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Face Check in System based on OpenCV

Yan Li, Yuhang Li, Haoran Li

College of information science and technology (College of network security, Oxford Brooks College), Chengdu University of Technology, Chengdu, 610059, China.

Abstract

Check-in system is in great demand both in schools and in companies. In this era of rapid development, the demand is more diversified and personalized. For the problems of time-consuming, laborious and replacing check-in with traditional check-in modes, this design puts forward a check-in system design scheme based on face recognition from the basis of computer vision. Based on OpenCV software library, the image is processed and acquired in real time, and then compared with the information in the database. This design takes the assessment management as the core, which can meet the basic needs of the schools and the companies.

Keywords

OpenCV; Sign in System; Image Processing.

1. OpenCV and SVD algorithm

1.1 OpenCV

At present, there are many image processing softwares and libraries, and OpenCV (open source computer vision library) library is one of the most frequently used and powerful software libraries[3]. Opencv is an open source software library for computer vision and machine learning. This software library has more than 2500 optimization algorithms,including a comprehensive set of classic and most advanced computer vision and machine learning algorithms. These algorithms can be used to detect and recognize faces, identify objects, classify human behavior in videos, and so on.

1.2 SVD algorithm

SVD (Singular Value Decomposition) is an important matrix decomposition in linear algebra, and singular value decomposition is the generalization of eigen decomposition on any matrix.

For the real symmetric matrix A with dimension $A \in R^{m\times m}$ we can express it as A=$Q\Sigma Q^T$ by eigen decomposition, where Q is the unit orthogonal matrix and Σ is the eigenvalue matrix of matrix A.The dimension of matrix Q is $Q \in R^{m\times m}$, and the dimension of matrix Σ is $\Sigma \in R^{m\times m}$.

$$A=Q\Sigma Q^T=Q\begin{bmatrix}\lambda_1 & \cdots & 0\\ \vdots & \ddots & \vdots\\ 0 & \cdots & \lambda_n\end{bmatrix}Q^T \quad (1)$$

For a general matrix whose B dimension is $B \in R^{m\times n}$ we can also realize the above decomposition B=$U\Sigma V^T$, where U is called the left singular matrix, V is the right singular matrix, and Σ is the singular value matrix of matrix B. The above three matrix dimensions are $U \in R^{m\times m}$,$\Sigma \in R^{m\times n}$, $V \in R^{n\times n}$.

$$B=U\Sigma V^T=U\begin{bmatrix}\lambda_1 & \cdots & 0\\ \vdots & \ddots & \vdots\\ 0 & \cdots & 0\end{bmatrix}V^T \quad (2)$$

The image is also a matrix composed of gray values, so singular value decomposition can be used for image preprocessing

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2. General design of the system

The system is mainly composed of three parts: First, OpenCV will process and obtain the image in real time, Second, SVD will compress the real-time acquired image to reduce the time of subsequent calculation, Finally, the processed image will be compared with the pre-collected images, and the matching is completed successfully within the specified error. [4]

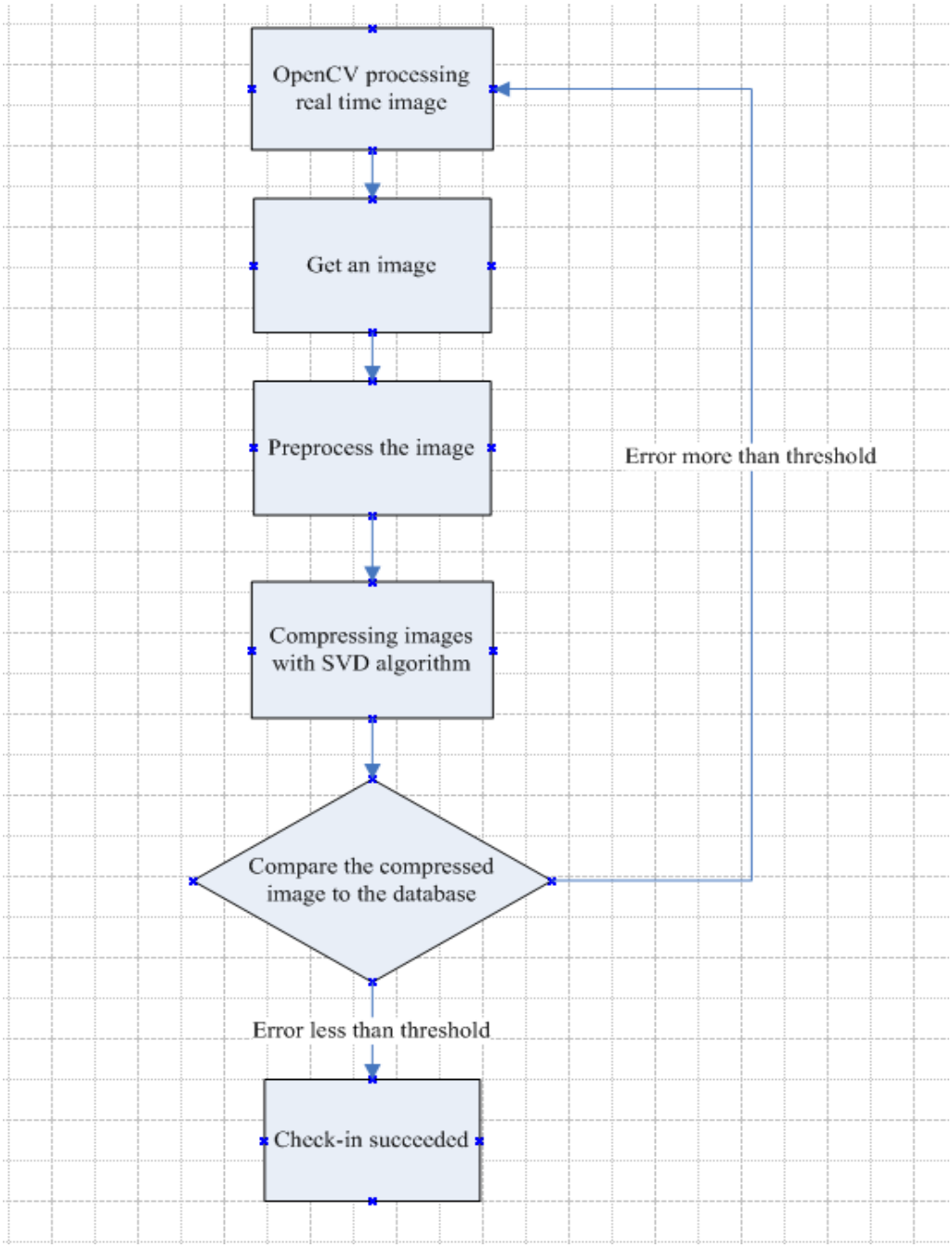

Figure 1. Overall flowchart

2.1 Real-time image acquisition

OpenCV software library is designed for real-time processing and image acquisition.

(1) Eliminate noise: Pre-process the image with the Gaussian filter of linear smoothing filter to achieve the effect of noise reduction, while better preserving the overall gray distribution of the image, so as to obtain a clearer image;

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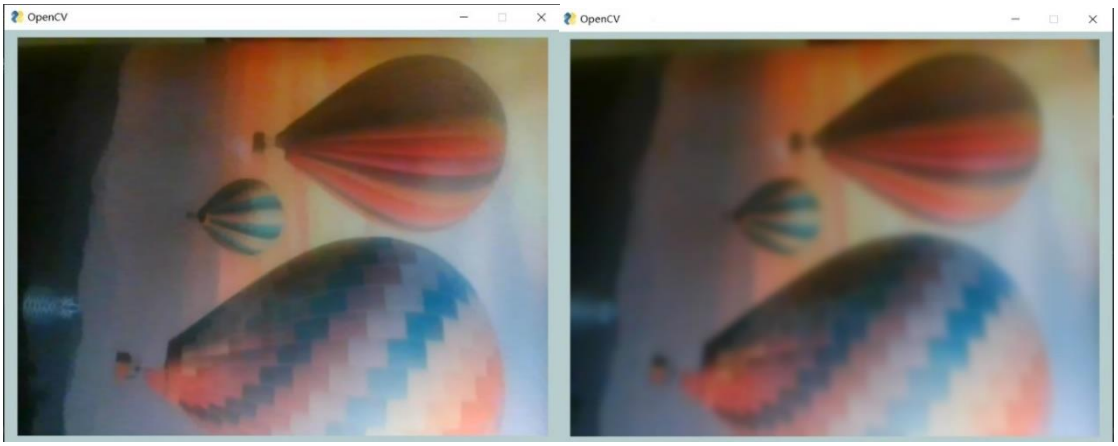

Figure 2. Real-time image processing with Gaussian filter

(2) Adjust contrast: Contrast reflects the different levels of brightness between the brightest and darkest areas in an image. Adjusting contrast enlarges or reduces the difference between bright and dark points while keeping the average brightness constant so that the design can be applied to more scenes.

(3) Threshold Binarization: Binarization of an image sets the gray level of a pixel point on the image to either 0 or 255 values, so the entire image will appear black and white only. An image includes target objects, background and noise. To extract target objects directly from a multi-value digital image, a common method is to set a threshold value, which divides the image data into two parts: the group of pixels larger than the threshold value and the group of pixels smaller than the threshold value.

Figure 3. Threshold Binarization for Real-time Image Processing

(4) Real-time image acquisition: When you start punching, OpenCV randomly acquires a real-time image to compare with the information in the database.

Figure 4. Real-time images acquired

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2.2 Image Compression

Because of the large amount of image information obtained,it will take more time and space to analyze and compare images directly.Therefore,image compression is particularly important,but it should be noted that important information in the original picture cannot be lost during the compression process.

For the obtained image,it is a matrix composed of gray values.The above mentioned decomposition B=$U\Sigma V^T$ can also be achieved for a general matrix B dimension of $B \in R^{m\times n}$.U is called left singular matrix, V is called right singular matrix, and Σ is the singular value matrix of matrix B.

The key to reconstructing a matrix is to extract the singular values, which can be viewed as the representative values of a matrix, or the singular values can represent the information of the matrix. The larger the singular value, the more information it represents.The singular values in the singular value matrix obtained by the SVD algorithm are arranged from large to small,so we can basically restore the data itself by taking the first few largest singular values.

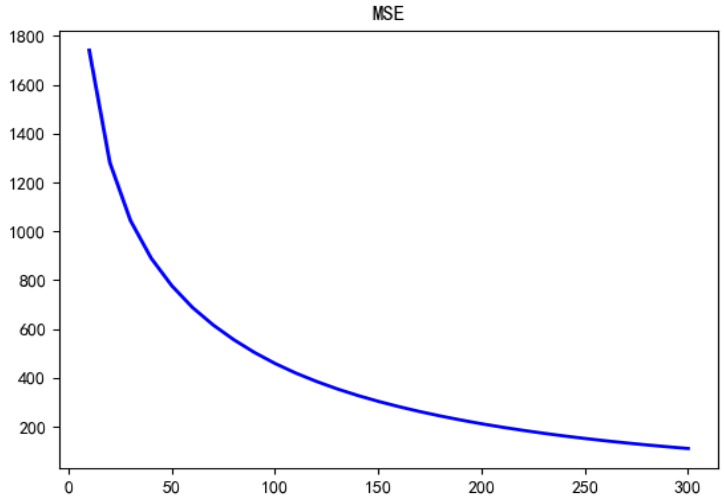

Figure 5. Error between Compressed Matrix and Original Matrix

From Figure 5, it is clear that the error between the compressed reconstructed matrix and the original matrix decreases with the increase of the number of singular values, so we can restore the original matrix well by selecting the appropriate singular values and reduce the subsequent operation time without losing important information.

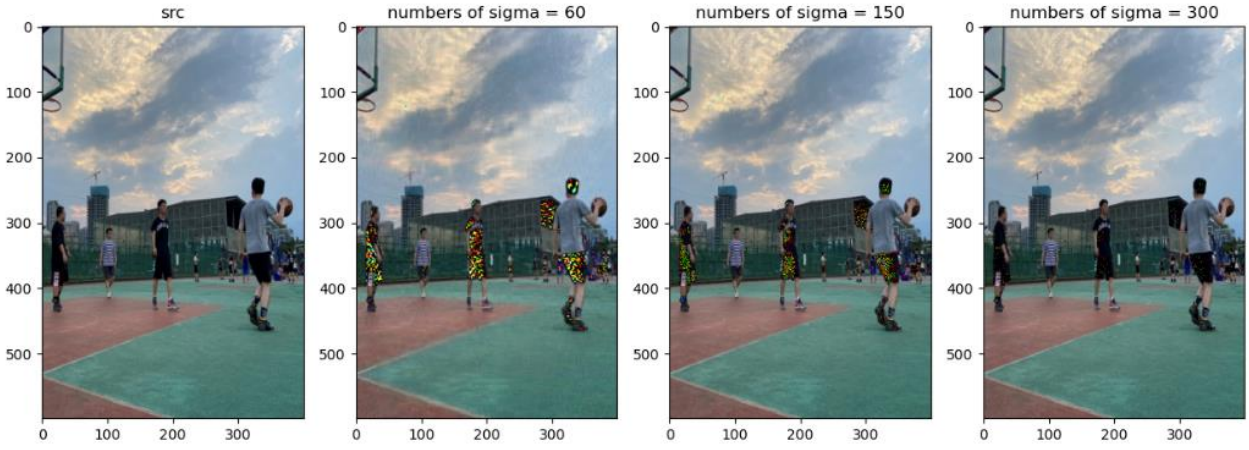

Figure 6. Compressed image using SVD algorithm

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From Figure 6, it can be seen that the difference between the compressed image and the original image decreases as the number of singular values increases,and the compressed matrix can restore the information contained in the image very well.

2.3 Validation

After the above steps,we get the compressed image,what we need to do next is to compare the obtained image with the image in the database, do an error calculation,if the error is within the specified range, it will return a match success signal; otherwise, it will return a match failure signal,and the program will return to the first step to restart.

3. Performance improvement solutions

Because differences in the environments used by users may affect the recognition rate,appropriate modules should be added outside the real-time image acquisition to compensate for the environment,such as adding a light compensation module,providing light compensation according to different light conditions so that the acquired image will not lose critical information,etc.Key information can be compared with the database in subsequent calculations,for large errors can be directly excluded,and then the remaining data for a comprehensive comparison calculation,so as to save computing time and so on.

4. Concluding remarks

Face recognition check-in is widely used in many scenarios,which changes the traditional check-in mode and improves the efficiency to some extent.Using OpenCV software library for real-time image processing and image acquisition can meet most of the image processing needs.On this basis,we can also add more assessment methods to achieve a more secure and reliable check-in mode.

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