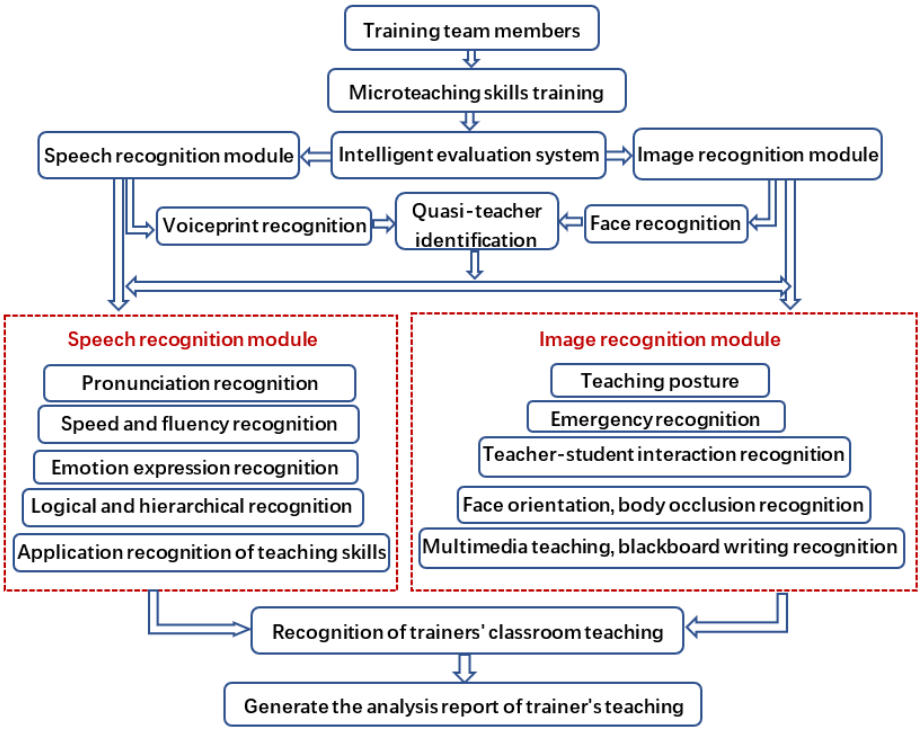

FIGURE 4. Framework of intelligent evaluation system for microteaching skills training

TABLE 2. Case table for speech recognition test results

Name	Test conditions	Expected objectives	Test result	Conclusion
voiceprint recognition	sample space: group or class members	accuracy $> 98\%$	100%	usage
word recognition	Mandarin	accuracy $> 95\%$	$> 96\%$	usage
speech speed evaluation	normal speed: $180 \sim 220$ words/min	slow/normal/fast	100%	usage
semantic analysis	around teaching skills	accuracy $> 95\%$	$> 95\%$	usage
emotion	application	85%	67.8%	suspend application

TABLE 3. Case table for image recognition test results

Identify objects	Test conditions	Expected objectives	Test result	Conclusion
teaching posture	standing time, hand swing amplitude	accuracy $> 95\%$	$> 95\%$	usage
face orientation	proportion of time not facing students	accuracy $> 95\%$	$> 96\%$	usage
teacher-student interaction	man-machine identification comparison	accuracy $> 95\%$	$> 98\%$	usage
blackboard writing/ multi-media	using blackboard writing/multi-media	accuracy $> 95\%$	$> 95\%$	usage
emergency	teachers and students in abnormal state	accuracy $> 85\%$	$> 92\%$	usage

by the instructor's experience in the past. Through in-depth learning, the intelligent system can also continuously improve the recognition accuracy on the efficiency of teacher-student interaction, the correct rate of the semantic and logical in lectures, deciding the face orientation (time) of quasi-teacher, judging the use of multi-media in teaching, etc.,

and the recognition accuracy is higher than expected at present. Due to the complexity and comprehensiveness, more instructional design cases need to be provided to machine learning in terms of rationality and presentation effect of instructional design. There is no high recognition precision in emotion expression recognition at present; therefore, the evaluation of instructional design and emotional expression still depends on human. To sum up, human-computer collaborative evaluation in microteaching skills training can help the trainees improve their teaching level better.

5. **Conclusions.** The intelligent evaluation system of microteaching skills training based on pattern recognition basically achieves the designed goal. The real-time evaluation of the problems existing in training will be better completed by the help of speech recognition, face recognition, human posture recognition, and other technologies. The intelligent evaluation system can not only help teachers guide the training of normal students, but also facilitate the independent training of individual and group students. It is especially in line with the education concept of student-centered. The further improvements of the system mainly include the following: (1) The recognition accuracy about students needs to be further improved, that is, what books they are reading and whether they play cell phones in class; (2) The recognition method and accuracy need to be further improved in the expression and embodiment of quasi-teacher's emotion in training.

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