Review of Face Recognition and Anti-mask Interference Technology

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Abstract. Face recognition is one of the hottest research directions in artificial intelligence. Its development is relatively mature, so it is widely used in various fields. However, since the outbreak of novel coronavirus pneumonia in 2019, most of them recommend or require people to wear masks to prevent infection, this has caused a lot of trouble to some existing face recognition systems. Some systems have not been optimized for large-scale occlusion on the face, these interferences will sharply reduce the recognition accuracy of the system. Wearing masks is an issue that cannot be completely avoided in the current era. This paper investigates some existing face recognition algorithms and models, and finds that a considerable number of face recognition technologies are faced with an important problem: they did not consider the situation of large-scale users wearing masks at the beginning of their design. On this basis, this paper summarizes the research status and application of face recognition technology, and analyzes the problems and development trend of face recognition technology under the current epidemic prevention background.

Keywords: Face Recognition · Interference · Accuracy

1 Introduction

1.1 Background

Since the COVID-19 has broken out, and governments around the world have formulated corresponding preventive measures against the epidemic. As of this year, although many drugs and vaccines targeting COVID-19 have been developed around the world, wearing masks is still one of the most mainstream epidemic prevention measures, and there is a high risk of infection when taking off the mask during identification and. A survey from Kassem University shows that the number of research work on face mask detection from multiple research institutions has increased several times since 2019 [1]. The specific data is shown in Fig. 1. So that the recognition of people wearing masks has become an emerging problem in the field of face recognition.

The National Institute of Standards and Technology of the United States also analyzed the recognition rate of the face recognition algorithm for the people wearing masks before and after the outbreak of COVID-19. It believed that the face covered by the mask

J. Yen et al. (Eds.): ICBIS 2023, AHCS 14, pp. 1329–1335, 2023.
https://doi.org/10.2991/978-94-6463-198-2_138

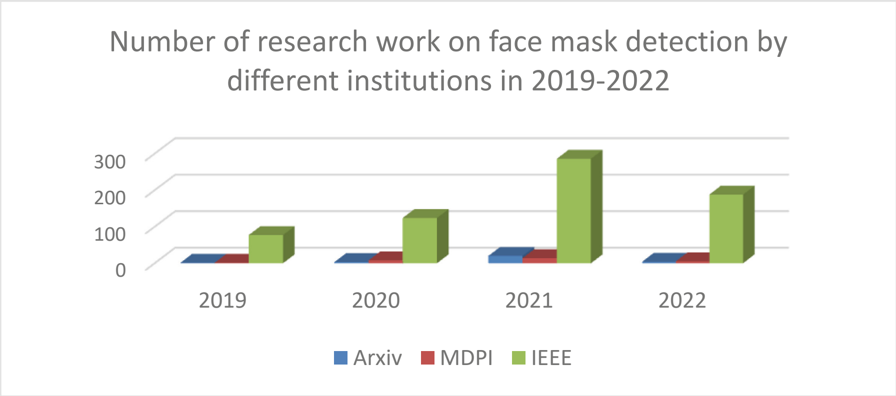

Fig. 1. Number of research work on face mask detection

would have a very negative impact on the face recognition system. In addition, some research institutions also evaluated the ability of different systems to cope with mask interference [2]. Taking the National Security Administration of the United States as an example, it found that the recognition rate of some academic face recognition systems significantly decreased in the face of mask interference.

1.2 Development of Face Recognition

As one of the main research directions in artificial intelligence, computer vision has been widely used, especially in the field of face recognition. Now there are many mature algorithms. Early face recognition algorithms include algorithms based on geometric features and algorithms based on template matching, but these algorithms rely heavily on training sets and test sets of scenes, and are very sensitive to image background, facial expression and other factors, and have low practical value. After that, some scholars tried to use the idea of artificial features plus classifiers for face recognition, extract features and use support vector machines for training, thus creating the YOLO-Mask algorithm [3]. Some researchers tried to optimize on the existing YOLO-V4 network, improved the accuracy of face recognition, and was able to solve the problem of mask face recognition to a certain extent [4]. However, the use of artificial features for recognition has certain limitations. Some other researchers have found that there is a positive correlation between high-dimensional features and verification performance [5, 6]. This means that the higher the face dimension, the higher the accuracy of verification. Sometimes, in order to ensure accuracy, it will lead to poor performance of network training speed.

At present, a mainstream direction of human face recognition is to use the deep learning method for face recognition. Convolution neural network (CNN) has excellent performance in image classification, and does not need to design features manually. CNN can learn useful feature vectors of different faces in massive face images by itself. Among the above recognition methods, CNN is the relatively powerful one at present.

2 Literature Review

2.1 Traditional Face Recognition Algorithms

Since the appearance of face recognition research in the 1950s, it has been one of the hot research directions in the field of artificial intelligence, resulting in many algorithms [7, 8]. Subspace algorithms such as principal component analysis (PCA) and linear discriminant analysis (LDA) and hidden Markov model (HMM) are used in relatively early face recognition algorithms, but most of them are limited by recruitment illumination changes and human pose problems, and have obvious defects in practical applications [9]. Then, in order to solve the problem of using scene of face recognition technology, people began to use Bayesian, support vector machine and neural network technologies. Most of these algorithms need to be used with artificial features, such as using local binary pattern (LBP) or Gabor for recognition [10, 11]. These algorithms have quite good accuracy in specific scenes, but need to do a lot of processing on the data set in advance, and the recognition accuracy will drop sharply when the face is interfered by occlusion.

2.2 Deep Learning and Face Recognition

Since the deep learning algorithm has been applied in the field of face recognition, it has rapidly made great achievements and attracted the attention of many researchers. Taking the LFW database collated by the Computer Vision Laboratory of the University of Massachusetts, Amherst, as the standard reference object, many deep learning algorithms have outperformed traditional algorithms. Table 1 below shows the recognition rate of some deep learning algorithms and traditional recognition algorithms on LFW [12].

The DeepID project of the Chinese University of Hong Kong and the DeepFace project of Facebook have achieved 97.45% and 97.35% recognition rates respectively on LFW, which is extremely close to the recognition rate of 97.5% of normal human beings. The recognition rate of DeepID3 on LFW has reached an amazing 99.53%. The DeepID3 architecture is significantly deeper than DeepID2 + [13, 14]. However, when some wrong image labels in LFW are corrected, the advantages of DeepID3 have

Table 1. Recognition rate comparison of some deep learning algorithms and traditional face recognition algorithms on LFW

Method	Recognition rate (%)
High-dim LBP	95.17
TL Joint Bayesian	96.33
DeepFace	97.35
DeepID	97.45
DeepID2 +	99.47
DeepID3	99.53

been significantly reduced, and there is no direct evidence to prove that the DeepID3 architecture is completely superior to DeepID2 + in ultra-large use scenarios.

Nowadays, most face recognition algorithms based on deep learning can show strong recognition ability (over 98%) on LFW data sets. Although some of these algorithms do not perform well in practical application scenarios, it still shows that deep learning algorithms have sufficient potential in the field of face recognition.

2.3 Convolution Neural Network

The concept of convolutional neural network was first proposed by Hubel and Wiesel in 1962, and the concept of receptive field was first proposed from the perspective of biological visual cognition, tt can also be classified into deep learning [15]. Since the 21st century, CNN has been widely used in the field of face recognition. AlexNet won the first place in image classification in the Large Scale Visual Recognition Challenge in 2012, making CNN increasingly famous in the field of image processing. CNN can also be used in combination with many traditional recognition models, such as SVM and LSP, and many new models have been constructed. It is a non-parametric face detection method, which can eliminate a series of complex processes such as modeling, parameter estimation, parameter testing, and model reconstruction in traditional methods.

3 Anti-interference Technology in Face Recognition

3.1 Traditional Anti-interference Technology

For most face recognition algorithms and models, the image quality of the training data set is very important, which can directly affect the final accuracy of the algorithm. As mentioned above, face recognition using some traditional algorithms such as PCA and HMM can also achieve recognition rates that are higher than those of ordinary humans in some cases. However, these algorithm models have high requirements for image illumination, expression and posture, and are easy to be affected in actual use [16]. Therefore, some optimization schemes will be adopted to eliminate the interference of these objective factors.

For example, the combined Bayesian method is an improved method for Bayesian face recognition. It selects LBE and LE as the basic features, and converts the difference between face images into the difference caused by the same person's posture, expression and other reasons, as well as the difference between different people's faces, which can better verify the correlation of faces, and eliminate the influence of posture and expression to a certain extent. The combined Bayesian method has achieved a recognition rate of 92.4% on LFW [17]. In addition, some scholars expect to eliminate the interference in the original image and improve the recognition rate by enhancing the quality of the binary image and optimizing the training data set.

3.2 Mask Face Recognition

Some of the traditional anti-interference methods mentioned in the previous section will focus more on improving the image quality and reducing the difference of the same face in different images, without taking into account the need for users to wear masks for a long time.

But a study by scholar Hariri proposed an algorithm based on deep learning, which can remove mask interference. The algorithm directly removes the image of the occluded part of the face, and sends the remaining part of the face image into CNN to extract features, and uses multi-layer perceptron in the classification process [18]. This method can achieve higher recognition rate by using masking face recognition in some use scenarios, but sometimes it can remove some useful image areas at the same time. However, the wearing posture of the mask is still a key issue. Although most users will wear the mask consciously, some people still wear the mask in an irregular manner, such as missing the nose, mouth or wearing the mask askew. Sometimes this will greatly change the image features and may directly lead to recognition errors.

In addition to directly removing the parts of the face covered by masks and other coverings, some scholars also intend to achieve masking face recognition by detecting the key features of other parts of the face. Some models, such as MaskTheFace, will also detect the features of the mask in addition to the face features, and match the corresponding mask parameters from the mask template library, which to some extent solves the problem of the wearing posture of the mask. However, there are still some problems in this algorithm, that is, the update speed of masks is fast, and the styles are mostly different. It is impossible to save most of the mask parameters on the market in real time in the mask database, and the recognition rate in actual application scenarios may not be so ideal.

3.3 Mask Detection

Although it is not realistic to keep most of the popular mask parameters on the market in real time in the database, the face recognition system can recognize and classify the mask types by using algorithms first, so the system does not have to pay attention to specific types of masks.

Some scholars proposed the YOLO-Mask algorithm to perform target detection of multi-scale feature fusion through Feature Pyramid Networks, which can effectively detect the wearing of target masks in some relatively simple application scenarios [19]. After that, the algorithm has also been optimized and updated several times. Some scholars try to use deformable convolution to replace the convolution in YOLO-V4 network, which can ensure that the network will not convolution the unfocused area due to the restriction of convolution shape product, this improves its recognition rate to about 91.3% [20]. However, the network model has not yet taken into account the operational efficiency, so it still needs some optimization to combine it with the existing face recognition system.

4 Conclusion and Prospect

In the previous chapters, this paper proposed the normality of mask wearing in the background of COIVD-19. Combined with the investigation of some research institutions, it was found that it would indeed bring a significant impact on the existing face recognition system. After that, this paper reviews some traditional and existing face recognition algorithms, and investigates some algorithms and models to resist the interference of masks, and comprehensively discusses their advantages and disadvantages. To sum up, due to the short time of the outbreak of the epidemic, there are some face recognition systems that can resist the interference of masks on the market, but they are not mature enough. At present, there are two main development directions in the fight against mask interference. One is to try to peel off the mask covered area through different algorithms, and the other is to directly detect the uncovered area; Some of these algorithms need to maintain a real-time mask database, which is difficult to maintain in actual application scenarios.

This paper notes that some scholars are studying the algorithm models related to the detection and classification of masks. It may be a future development direction to combine the detection and classification of masks with the recognition system against the interference of masks, but in addition to the recognition rate, we still need to pay attention to the efficiency and anti-interference issues. This paper summarizes some anti-interference technologies and development directions of face recognition, and provides some inspiration for future development and research.

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