Application and Algorithm Analysis of Micro-Expression Recognition

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Abstract—Micro-expressions (MEs) are the expressions of real emotion in people's heart. It usually happens when people want to hide their true emotions. Through the study of MEs, we can correctly speculate on the inner activities of the expressors, which has important application value in the fields of criminal investigation, arrest, psychotherapy, education and teaching. At present, more and more people are paying attention to the research of ME recognition. People try to detect MEs by faster algorithms, but the recognition process is affected by many factors, so it is necessary to optimize related technologies as soon as possible to achieve higher accuracy. Therefore, this paper analyzes the application of ME recognition and related algorithms, and puts forward the development prospects.

1. INTRODUCTION

Micro-expressions (MEs) refer to the expressions made by persons in a very short period of time because they cannot control their true emotions. This very short period of time is usually 0.04s to 0.2s [1]. Through a series of experimental studies, psychologists have found that even if people deliberately hide their true emotions, they can still observe short and slight changes in facial expressions, which are difficult to be successfully masked. This research discovery has opened people's research on ME recognition. People have applied this achievement to various industries and obtained certain application value.

At present, the research on ME recognition has attracted the attention of many people, especially in deep learning. The earliest practice is to apply traditional recognition algorithm to ME recognition. The main feature extraction methods include Local Binary Patterns (LBP) [2], Local Binary Patterns from Three Orthogonal Planes (LBP-TOP) [3], Histogram of Oriented Gradient (HOG) [4], etc. However, the extraction effect is too simple, and it does not have a good effect for some occlusion expressions or more flexible recognition at the corners of the mouth. Subsequently, in the field of ME recognition, algorithms based on convolutional neural networks have developed rapidly. The convolutional neural networks that can only process two-dimensional spatial information, have been expanded to 3D Convolutional Neural Networks (3D-CNN), which can process multi-dimensional spatial information [5]. In addition, ME database has been established for researchers to study, and more commonly used include SMIC, CASME and CASME II. The short change time of ME and the lack of spontaneous database are both important challenges for ME recognition. Therefore, we need to concentrate on solving these problems in the future research work.
2. RESEARCH ON APPLICATION OF MICRO-EXPRESSION RECOGNITION

People have organized a lot of common MEs, and conducted in-depth research on ME recognition technology. At present, the existing technology can effectively recognize MEs with high accuracy. People can analyze human psychological activities based on the recognized MEs to achieve a variety of recognition purposes. The popularization of this technology is conducive to the development of various industries and brings higher enterprise benefits. At present, ME recognition has played a huge application value in the fields of anti-terrorism, torture, education and medical treatment. The main process is to use advanced recognition algorithms to recognize human facial MEs and comparison through computer processing technology.

2.1 Polygraph detection

At present, the application of ME recognition in the detection of polygraphs has received extensive attention. The occurrence of MEs is spontaneous and difficult to control. According to this feature, it can be effectively analyzed whether the speaker violates the heart, and then it can be judged whether the detected person lies [6]. The application of ME recognition in the field of polygraph detection is mainly manifested in the interrogation process of criminal suspects. By identifying the facial expression of the suspect, it can effectively determine whether the suspect lied, which can help the criminal investigation police to discover the truth and is conducive to the smooth development of the case. At present, relevant polygraphs have been successfully developed on the market to facilitate the police officers to carry, and they can handle cases anytime and anywhere, which improves the efficiency of police work. At the same time, when conducting some more dangerous border activities, facial recognition can effectively judge abnormal behavior and troubleshoot dangerous people.

2.2 Medical treatment

ME recognition can also be used in the field of medical treatment. By identifying the ME of the patient, the doctor can effectively judge the psychological state of patient, which can help the doctor to analyze the patient's physical pain and help the doctor implement effective treatment for the patient. Through clinical research, Russell team found that the METT procedure has a very obvious therapeutic effect on schizophrenic patients [7]. This method can effectively assist mental patients to recognize other people's emotions and MEs. After long-term training, it can further improve the ability of patients to distinguish expressions and emotions, and avoid social conflicts caused by patients' judgment errors.

However, the application of ME recognition still has many problems in the specific implementation process. The recognition effect of many studies in trained people is significantly better than that in untrained people. Such a training process is too complicated, which has hindered the ME recognition on the road of further popularization. Therefore, the algorithm needs to be further optimized to improve the effect of ME recognition.

3. COMPARISON OF MICRO-EXPRESSION RECOGNITION ALGORITHMS

3.1 Micro-expression recognition algorithm based on Radon

The action time of MEs is very short and the degree of change is weak. The ME recognition algorithm based on Radon transform first performs dimensionality reduction preprocessing on the video sequence in the database and extracts the motion features of the images to obtain the optical flow images [8]. The method used in the process is mainly the optical flow method. And then, based on the Radon transform algorithm, the input optical flow images are processed to a certain extent to obtain feature values and feature images. Finally, the feature images of MEs are input into the SVM model to realize classification recognition. The recognition accuracy rate on CASME II database is 82.17%. The overall effect of ME recognition based on Radon is relatively high, but there are still shortcomings. This method does not achieve a high recognition accuracy for happiness expressions.
3.2 Micro-expression recognition algorithm based on 3D-CNN
At present, ME recognition algorithm based on 3D Convolutional Neural Network (3D-CNN) has been widely used [9]. This algorithm fuses two-dimensional spatial features and one-dimensional temporal features, and selects keras as the network framework, which provides a classification basis for the recognition of MEs. In order to prevent over-fitting, the 3D Visual Geometry Group Block (3D-VGG-Block) network structure incorporates the BN and discard method, which further improves the accuracy of ME recognition, and also achieves high-speed training. ME recognition algorithm based on 3D-CNN can effectively deal with the difficulty of data shortage. The starting frame position is set to a randomly selectable mode, and the database is circularly traversed to achieve data augmentation. Finally, the recognition accuracy on CASME II database is 68.85%.

3.3 Micro-expression recognition algorithm based on AC-CNN
The ME recognition algorithm based on AC-CNN is implemented based on MTCNN and VGG16 network, which can accurately obtain the facial MEs and effectively recognize them [10]. The feature of this algorithm is the introduction of atrous convolution kernel. The two tasks of face detection and MEs feature extraction are mainly achieved by atrous convolutions. This method can effectively extract the details of MEs. The convolution kernel has a wider field of perception, and the distinguishing features of the multi-layer network are fully utilized, which makes the recognition of MEs more robust. Aiming at the advantage of automatic ME recognition, the function of automatic ME detection and recognition can be achieved through the construction of the system. The application of network with similar structure can effectively reduce the pressure of manual screening at a certain level.

3.4 Micro-expression recognition algorithm based on DTSCNN
The ME recognition algorithm based on DTSCNN is mainly an algorithm developed for spontaneous MEs [11]. In Fig. 1, we can see the DTSCNN dual-stream network structure. DTSCNN is an end-to-end trainable dual-stream network composed of DTSCNN64 and DTSCNN128. It uses 3D convolution and pooling units to effectively process ME sequences through a slow fusion model. In the process of pre-processing the MEs, the method is simple. Firstly, the segment is aligned with the first frame. Secondly, the optical flow estimate is calculated from the aligned and normalized samples. DTSCNN can automatically learn features from simple pre-processing samples and complete classification recognition.

CASME II is a ME database developed by the Fu Xiaolan team in China. CASME II include about 3000 facial MEs with sufficient ambient light collection. The entire database includes 7 kinds of MEs, which is relatively comprehensive [12]. Therefore, this paper summarizes the accuracy of CASME II database recognition by the above several algorithms, as shown in Table I.

| TABLE I. ACCURACY COMPARISON OF DIFFERENT ME RECOGNITION ALGORITHMS |
|----------------------|------------------|
| Algorithms      | Accuracy       |
| Radon           | 82.17%         |
| 3D-CNN          | 68.85%         |
| AC-CNN          | 72.26%         |
| DTSCNN          | 66.67%         |
By comparing these several algorithms, we found that Radon-based ME recognition algorithm has a higher accuracy rate on the CASME II, which has broader development value. At present, many studies have achieved more accurate ME recognition by fusing multiple algorithms.

4. PROSPECTS FOR THE DEVELOPMENT OF MICRO-EXPRESSION RECOGNITION

The application of ME recognition is very popular recently, and it will be faster in the future development [13]. However, there are still some problems that need to be solved in the recognition process of MEs, such as pre-processing of the original captured images, optimization of the algorithms for extracting MEs from the images, and inadequate ME database [14]. Especially in some applications, MEs extraction and recognition are required for longer videos, and the current recognition methods cannot yet perfectly solve such cases. Therefore, the technology of ME recognition needs to focus on the following perspectives in the future to achieve more in-depth research:

4.1 Pre-processing of acquired images

Before inputting the original images into the recognition system, some optimization processing is needed, and further improvement of the pre-processing steps is needed [15]. The main purpose is to increase the coherence of the images in the video stream and achieve continuous feature values. In the pre-processing stage, the MEs can be enlarged and enhanced. The ROI pooling can be divided according to the standardized rules and aligned processing operations can be added.

4.2 Optimize the algorithm of micro-expression feature extraction

Image feature extraction is a particularly important link in the process of ME recognition [16]. Judging from the recognition effect, the current LBP, HOG and other features cannot fully describe the original image features. Therefore, the algorithm used by the MEs in feature extraction should be further optimized. Optimized ME feature extraction algorithm plays a very important role in the further development of ME recognition.

4.3 Improve the micro-expression database

The technology of ME recognition started late in China. At present, the domestic ME database is not comprehensive [17][18]. Especially for the field of ME recognition in the video stream mentioned above, the current database cannot meet the relevant training requirements. In addition, the collection environment of the existing database lacks interference factors. But in the actual ME recognition, there are a series of external interference factors, which will lead to poor recognition of the well-tested algorithm in the actual situation. Therefore, in order to achieve a better ME recognition system, the ME database should be improved first.

5. CONCLUSION

This paper introduces the popular application directions of ME recognition, briefly introduces the more commonly used algorithms and compares the recognition accuracy rate. In addition, corresponding solutions are proposed for the development challenges faced by ME recognition. To overcome the difficulties encountered in the recognition process in a targeted manner can effectively help ME recognition to be successfully applied in real life, which is helpful for ME recognition to contribute huge practical value to society.

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