Research on Students' Listening Level and Teaching Quality Based on Big Data Face Detection

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Abstract: With the increase of the number of college enrollment and the development of education reform, the quality of higher education has become a hot spot of concern to the public. In China, colleges and universities still take classroom teaching as the main form, whose quality has a direct and significant impact on the quality of talent training. This paper explores the application of face recognition technology in the classroom quality assessment of college teaching. Based on real-time monitoring of the class situation by the camera, we give feedback on the level of students' listening in the class through the capture processing and analysis and evaluation of face information. And with the help of the database, we can statistically measure the phenomenon of students in different classrooms. After the analysis of a large amount of data, we'll get the level of attention and the level of concentration which finally lead to the level of students' listening and the quality of the class. The results can provide theoretical support for teaching management and classroom optimization.

1. Introduction

The exploration and research on classroom quality monitoring is an important part of the teaching research in colleges and universities. A traditional classroom monitoring is mostly controlled by an instructor, who still pays attention to the discipline and the students' attention. This disperses the energy of the lecturers and affects the quality of the lectures. Some schools have faculty members to check and record the classroom situation, but it often takes efforts and they may not get a real full picture, which generally is of little effect. With the help of OpenCV, MATLAB, Visual Studio and other tool, this paper combine's face recognition with the needs of the teaching monitoring system to achieve real-time monitoring of the classroom, record the student's classroom seating distribution, lecture status and other information, and listen to the students captured by the machine. The behavioral information is analyzed and evaluated to obtain the level of the students' listening, and also reflects the level of classroom teaching quality.

2. Research status at home and abroad

Han Wei et al. focus on the full range of face monitoring, using the API of OpenCV which has its own strong algorithm level, the operation speed is very fast; After obtaining the student's face image, the image information is stored by the storage device and sent to the server to facilitate the comparison of image information and reduce the workload of the face recognition system [1].

Peiyun Hu explored three aspects of the problem in the context of finding small faces: the role of scale invariance, image resolution, and contextual reasoning. In particular, when compared to prior art on WIDER FACE, their results reduce error by a factor of 2 [2].

Aiming at the defect that fixed cameras cannot automatically track and shoot moving targets, Qingdeng Zheng et al. designed a moving camera system based on steering gear to realize the location and tracking of moving faces. The test results show that the recognition accuracy can reach 100% in bright environment and 95% in dim environment, and partial occlusion of the face as well as upper, lower, left and right faces can be detected [3].

Zuying Luo and Danhui Zhang put forward the automatic evaluation theory of classroom teaching, which helps to use video capture, video analysis, and data analysis, pattern recognition and so on to automatically analyze and evaluate class teaching, students' attention and expression [4].

Ligang Hou proposed the use of face recognition system to measure the student's head-up rate in the classroom, and to evaluate the student's listening status with the head-up rate. They initially optimized the algorithm and obtained an average classroom head-up rate of 23% for a class based on statistical analysis of the data [5].

3. Students' attention in class

3.1 Overview of students' attention in class

Students' attention in class refers to the external manifestation of students' concentrated attention in class. Here we combine the two indicators of student head-up behaviour and student seating distribution to reflect students' attention.

3.2 Calculation of the level of attention

The calculation formula of Level of Attention *(LOA)* is:

$$LOA = w_1 \times F + w_2 \times P \tag{1}$$

Where, the calculation formulas of *F* and *P* are as follows:

$$F = \sum_{i=1}^{N} face\_per / N \tag{2}$$

$$face\_per = num\_face / face\_total \tag{3}$$

$$P = V_1 \times \frac{fronts}{all\_sitting} + V_2 \times \frac{middles}{all\_sitting} + V_3 \times \frac{backs}{all\_sitting} \tag{4}$$

$$all\_sitting = fronts + middles + backs \tag{5}$$

Where, *F* represents the level of students' heading rate in this class; *N* represents the total number of photos collected for the class; *face_per* represents the average number of students that head up to the lecture detected per image; *num_face* represents the number of people in a picture who have their heads raised; *face_total* represents the actual number of students in the picture (approximately the number of students attending the class); w_1, w_2 are the weights of the head-up level and the students seating distribution level in *LOA*. The weight assignment is based on the influence aspect and degree of the factors. And the weight of w_1 should be greater than the weight of w_2 (can be set to $w_1 = 0.7$, $w_2 = 0.3$).

As to the seating distribution of students, from the first row of the classroom to the last row, the seats occupied by students are the listening area. And this area is divided into three sub-areas: front, middle and back. *P* represents the seat distribution level of students; *fronts* indicates the number of students in the front row; *middles* indicates the number of students in the middle row; *backs* indicates the number of students in the back row; *all sitting* stands for the total number of students in the classroom. The V_1, V_2 and V_3 appearing in the formula for calculating *P* are the weights of the ratio of the number of people in the front, middle, and back rows, respectively. Among them, the closer the

seat is to the platform, the greater the contribution to students' attention will be. Therefore, the weight of the divided area is set as 6:3:1.

4. Students' concentration in class

4.1 Overview of students' concentration in class

Different from the research of attention, as to students' concentration in class level, some qualitative factors should be take into consideration, such as expressions and postures (collectively called attitudes) during lectures. In order to facilitate image information capture, we first study the students in front rows. In our study, Level of Concentration (*LOC*) refers to the level of class attention based on the level of interest in the class, and the *LOC* of the front rows can be expressed by *LOCF*, which mainly consists of three indicators: the front-row heading rate, the front-seat occupancy rate and the front-row listening attitude. And the first two parts of *LOC* can be directly counted and the front-row listening attitude is a qualitative indicator.

4.2 Calculation of the level of concentration

The level of student concentration in class - the front-row level is calculated as:

$$LOCF = w_1 \times FF + w_2 \times FR \tag{6}$$

Where *FF* and *FR* are calculated as follows:

$$FF = \sum_{i=1}^{N} front\_face\_per / N \tag{7}$$

$$front\_face\_per = num\_front\_face / front\_face\_total \tag{8}$$

$$FR = fronts / front\_seats \tag{9}$$

Where *FF* represents the front-row heading rate; *N* represents the total number of photos collected for the class; *front_face_per* indicates the front-row heading rate detected for each picture; *num_front_face* indicates the number of students in front rows that head up to the lecture in a picture; *front_face_total* indicates the number of students sitting in front rows in the picture; *FR* indicates the front-seat occupancy rate; *fronts* indicates the front row number; *front_seats* indicates the number of front seats; w_1 and w_2 are the weights of the front row head level and the front row occupancy rate in the front row concentration level, respectively, and these weights are the same as the weights in the previous *LOA* formula.

The front-row listening attitude is an optimization study based on the occupancy rate of front-row seats, which makes up for the deficiency in the seats occupancy and its distribution in a classroom (not considering the orientation or the reason for the students sitting in front rows, but directly classifying these students as those who is motivated to learn). In the actual classroom, we believe that the behaviour of students sitting in the front row has two characteristics: one is to have interest in listening to the class and take the initiative to sit in front rows; the other is to have no interest and be forced to sit in front rows (generally because the quality of the lecture is poor and most of the students are not interested in it, and the rear positions are occupied, which leads to the student's passive selection of the front seats).

The attitude has two state values, so there are two formulas:

$$g(LOCF \mid attitude = 1) = B + \sqrt{A_1 \times LOCF \times LOA} \tag{10}$$

$$g(LOCF \mid attitude = 0) = B - \sqrt{A_2 \times LOCF \times LOA} \qquad (11)$$

Wherein, A and B are parameters. B represents the basic score to ensure that the last calculated LOC is positive; A is a conversion coefficient, which represents the value that $LOCF$ reflects to the overall level, A_1 and A_2 correspond to the conversion coefficients in the positive and negative states, respectively; *attitude* corresponds to the front-row listening attitude, which can be judged by the expression of the students in front rows (positive (marked as 1) or negative (marked as 0)). And we use different formulas to calculate under different attitude markers.

5. Assessment of the level of students' listening and the quality of the classroom

5.1 Level of students' listening

By combining the evaluation levels of these two factors, the final class's overall student's listening level can be obtained. The formula for calculating the level of students' listening is as follows:

$$W_{(j)}(LOA, LOC) = Q \cdot X^T \qquad (12)$$

$$Q = [LOA, LOC] \qquad (13)$$

$$X^T = [x_1, x_2]^T \qquad (14)$$

Among them, $W_{(j)}$ is the value of the students' listening level in the jth class of a course, Q is the matrix of attention and concentration, and X^T is the transposed matrix of the weights reflected by the LOA and LOC at the listening level.

5.2 Quality of the class

According to videos of all courses of a certain college collected before, they are divided into key courses, sub-key courses and general courses according to previous courses evaluation from students and the school's emphasis on this course in advance.

We adopted stratified sampling statistical method, randomly selected 30 courses from different categories of courses, and analyzed the attention and concentration of students from different courses.

The final scores of the teachers are partially demonstrated in Table 1.

Table 1. Comprehensive Scores

Class_no	F	P	LOA	FF	FR	LOCF	LOC	W
1	0.198502	0.31236	0.232659	0.460317	0.538462	0.483761	0.806496	0.519577
2	0.224719	0.317978	0.252697	0.375	0.615385	0.447115	0.821154	0.536925
3	0.127341	0.289888	0.176105	0.422222	0.384615	0.41094	1.246564	0.711334
...	...	...	...	...	...	...	...	...

And the measurement criteria (range) of attention and concentration of high quality class, medium quality class and low quality class are divided as follows:

Table 2. Measurement Criteria

Quality of class	LOA	LOC
High	>0.6	>1.3
Middle	[0.4,0.6]	[0.8,1.3]
Low	<0.4	<0.8

6. Conclusion

This paper makes use of face detection technology to analyze the class seating distribution and students' head-up rate indicators, also overcomes some limitations, and provides students' assessment level based on students' attention and concentration in classrooms, which makes teaching management decisions more rational, accurate and pertinent. Through the calculation results of the level of students' listening, the class quality of the course can be scored in the semester, which can be used for comparative ranking between courses. It would facilitate the management improvement of courses of different quality levels.

Acknowledgments

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