

Prediction of Students' Psychological States Based on Facial Expression Recognition Under the Influence of COVID-19

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Abstract: Affected by COVID-19, people have to face long-term and wide-ranging social group isolation. College students, as one of the important groups in society, have converted to online learning systems, which may lead to various psychological and emotional problems. Their mental health problems should be paid special attention to. In this article, we utilize facial expression recognition technology to predict students' psychological problems during online learning, with the international Self-Rating Anxiety Scale (SAS) as an auxiliary prediction tool. Experimental results show that it is feasible to use facial expression recognition technology to predict students' psychological problems. In the end, we gave intervention measures to students with different anxiety levels under the influence of the epidemic from a scientific perspective to help students adjust their mentality in time and return to normal study and life.


1 INTRODUCTION

At the beginning of 2020, coronavirus pandemic struck world. The World Health Organization announced that the COVID-19 disease caused by SARS-cov-2 coronavirus is a mass disease, which poses a broad public health threat all over the world (Panskyi et al., 2021). In January 2020, the Chinese government entered a state of emergency: areas with high risk of the epidemic implemented a "blockade" and areas with low and medium risk of the epidemic, restrictions on social and economic life were imposed, including prohibition of leaving the place of residence, isolation at home, restrictions on engaging in economic or professional activities. Of course, this also meant the closure of schools and other educational institutions. In order to ensure the health and safety of teaching and students, all kinds of schools at all levels, especially higher education schools, made use of the advantages provided by information technology to carry out distance education, which made students' learning mode change to online learning (Alzahrani et al., 2021).

A few months later, the epidemic situation has been significantly controlled, but people still have to face prolonged isolation. Students, as one of the

important groups in society, because of the unsealing of the school, are facing emergency remote learning (ERL) (Tulaskar et al., 2021) and waiting for school start. Due to the hasty transition to distance learning, students lack experience and are not familiar with new online resources, which may lead to various physical, psychological and emotional problems. Their mental health problems should be paid special attention to (Fu et al., 2021). In this paper, our work is to accurately identify the mental health problems of students, timely help students adjust their mentality and restore their normal study and life state during the epidemic period.

Mood and facial muscle fluctuations are called facial expressions. It provides us with clues about a person's state and enables us to talk to each other according to their emotions (Luqin et al., 2019). Facial expression is a spontaneous psychological state, without conscious efforts to make physiological changes in facial muscles. Facial expression is a very important means of nonverbal communication, which can express people's inner emotions and emotions (Calbi et al., 2021). For students, they may frown and close their lips when they feel uncomfortable. Timely identification of students' facial expression is helpful to understand students' psychological state in time.

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Emotions are divided into seven categories: happiness, anger, fear, sadness, disgust, surprise and nature (see Figure 1) (Kumar et al., 2017). The main purpose of this paper is to use a facial expression recognition technology based on convolutional neural network to predict students' psychological problems by recognizing students' facial expressions. In the experiment, we recruited 100 college student volunteers to collect facial expressions through the network teaching platform, and input the collected pictures into the pre training model for facial expression recognition. After the experiment, the international Self-Rating Anxiety Scale (SAS) was used to test the psychology of volunteers. At the same time, volunteers were asked to report whether they were distracted and whether their emotions fluctuated, which was taken as the goal of the prediction model. Through comprehensive analysis, 53% of the volunteers had different degrees of anxiety. It was learned from the interview that this was directly related to the isolation of home and school caused by the epidemic. Finally, we give corresponding suggestions for students' psychological problems.



Figure 1. (1) is Angry face, (2) is disgusted face, (3) is fearful face, (4) is happy face, (5) is sad face, (6) is surprised face, (7) is natural face

The rest of this paper is structured as follows. The application scenarios and the latest development of facial expression recognition technology are discussed in Sect. 2. In Sect. 3, the facial expression recognition experiment and model algorithm based on convolutional neural network are described. In Sect. 4, the experimental analysis and SAS are discussed to prove the efficiency of students' psychological problems prediction based on facial expression recognition technology. The causes and corresponding suggestions of students' psychological problems brought by COVID-19 are discussed in Sect. 5. Finally, the conclusion of the paper is presented in Sect. 6.

2 RELATED WORK

Charles Darwin was one of the first scientists to realize that facial expression is one of the most powerful and direct ways for human beings to exchange emotions, intentions and opinions (Bartlett et al., 2003). Facial expressions not only provide

emotional state information, but also show cognitive state information such as interest, boredom, confusion and stress. John Gottman, an American psychologist, believes that from the perspective of individual psychology, human facial expressions are uncontrollable and subconscious behavior. For example, when you see terrible things, you will feel afraid; when you see delicious food, you will drool subconsciously.

Nowadays, facial expression recognition technology has been applied to different fields, including human-computer interaction, security, robot manufacturing, medical treatment, games and automobile manufacturing (Căleanu et al., 2013).

In terms of security, such as the lie detection work of criminals, some criminals are good at camouflage when they are interrogated. But some criminal psychologists believe that after repeating the same problems, criminals will become tired and reveal their flaws. Misjudgment may be caused by different evaluation criteria and expression omission if police only rely on human observation. So it is necessary to use a computer with expression recognition ability to assist in judgment (Li et al., 2021). In the field of automobile, facial expression recognition mainly carries out for drivers to judge whether they are tired or not. The drivers' state behind the expression is analyzed by using the camera to capture the driver's facial expression features in real time (Chanchal et al., 2016). Once it is found that the drivers may be tired driving (eye closure timeout, drooping eyebrows, passive eye opening, etc.), the driving system will start a series of intervention means (Jabon et al., 2010), such as voice broadcast prompt, playing loud music to refresh the driver, etc. Zhao et al. proved the accuracy of driver fatigue prediction by using face recognition technology (Zhao et al., 2018). In robot manufacturing and medical treatment, such as in clinical treatment and service industry, the combination of facial expression recognition can make the robot better understand people's psychological activities, so as to provide people with more accurate and thoughtful services (Ilyas et al., 2021). In terms of games, In the field of education, face recognition technology is widely used at present. For example, face recognition technology can be used to confirm the identity of candidates in various major examinations in universities to prevent substitute exams. However, the research on students' facial expression of teachers' teaching and students' learning is relatively few. Emotion has a positive effect on motivation. Students' classroom emotion is closely related to learning motivation and is one of the important factors affecting learning effect.

Students' facial expression is the most effective way to express emotion. Facial expression is the main source of information second only to speech when determining a person's inner feelings. Teachers can interpret students' emotions by paying attention to the changes of students' facial expressions to adjust their emotional state in time. But affected by the number of classes, teachers' ability and experience, the effect is poor (Mohiadeen et al., 2021). With the wide application of intelligent technology in education, schools have built smart classrooms, which can capture facial features in real time to recognize their facial expressions, so as to analyze the learning state of students.

Under the influence of COVID-19, depression, panic and anxiety have been a serious problem for people due to lack of knowledge. Especially for college students, online studying has great impact on their learning habits. Many students even have some psychological pressure, anxiety and irritability due to academic pressure and employment pressure. With the global epidemic continuing, it is very important to pay attention to the mental health education of college students during the epidemic.

3 METHODOLOGY

We use algorithm model provided by GitHub user ID "WuJie1010". This algorithm uses convolutional neural network to integrate facial expression feature extraction and expression classification into an end-to-end network. VGG19 consists of 16 convolution layers and the last 3 full connection layers. The algorithm removes multiple full connection layers in the traditional VGG19 and directly divides it into seven categories after a full connection layer. The specific code can be found in GitHub <https://github.com/WuJie1010/Facial-Expression-Recognition.Pytorch>.

3.1 Dataset

We continued to use the CK+ dataset. CK+ dataset is an extension of CK dataset and a standard database in facial expression recognition. Many studies will use

this data for testing. It contains 327 tagged facial videos. We extracted fragments from the CK + dataset, which contains a total of 981 facial expressions. In addition, we also performed data enhancement operations. On the CK+ dataset, we artificially do some image transformations such as flipping and rotation, as shown in Figure 2, so as to prevent data over fitting, expand the amount of data in the database and make the trained network more robust.

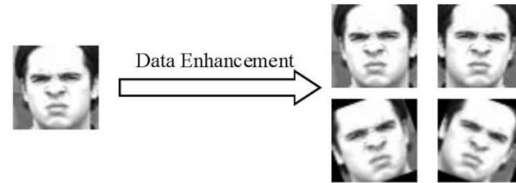


Figure 2. Data enhancement operation

3.2 Model Training

In this process, we divide the image data set into training set and test set. The eigenvalues are calculated in the training set, and the features are divided into 7 categories. The pre-training model is generated through 300 rounds of learning and training, and verified by the test set. Through the experimental evaluation, good results are obtained, and the accuracy has a certain reference value for the future research of computer-based emotion recognition system model. The accuracy of facial expression recognition of this model is as high as 93.57%. As shown in Table 1.

Table 1. Model accuracy

Model	Accuracy	
	Training	Testing
VGG	98.7%	93.57%

Then, we input the test pictures into the best model trained under CK + data set, get the probabilities of different expressions, and then visualize the probabilities of pictures in different classifications and the results predicted by the model. As shown in Figure 3.

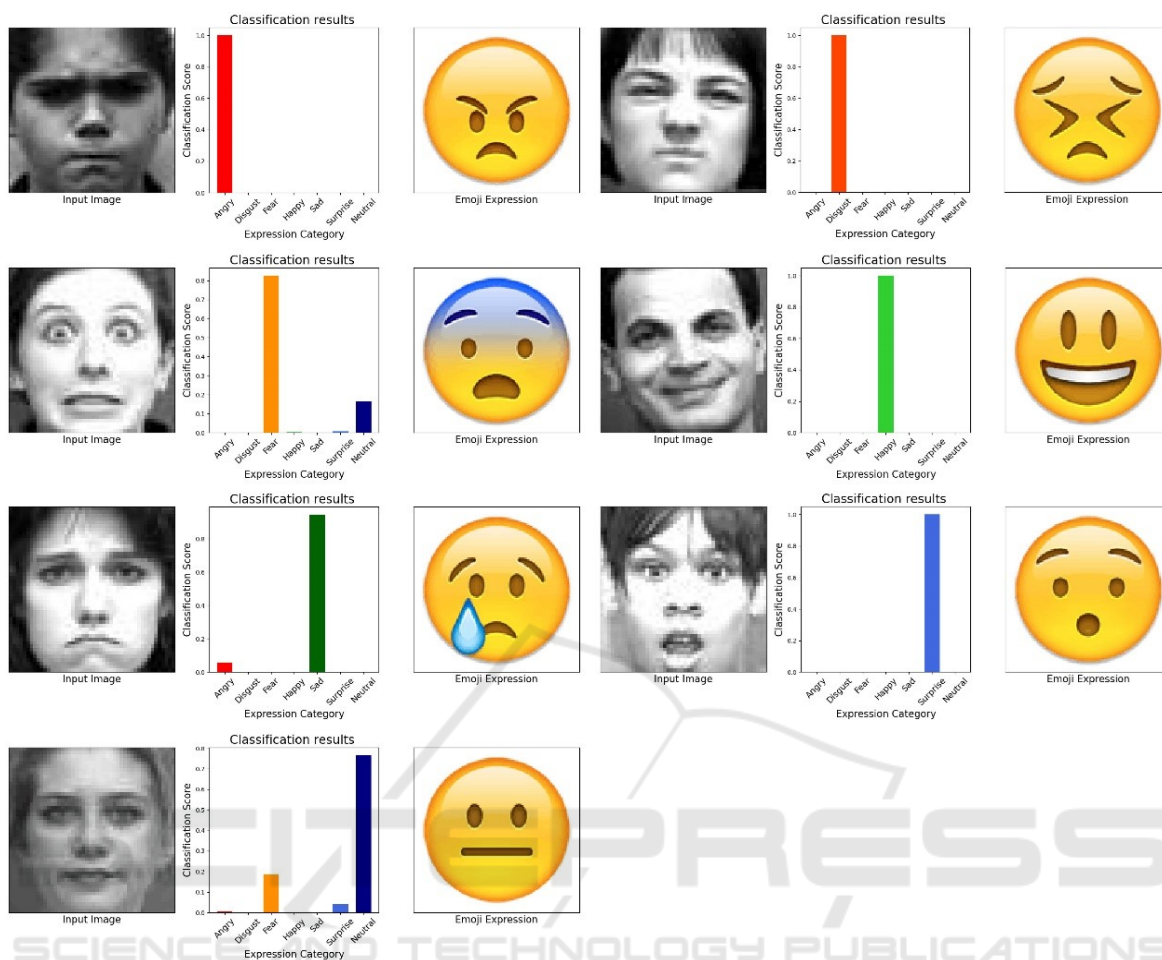


Figure 3. Visualization results of facial expression recognition

4 EXPERIMENT

We recruited 100 college student volunteers (20 < age < 25) to collect their facial expressions through the network teaching platform and input the collected pictures into the pre-training model for facial expression recognition. Volunteers were asked to report whether they were distracted and whether their emotions fluctuated, which was the goal of the prediction model. In order to better evaluate the psychological state of volunteers, the international Self-rating Anxiety Scale was used to test the

psychological anxiety of volunteers after the experiment.

4.1 Acquisition of Facial Expressions

We invited teachers' volunteers and students' volunteers to use the online learning platform for online teaching and studying. During the teaching process, we continuously intercepted the learning status of students at a certain interval. Some of them are shown in Figure 4. We cut and flip the obtained student pictures, and finally obtained 100 student facial expression pictures.



Figure 4. Acquisition of students' facial expressions in the process of online learning

4.2 Facial Expression Recognition and Analysis

1000 pictures of students' facial expressions were input into our trained model for facial expression recognition. The results are shown in Figure 5.

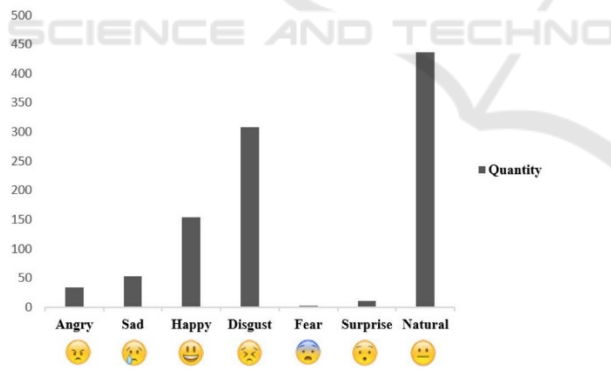


Figure 5. Analysis of facial expression recognition of 100 student volunteers

According to statistics, during online class, students with a neutral expression ranked first. But it is worth noting that among the seven expressions, disgust emotion ranks second, and most of the expressions appear in the middle and late stage of the online studying. We speculate that this situation may be related to the aversion of students due to the long teaching time. In addition, anger, sadness, fear and

surprise account for a relatively small proportion, indicating that students do not have large emotional fluctuations during online classes.

After the class, we interviewed some volunteers. In the interview, we learned that majority of students have difficulty concentrating during distance teaching, which will affect what they learn. In addition, most students believe that virtual courses usually take more time. When asked about the course assignments completed this year compared with those before COVID-19, nearly half said they spent more time on these assignments.

4.3 SAS Prediction

We use facial expression recognition technology to identify whether there are abnormalities in the psychological state of volunteers. In order to verify the accuracy of our experiment, we used the Self-rating Anxiety Scale. SAS was compiled by William W.K. Zung. The scale has become one of the most commonly used psychological measurement tools for psychologists.

The scale contains 20 subjective feeling items of reaction anxiety. Each item is divided into four grades according to the frequency of symptoms, from no or little time to most or all of the time. Among them, 15 were positive scores and 5 were negative scores. As shown in Table 2.

Table 2. Model accuracy

SN	PROJECT	No or little time	A small part of the time	Quite a lot of time	Most or all of the time
1	I feel more nervous and anxious than usual	1	2	3	4
2	I was scared for no reason	1	2	3	4
3	I tend to feel upset or frightened	1	2	3	4
4	I think I might be going crazy	1	2	3	4
5	Everything is fine and nothing bad will happen	4	3	2	1
6	My hands and feet trembled	1	2	3	4
7	I suffer from headache, neck pain and back pain	1	2	3	4
8	I feel weak and tired easily	1	2	3	4
9	I feel calm and easy to sit quietly	4	3	2	1
10	I feel my heart beating fast	1	2	3	4
11	I was distressed by bouts of dizziness	1	2	3	4
12	I've had fainting attacks or feel like I'll faint	1	2	3	4
13	It's easy for me to breathe	4	3	2	1
14	My hands and feet are numb and tingling	1	2	3	4
15	I was afflicted with stomachache and indigestion	1	2	3	4
16	I often have to pee	1	2	3	4
17	My hands are often dry and warm	4	3	2	1
18	My face is red and hot	1	2	3	4
19	I sleep easily and sleep well all night	4	3	2	1
20	I often have nightmares	1	2	3	4

Multiplying the total score by 1.23 to take an integer is the standard score. The standard score divides the severity of anxiety symptoms into none (<50), mild (50-60), moderate (61-70) and severe (> 70).

According to the above standards, we made statistics on the questionnaire test results of 100 volunteers, and the results are shown in the Figure 6. According to statistics, 47% of the students have a healthy mental state with no anxiety; 53% of the students had different degrees of anxiety. Among them, 38% of the students have mild anxiety, and the standard indicators of some students are around the critical line, which requires a long time of psychological counseling and pressure release; 13% of the students had moderate anxiety; 2% of the students had severe anxiety.

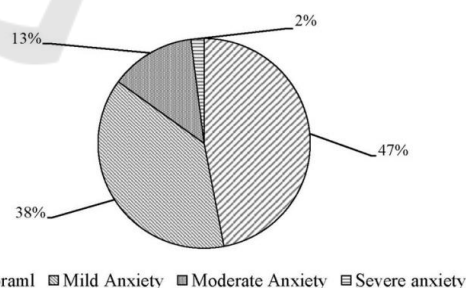


Figure 6. Statistical chart of SAS scale test results

The psychological anxiety tendency of students measured by SAS is about the same as that obtained by facial expression recognition technology, which shows that it is effective to use facial expression recognition technology to predict students' psychological problems.

4.4 Experiment Analysis

Anxiety is an autonomous response composed of vague and uneasy feelings, which leads individuals to experience or expect threatening or dangerous events (Aloufi et al., 2021, Sun et al., 2016). Research shows that appropriate anxiety can promote students' learning. As shown in Figure 7. There is an inverted U-shaped relationship between anxiety and students' academic performance. Certain anxiety can make students perform better, but once beyond a certain stage, excessive anxiety will make students collapse completely.

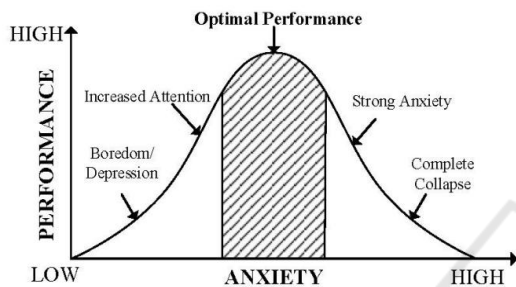


Figure 7. Anxiety-performance curve

For students, psychological symptoms of anxiety include feeling nervous before class, panic, blank brain during examination, feeling helpless when doing homework, or showing interest in subjects considered difficult, while physiological symptoms include sweaty palms, accelerated heartbeat, or dizziness and chest tightness (Ruffin et al., 2007). Those with a high degree of anxiety will show excessive tension and worry in terms of emotion, including worries about the future. Through the interview, we learned that students with severe anxiety will worry about major accidents or bad things in the future. Sometimes they will cry suddenly at night and be extremely frightened. There will also be physical manifestations, such as shortness of breath, panic and other physical symptoms, accompanied by serious sleep disorders, and the possibility of suicide in serious cases. There are many suicide cases of patients with severe anxiety disorder in China every year.

Anxiety is one of the emotional behaviors that affect students' daily life, such as learning, daily activities and social networking. In the classroom environment, anxiety disorder may be manifested in students' behavior, like being easily irritable and unable to focus on what teachers say. Deeper anxiety is related to students' life and health. In addition, high anxiety is also closely related to the poor performance

of low ability students (Whitaker Sena et al., 2007), which will reduce memory and affect attention.

5 THE CAUSES OF STUDENTS' LEARNING ANXIETY

Learning anxiety is a real phenomenon, so it is very important to understand learning anxiety, especially to be able to identify its source and deal with it. Family status, living environment, learning environment and psychological quality of college students during the outbreak of COVID-19 affected the mental health of college students by interviewing the volunteers with different degrees of anxiety. Through interviews, the reasons are as follows:

5.1 It is Difficult to Adapt to Abnormal Learning State

In the most serious period of the epidemic, schools were closed and students studied at home. Without a collective learning atmosphere, students have difficulty concentrating. Teachers use a large number of assignments to urge students to learn during online studying. Some students need to spend twice as much time completing their homework as most students in school, which makes students feel bored (Zhu et al., 2020). The efficiency of students studying at home is far less than that in school. Most students are annoyed by wasting time. Such prolonged repetitive cycle for a long time has led to anxiety or depression (Cao et al., 2020).

5.2 Poor Environmental Adaptability

With the resumption of college and students returning to school, universities implement semi closed management to reduce students' unnecessary going out. Students need to report in advance before entering or leaving the school and measure temperature at the gate of the campus. Under this circumstance, students' daily shopping, traveling, social practice and other social activities have decreased sharply, making students feel strange, repressive and monitored (Kılınçel et al., 2021). These conditions lead to the decline of students' psychological adaptability and the disorder of psychological adjustment ability, which affect their normal study and life in school (Zawadka et al., 2021).

5.3 Family Factors

In the early stage of the epidemic, due to the need for epidemic prevention and isolation, teachers and students taught and studied at home through online classes. Students study and live at home with their families for a long time. They are prone to quarrels and contradictions due to family chores, tense parent-child relations and disharmonious family relations, which can lead to certain harm and impact on students' mental health (Li et al., 2021). At the same time, due to the local epidemic situation, some students' families are isolated, which makes their parents cannot go out to work, and their family economic income decreases sharply. The burden of family life has brought invisible psychological pressure and psychological anxiety to the students themselves.

According to the research of this paper, students need some intervention to reduce anxiety and help improve academic performance (Chen G et al., 2020). Learning anxiety intervention aims to help students deal with anxiety problems in the process of learning (Deng et al., 2021).

6 CONCLUSION

This study used facial expression recognition technology to predict students' psychological problems. The latest information provided of this research results offers a necessary basis for the research and intervention of College Students' psychological problems during COVID-19. It is worth noting that COVID-19 has indeed brought different psychological effects to students. This paper emphasizes that the relationship between the impact of the epidemic and different degrees of anxiety should be analyzed longitudinally, and intervention measures should be taken from a scientific perspective to eliminate the fear of students in educational activities.

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