浙江工业大学

本科毕业论文（设计）

开题报告

论文题目：Design and Implementation of Lab Attendance System based on Face Recognition

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1 Background and Significance of The Topic

1.1 Purpose of Research and Development

Face recognition using camera equipment to collect face image is a technology for identification according to the facial features of the target to be detected.With the popularization and application of computer network technology, face recognition technology is widely used in gate access control, attendance management, face payment and many other fields.Traditional biometrics, such as fingerprint recognition, voice recognition and iris recognition, are either seriously affected by internal and external factors, so the recognition efficiency is low, or have high requirements for software and hardware facilities, so it is difficult to popularize and apply.Compared with the traditional biometrics technology, face recognition technology can be more intuitive and convenient through video surveillance equipment to check personnel identity information, has the characteristics of simplicity, efficiency, economy and scalability, can be applied to security verification, video surveillance, personnel control and many other aspects.Traditional face recognition methods mainly use manual facial feature detector design, in unconstrained environment, the feature information is easy to be affected by external factors, resulting in reduced robustness of face recognition algorithm.At present, traditional face recognition methods have been gradually replaced by deep learning methods based on convolutional neural networks. The advantage of deep learning methods lies in the use of a large number of data sets for feature training, so as to learn the best features of the deep level of the target to be detected[1].

The traditional laboratory attendance system requires laboratory staff to sign in and sign out according to a specific Angle, which has the following two disadvantages :1) once the location of the face is not accurate, the accuracy of the system recognition will be very low.2) Staff need to remember to clock in every day, once forgotten, a day's work will be wasted.The laboratory attendance system designed by this project is a face recognition system based on deep learning model MTCNN and Facenet.It mainly uses MTCNN model for face detection and image extraction, uses Facenet model for face feature extraction, and completes real-time recognition of face image by building local face feature database.Laboratory staff in and out of the laboratory every day, the system will real-time face recognition and automatic attendance, improve the accuracy and convenience of recognition.

1.2 Research and Development Status at Home and Abroad

1.2.1 Methods of Face Recognition

Since the 1960s, scholars began to study face recognition. Through decades of development, face recognition has been applied and developed in many fields, and the research at home and abroad is also very active.Some developed countries and some developing countries have set up research institutions and teams for face recognition.

Face recognition research was first carried out in the United States, and its research technology is higher than other countries. In 1993, The U.S. Department of Defense's Advanced Research Projects Agency and the U.S. Army Research Laboratory established Feret(Face Recognition) Technology project team, established the FERET face database, used to evaluate the performance of face recognition algorithms.[2].In recent years, Japan has been accelerating the research of intelligent video analysis technology, in 2015, a Japanese company launched a video surveillance face recognition technology scanning speed has been able to reach 36 million images per second. In the same year, the backbone airports in Japan introduced face recognition systems to provide a more convenient way for inbound and outbound tourists to enter and exit the country[3].

Compared with foreign countries, China's face recognition algorithm research is relatively lagging behind, the earliest began in the 1990s. At the beginning of the transformation from artificial to computer intelligent recognition in China, the biometric technology used is fingerprint recognition. However, with the development of The Times, people's needs have also changed, therefore, more accurate technology is needed to meet the new needs of practical applications, so face recognition came into being. Face recognition was first used in the field of security. In 2001, the public security department began to use face recognition technology to prevent and combat major criminal crimes, and won the support of the state. Li Ziqing, a doctor of automation from Chinese Academy of Sciences, led a team to develop "Zhongke Oxen", which was applied in the 2008 Beijing Olympic Games and the 2010 World Expo to improve the safety index of the venue and ensure the smooth implementation of activities[4].In 2010, the Shanghai World Expo, the technology has been more widely used, while major companies compete to join the camp of this technology, to achieve the large-scale application of face recognition in China.

From 1960s to 1990s, the research on face recognition mainly used the geometric features of facial features for matching. Firstly, the position of facial features was located, and then the relationship between their shape and position was analyzed. Finally, the pattern matching was carried out by measuring Euclidean distance and classifier. This

method is easy to lose face information, recognition effect is not ideal, temporarily stay in the theoretical stage, can not be used in the actual scene.

In 1987, Sirovich and Kireby proposed a principal component analysis-based feature face dimensionality reduction method[5] for PCA(Principle Componet Analysis) based face representation and recognition. With this approach, Turk and Pentland convert the entire face image into a vector and compute the feature face with a set of samples. PCA is able to obtain data representing a face at an optimal level with the data obtained from the image. Different faces and light levels of the same person are considered as the weakness of PCA.

In 1997, Yale University Belhhumur improved on Fisherfaces and introduced linear discriminant analysis[6]. This method uses supervised training to map faces onto the feature space, so that the feature information of the same person can be as close as possible and the feature information points of different people can be as far away as possible to reduce the impact of facial expression, posture, and lighting.Improve the identification efficiency.France and Herault Jutten put forward the method of independent component analysis[7], will get the face feature vectors independent component of the linear combination, as PCA algorithm.Hong Ziquan proposed a dimensionality reduction method based on singular value decomposition. First, singular value decomposition is used as the feature vector of face image, and finally, high-dimensional information is compressed into a low-dimensional subspace for classification.

F. maria uses the hidden Markov model of five states[8], and uses a group of unobstructible state sequence parameters to represent the relationship between various organs of the face, and puts forward a pseudo-two-dimensional hidden Markov model.Applied to face recognition, this model can well reflect the correlation between organs, is not sensitive to the change of expression, and has good robustness.

Researchers combined with the learning ability and association ability of neural network, neural network applied to face recognition, neural network can learn and extract face features through the learning ability of the data set, do not need researchers to spend time and energy to design face feature extraction algorithm, at the same time, neural network has good classification ability, especially in the field of face recognition.Kohenen proposed that the self-organizing mapping network[9] could reproduce faces well.Lin applies probabilistic neural network to face recognition, repeatedly trains samples, and improves the learning efficiency and convergence speed of neural network through modular structure.Many traditional neural network models have been proposed.

In 2006, Galundor University GeofferyHinton et al.[10] proposed the concept of

deep learning and the method of greedy layer by layer pre-training for the single problem of neural network single hidden layer structure. The paper proposed that the multi-hidden layer can better extract features without the need of artificial design algorithm, thus improving the accuracy of classification.Unsupervised learning is used for layer by layer pre-training to solve the problem of too many network parameters.Convolutional neural network is one of the classical algorithms in deep learning at present. Due to its simple structure and few training parameters, it has become a widely used model in deep learning and a mainstream method for face recognition, playing an extremely important role.

In 2014, Tang Xiaoou team of the Chinese University of Hong Kong[11] proposed DeepID algorithm based on convolutional neural network, which fused deep features of different regions of face image, verified faces by using Bayesian method, and tested on open face data set LFW[12], achieving 97.45% accuracy.The framework is mainly used for face verification, that is, comparing whether two faces are the same person, and finally, face recognition is carried out through softmax regression.FaceBook proposed DeepFace[13] algorithm to triangulate faces, reconstruct faces through key feature information, and finally, extract and classify features to realize face recognition, achieving a recognition rate of 97.35%.In 2015, FaceNet[14] system developed by Google in the United States introduced the TripletLoss function to map face features to Euclidean space, so that the spatial distance of images matching samples is closer, while that of unmatched samples is farther.The accuracy of LFW data set was 99.63%.In 2016, IacopoMasi proposed an unconstrained face recognition method[15]to study the recognition problem caused by changes in face posture.

With the development of Convolutional neural network, in recent years, more and more companies at home and abroad, such as Google, Facebook, and SenseTime, have applied face recognition to the security check of public places, the place where the company checks in for attendance and signs in for meetings. However, there are still some problems and challenges in the actual application. Although many methods have achieved high accuracy in LFW data sets, even exceeding the ability of human eye recognition However, these deep models need to be trained through a large number of samples, which is difficult to achieve for universities or small research institutions. Therefore, how to train a relatively simple model with good performance, which can obtain more distinctive facial features and match faces well is an urgent problem that we need to solve.

1.2.2 Development of Attendance System

The attendance system was first born in the 1970s[16] and has undergone the following evolution:

The first generation of attendance is a paper card system, replacing the traditional manual attendance system.The time is printed on the card through the micro print head to realize attendance.Advantages are simple operation, the machine is not complex;The disadvantage is that it can not effectively identify the identity of the attendance person, it is easy to take the exam on behalf of the situation, and there is a lot of statistical work in the later period, the paper consumption is large.

The second generation of attendance is the bar code attendance system.It is mainly to record the situation of mine workers in the well[17]. The bar code is projected far away from the optics, and the bar code is scanned by the mining lamp irradiated by the camera, so as to realize the attendance check.The advantages are high accuracy, low cost and fast speed, but the disadvantages are that the bar code is easy to be damaged and forged.

The third generation of attendance is magnetic card type attendance system.The attendance test is now widely used in major enterprises and institutions with remarkable results.The advantage is high attendance efficiency, the disadvantage is that the magnetic card is easy to lose, easy to take the test.

The fourth generation of attendance is biological information identification attendance system.First input fingerprint, iris[18], face information, and then compare the information for recognition.The advantage is that there is no need to carry other proof, identity identification is unique, there will not be a proxy test.The disadvantage is that it is easy to be affected by external factors, the fingerprint needs to be clean and not damaged, the face needs no external occlusion, the stability and accuracy of the verification is low, the cost is high.

2 The Basic Contents and Objectives of Research and Development, The Main Problems to be Solved or The Key Technologies

2.1 Research Objective

In the comparison of domestic and foreign face recognition technology, in the study of similar system design and implementation abroad, put forward their own design and implementation.The research objective of this topic is to use MTCNN model and FaceNet model to realize the laboratory attendance system based on face recognition, especially the application of some key technologies in face recognition, such as OpenCV, etc.

2.2 The Basic Content of The Study

The specific contents of the project include:

(1) Face image acquisition module

The module is used to capture facial images of lab workers as they enter or leave the lab.

(2) Face detection module

The module is used to detect the position of the facial region of the captured face image.Face detection can be performed using MTCNN.

(3) Face recognition module

The module is used to recognize the detected face image. The pre-trained network model FaceNet can be used for face recognition.

(4) Complete attendance statistics, including: daily attendance and weekly attendance automatic statistics

The module is used to generate a report detailing the weekly and monthly lab attendance of all lab members, including the average working time of each lab member, etc.

2.3 Technical Difficulties to be Solved

1. MTCNN was used to extract non-positive faces
2. Train the FaceNet network model

3 Research and Development Methods and Technical Routes

(1) System platform：Microsoft Windows 10

(2) OpenCV

OpenCV is a classic computer vision library, which supports multi-language, cross-platform, powerful.Opencv-python provides a Python interface for OpenCV, so that users can call C/C++ in Python, under the premise of ensuring legibility and operation efficiency, to achieve the required functions.

(3) Programming language：Python

Python was designed in the early 1990s by Guido van Rossum of the Dutch Society for Mathematical and Computer Science Research as a replacement for a language called ABC. Features:

First, simplicity: Python is a language that represents the idea of simplicity.Reading a good Python program is like reading English.It allows you to focus on solving problems rather than figuring out the language itself.

Second, easy to learn: Python is extremely easy to learn because Python has extremely simple documentation.

Third, easy to read, easy to maintain: the style is clear and uniform, forced indentation.

Fourth, JAVA is also versatile, fast, portability, object-oriented and other advantages.

(4) Model used：MTCNN + FaceNet

MTCNN(Multi-task convolutional neural Network) is a network proposed in Joint Face Detection and Alignment using Multi-task Cascaded Convolutional Networks[19]. By using the convolutional neural network (CNN) structure, MTCNN can complete the two tasks of face detection and face alignment simultaneously through multi-task learning, and output the coordinate of the center point, the scale and the position of the feature point of the face.MTCNN adopts image pyramid + 3-stage cascade CNN (P-Net, R-Net, O-Net) for face detection, and its detection framework is shown in Figure 2：

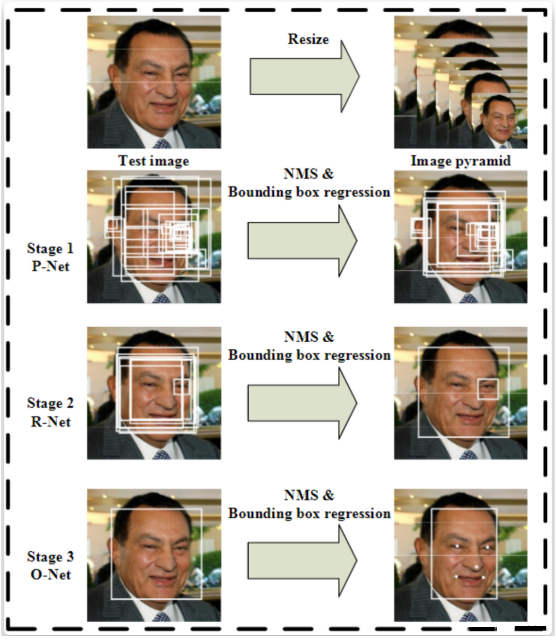

Figure 1: Pipeline of cascaded framework that includes three-stage multi-task deep convolutional networks.

FaceNet is a unified solution framework proposed by Google on FaceNet: A Unified Embedding for Face Recognition and Clustering to identify[20] (who is this), verify (whether it is the same person), and cluster (find the same person in multiple faces).

FaceNet believes that all the above problems can be uniformly handled in feature space, and the difficulty lies in how to better map faces to feature space.Its essence is to learn the mapping of face image to 128-dimensional Euclidean space through convolutional neural network. This mapping maps face image to 128-dimensional feature vector, and uses the reciprocal of the distance between feature vectors to represent the similarity between face images.For different images of the same individual, the distance between the feature vectors is small, and for images of different individuals, the distance between the feature vectors is large.Finally, based on the similarity between feature vectors, face image recognition, verification and clustering are solved.

(6) System development tool：Visual Studio Code

Visual Studio Code (" VS Code "for short) was officially announced by Microsoft at the Build Developer Conference on April 30, 2015, as a new version of the software that runs on Mac OS X, Windows, and Linux.A cross-platform source code editor for writing modern Web and cloud applications that runs on the desktop and is available for Windows, macOS, and Linux.It has built-in support for JavaScript, TypeScript, and Node.js, and a wealth of other languages (e.g. C++, C #, Java, Python, PHP, Go) and runtimes (e.g.NET and Unity) expanded ecosystem.

(7) Database software：Oracle 11g

Oracle11g is a powerful database management system launched by Oracle Corporation, convenient for users to operate the database.

4 Overall Arrangement and Schedule of Research Work

Table 1: Work arrangement

Task number	Start-stop time	Stage task points
1	2022.11.30-2023.1.20	Understand the subject related content, search Chinese and English materials
2	2023.1.21-2023.2.24	Consult literature, complete literature review, proposal report, foreign translation
3	2023.2.25-2023.2.28	Refamiliarize yourself with the Python programming language
4	2023.3.1-2023.3.5	Learn OpenCV, MTCNN, FaceNet and other related technologies
5	2023.3.6-2023.3.8	Carry out the outline design of the system
6	2023.3.9-2023.3.13	Carry out the detailed design of the system
7	2023.3.14-2023.3.15	System framework and development environment construction
8	2023.3.16-2023.4.3	Carry out project development
9	2023.4.4-2023.4.7	Complete system test
10	2023.4.8-2023.5.24	Sort out the materials and finish the graduation thesis
11	2023.5.25-2023.6.10	Submit the graduation thesis and prepare the graduation defense

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