1. Introduction
The increasingly sophisticated functions of smartphones and digital devices provide photographers with more choices to save their time by taking pictures. A large number of electronic photographs will then be produced. It is very important to manage a large number of digital pictures for photography enthusiasts. Most people manage photos by simply naming the album name by the location or time of the photo. It causes a lot of problems by this method of photo preservation. It’s more difficult to quickly find photos of your interest in a large number of photos, and it will waste more time and energy, so management efficiency is also very low. There are some similar products on the market. For example, "Organize Photo By Exif" can only categorize photos by time, and "Smart Photo Import" can set labels of photo and previews of photos after sorted by time. The software can be categorized by title, and others can only be used to classify people and scenes. Some software is based on user-defined categories, such as Netease Cloud, Baidu, QQ, etc. The functions are relatively simple, unable to meet the needs of users. However, there is no automatic classification function based on the image content. Photo automatic classification system based on face recognition is proposed in this paper to allow users to quickly find their own photos, which can reduce the time and labor cost of selecting photos. Processing efficiency will be greatly improved.

Face detection, recognition technology and image content retrieval technology are main core of photo automatic classification system. Bill gates said that face recognition is a biometric technology that uses human biometrics for identity verification and is the most important technological revolution in IT production. Although the accuracy of face recognition is lower than that of iris and fingerprint
recognition, it is the most easily accepted biometric method because it is non-invasive and the most natural and direct way for users. So the application of face recognition is the most widely used in life.

Face recognition technology has been studied at home and abroad. More famous research institutions abroad include AI lab of MIT in the United States and Cambridge University of England. The main methods they studied were: template matching, example learning, neural networks, linear expression and sparse expression, color information, shape analysis, and multimodal information fusion. The institutions that are more noted in China are: Institute of Automation in Chinese Academy of Sciences, Tsinghua University, Fudan University, etc. The research methods mainly focus on face recognition methods based on geometric features, algebraic features and connection mechanisms. SeetaFace face recognition engine and face++ software are popular applications in life. Currently, a good face image library is LFW (Labelled Faces in the Wild) and YFW (Youtube Faces in the Wild). In addition, face_recognition is simple and easy to open source python library.

The Photo Automatic Classification System was developed using the face_recognition open source library. Many methods are positive face recognition, and if the face angle changes, the accuracy will be greatly reduced. This is an important difficulty that this paper needs to solve. Another difficulty is to search for all images that match the face based on the face recognition results.

2. System composition and working principle

The system is mainly composed of face learning, face acquisition, face recognition, face search and image classification.

Photo automatic classification system based on face recognition is proposed, which is convenient for users to find their own photos. Given samples photo of a person, the system first conducts self-deep learning to obtain the feature value of the face to files. Give a photo of the face, or get a photo from the camera, the system detects whether a photo is included in the photo. If no face is detected, the photo is saved to a specified folder. If a face is detected, the face information is obtained and the distance from the sample data is calculated. And then the system can find all the photos in the given folder and copy the found photos including the sample face to the corresponding person name folder. At the same time, photos that cannot be recognized are also copied to the undetected face folder, so that the user can do a small amount of manual classification.

3. Detailed system design

3.1 Face learning

A 128-column digital code string is recognized for each face and is written to local files which are considered as standard data for the comparison. The name of the sample folder is the name of the face which is wanted to search. When adding a face sample, the more angles the higher the accuracy, the more the number, the higher the accuracy. Each person has a folder, and the folder name is the name of the person. Each folder contains one or more photos of a person, preferably different expressions at different angles. Local data mainly has three kinds of information: dataset_faces, dataset_imageName and dataset_NameNum..

Where dataset_faces represents the sample face information, dataset_imageName represents the sample image name, and dataset_NameNum represents the number of faces

The face used in the experiment is shown in Figure 1.
3.2 Image rotation

If the angle of photographing is incorrect when the face image is acquired, the face detection may not be performed correctly. The image needs to be rotated at an angle so that face detection can be performed correctly. The rotation of the image is implemented using the rotate function. The format of the rotate function is as follows.

rotate(image, angle, center=None, scale=1.0)
There are four parameters in the rotation method. The first is that the image needs to be rotated, and the second is the angle we want to rotate. The third parameter is the rotation datum, which provides two selectable variables: center point and scale. The fourth is the size, the default value is 1.0, which means there is no change in size. Use the getRotationMatrix2D function in OPENCV to complete the rotation.

\[ M = cv2.getRotationMatrix2D(center, angle, scale) \]

If each face of the picture is not recognized at a time, the picture is rotated by 90, 180, 270 degrees and then recognized again so as to be compatible with the horizontal or vertical mode.

### 3.3 Image clarity

Image clarity plays an important role in the recognition of faces. The specific method is to convolute a channel (usually with gray value) in the picture through the Laplacian mask, and then calculate the standard deviation, and the value can represent the picture clarity.

The Laplace transform of a two-dimensional image function is an isotropic second-order derivative, which is defined as formula 1.

\[ \text{Laplace}(f) = \frac{\partial^2 f}{\partial x^2} + \frac{\partial^2 f}{\partial y^2} \]  

In a two-dimensional function \( f(x, y) \), the second-order difference definition in the two directions of \( x, y \) is as shown in formula 2 and formula 3.

\[ \frac{\partial^2 f}{\partial x^2} = f(x + 1, y) + f(x - 1, y) - 2f(x, y) \]  

\[ \frac{\partial^2 f}{\partial y^2} = f(x, y + 1) + f(x, y - 1) - 2f(x, y) \]

The difference form of the Laplace operator is shown in formula 4.

\[ \nabla^2 f(x, y) = f(x + 1, y) + f(x - 1, y) + f(x, y + 1) + f(x, y - 1) - 4f(x, y) \]

The corresponding filter mask form is shown as following.

\[
\begin{array}{ccc}
0 & 1 & 0 \\
1 & -4 & 0 \\
0 & 1 & 0 \\
\end{array}
\]

Step 1: Get the resolution of the image.
Step 2: Compress the image into a single-channel grayscale image.
Step 3: Convolute the image with a 3x3 Laplacian.
Step 4: Determine the resolution based on the returned value.

### 3.4 Face recognition

Histogram of Oriented Gradients (HOG) is a description operator based on shape edge features that can detect objects. It uses gradient information to reflect the edge information of the image target, and characterizes the appearance and shape of the image by the size of the local gradient. The main steps in extracting HOG features are:

Step 1: normalize gamma and color space to reduce the effects of lighting and background.
Step 2: calculate the gradient information;
Step 3: weighted vote into spatial and orientation cells, and the count the histogram of the entire block.
Step 4: contrast normalize over overlapping spatial blocks to further reduce the effects of background color and noise;
Step 5: collect HOG’s over detection window, and use feature vectors to represent their characteristics.
Step 6: Separate the correct pedestrian target by the SVM classifier. The amplitude and direction of the gradient are calculated as formula 5 and formula 6. 

\[ G(x, y) = \sqrt{G_x(x, y)^2 + G_y(x, y)^2} \]  
\[ \alpha(x, y) = \tan^{-1}\left(\frac{G_y(x, y)}{G_x(x, y)}\right) \]  

Where: \( G_x, G_y, H(x, y) \) represent the gradient of the pixel point \((x, y)\) in the horizontal direction and the vertical direction, respectively, and the gray value of the pixel.

The result of face detection is shown in Figure 2.

![Figure 2. Face recognition results](image)

3.5 Face matching

Calculate the Euclidean distance from the 128-column digital code string of each face and the code string of the sample picture. When the calculated value is less than the threshold, it is judged to be the same person’s picture.

Euclidean distance is calculated by the following formula 7. 

\[ Y = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2} \]

\[ |M| = \sqrt{x_2^2 + y_2^2} \]

Where \( Y \) is the Euclidean distance between the point \((x_2, y_2)\) to the point \((x_1, y_1)\), and \(|M|\) is the distance from the point \((x_2, y_2)\) to the origin.

The accuracy of different distances is shown in Table 1.

| Table 1. Distance and accuracy test table |
|----------------------------------------|
| Euclidean distance | Accuracy/ % |
|---------------------|-------------|
| 0.5                 | 70          |
| 0.4                 | 85          |
| 0.36                | 91          |
| 0.3                 | 92.6        |

Test results show that the smaller the distance, the higher the accuracy. If the accuracy rate exceeds 90%, it can be considered the same person. Therefore, when the threshold is set to 0.36, the result of this recognition is optimal.

3.6 Image classification

Given samples photo of a person, the system first conducts self-deep learning to obtain the feature value of the face to files. Give a photo of the face, or get a photo from the camera, the system detects whether a photo is included in the photo. If no face is detected, the photo is saved to a specified folder. If a face is detected, the face information is obtained and the distance from the sample data is calculated. And then the system can find all the photos in the given folder and copy the found photos including the sample face to the corresponding person name folder. At the same time, photos that
cannot be recognized are also copied to the undetected face folder, so that the user can do a small amount of manual classification.

4. Conclusion
Photo automatic classification system based on face recognition is proposed, which is convenient for users to find their own photos. System composition and working principle are explained. The system design is also introduced in detail, including face learning, face acquisition, face recognition, face search and image classification. The test results show that the system can correctly find all images based on face recognition. The system is simple to operate and can meet the needs of users.

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