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FACE RECOGNITION USING MAHALANOBIS DISTANCE IN MATLAB

Pooja[1], Mr. Ajay Dagar[2]
[1]M.Tech. (ECE) HoD, Electronics & Communicating Engineering, [2]WCTM, Farrukh Nagar, Gurgaon

Abstract: Face is recognized after being requested from biometrics and has various uses in modern life. The problem of face recognition attracts researchers working on biostatistics, pattern recognition, and computer vision. Many face recognition algorithms are used in many different applications, regardless of biometrics such as video compression, indexing, etc. we can also use it to categorize multimedia content to quickly and effectively search interesting materials. An effective face recognition system can be very useful for forensic, law enforcement, surveillance, bank system authentication and security systems, and priority access to authorized users, i.e., access control to secure areas. With the recent increase in terrorism related cases, the problem of face recognition has become more important. While some of the latest face recognition algorithms, including machine learning tools, work well, unfortunately the training period and processing time are large enough to limit usage in real applications. Therefore, an ongoing struggle exists to propose an effective face recognition system with high precision and acceptable processing time.
Keyword: Mahalanobis Distance, Face Recognition, MATLAB, PCA , Euclidean Distance

I. INTRODUCTION

System for face recognition is consisted of two parts: hardware and software. This system is used for automatic recognition users or confirmation of password. For input is used either digital pictures or video frame from same video. State institution and some private organization are using this system for face recognition especially for identification face by video cameras like input parameter or for biometrics system for checking identity using cameras and 3D scanners. System must to recognize where is face on some picture, to take it from picture and to do verification. There are many ways for verification, but the most popular is recognition of face's characteristics. Face has about 80 characteristic parameters some of them are: width of nose, space between eyes, high of eyehole, shape of the zygotic bone and jaw width.

A rationally connected neural network examines small windows of an image, and decides whether each window contains a face. The system arbitrates between multiple networks to improve performance over a single network. Training a neural network for the face detection task is challenging because of the difficulty in characterizing prototypical "non-face" images. Unlike face recognition, in which the classes to be discriminated are different faces, the two classes to be discriminated in face detection are "images containing faces" and "images not containing faces". It is easy to get a representative sample of images which contain faces, but it is much harder to get a representative sample of those which do not. The size of the training set for the second class can grow very quickly.

II. LITERATURE REVIEW

The structure of the face recognition system consists of a wide range of tasks.

1. Acquisition (detection and tracking of images like faces)
2. Extract features (Hash, align, normalize facial images)
3. Recognition

2.1 Face Detection Approaches

Some of the main face detection methods are discussed here.

1) Knowledge methods are developed based on rules derived from researchers' knowledge of human aspects. The problem with this approach is that it is difficult to convert human knowledge into clear rules.

2) Advantage-based method: Use a fixed face to detect texture, skin tone. However, the characteristics of this algorithm can be severely damaged by lighting, noise and clogging

3) Matching Template: The input image is compared with a predefined face template. However, the performance here is bothered by differences in size, shape and shape.

4) Appearance-based method: In the template matching method, templates are predefined by experts.

Existing models are learned in appearance style from examples of photographs, but statistical analysis and automatic learning techniques can be used to find characteristics related to facial images and non-facial images

2.2 Face Recognition Approaches

The LFA method [2] analyzes the face in terms of local profiles such as eyes, nose etc. called LFA beads. The LFA technique provides better durability for local changes in facial images in the matching procedure, but does not represent global facial features. The neural network [4] relies on learning of faces in the example set by the machine in the "training stage and recognition" of the generalization stage. However, in order to prepare my work successfully, we need an example that takes full account of the difference in actual living conditions. The method of matching the face recognition model (Hidden Markov Model (HMM) [6] etc.) trains each person's model while learning the form, selects the best matching model and gives the query image. There is also a realistic modeling model that is necessary to get good results. The sparse expression recognition system (1) calculated by l-1 minimization works with the basic idea of assigning recognition as a sporadic expression problem. The main concern of this method is the existence of sufficiently large number of features and the correct calculation of sparse

expressions. This is a powerful and scalable face recognition algorithm based on linear or convex programming.

2.3 Zhi-Hua Zhou et al. [17] evaluated the performance of different classifiers for age estimation, including the nearest neighbor classifier, the Artificial Neural Networks (ANNs), and a quadratic function classifier. The face images are represented by the AAMs method. From experiments on a small database containing 400 images at ages ranging from 0 to 35 years, it was reported that the quadratic function classifier can reach 5.04 years of MAE, which is slightly lower than the nearest neighbor classifier, but higher than the ANNs. The SVM was applied to Face detection by Guo et al. on a large YGA database with 8,000 images. The MAEs are 5.55 and 5.52 years for females and males, respectively. The MAE is 7.16 for the FG-NET aging database. Kanno et al. Presented to use artificial ANN for the 4-class age-group classification which achieved 80% accuracy on 110 young male faces. Gaussian models in a low-dimensional 2DLDA+LDA feature space using the EM Algorithm. The age-group classification is determined by fitting the test image to each Gaussian model and comparing the likelihoods. For the 5-year range age-group classification, their system achieves accuracies of about 50% for male and 43% for female. For 10-year range age-group classification, it achieves accuracies of about 72% for male and 63% for female. For 15-year range age-group classification, it achieves accuracies of about 82% for male and 74% for female.

2.4 Other Model Based of Face Recognition

Michel F. Valstar, Timur Almaev [5] investigated three formulations for the aging function: linear, quadratic, and cubic, respectively, with 50 raw model parameters. The optimal model parameters are learned from training face images of different ages based on a genetic algorithm. The SDP is an effective tool but computationally very expensive . When the size of the training set is large, the solution to SDP may be difficult to achieve. An Expectation Maximization (EM) algorithm was used to solve the regression problem and speed up the optimization process . The MAEs are reported as 6.95 years for both female and male on the YGA database, and 5.33 for the FG-NET aging database. Zhou et al. presented the generalized Image Based Regression (IBR) aiming at multiple-output settings. A boosting scheme is used to select features from redundant Haar-like feature set. The proposed training algorithm can also significantly reduce the computational cost. The IBR can achieve 5.81 MAE of a 5-folds cross validation test on the FGNET aging database. Suo et al. compared Age group specific Linear Regression (ALR), MLP, SVR, and logistic regression (multi-class Adaboost) on FG-NET and their own databases and finally achieved the best performance with MLP in their experiments. Guo et al. , chose the SVMs as a representative classifier, and the SVR as a representative regressor, and compared their performance using the same input data. From their experiments, the SVMs perform much better than the SVR on the YGA database (5.55 versus 7.00, and 5.52 versus 7.47 years, for females and males, respectively), while the SVMs perform much worse than the SVR on the FG-NET database (7.16 versus 5.16 years). From the experimental results, we can see that the classification-based Face detection can be much better or much worse than the regression-based approach in different cases.

III. PROPOSED SYSTEM

We propose a real time face recognition system based on PCA and Mahalanobis. The main task of face recognition is to extract effective features. The proposed system uses the Eigen face method to reduce image information. Even small faces have incredible information. This method should be able to break the image, generally to represent the face image effectively rather than the image. Once the basic surface is created, the system can express the image to be analyzed as a linear combination of these basic planes. You can display each plane you want to classify in a parallel space and analyze it as a vector. Approach k - neighbors, neural networks, or even Euclidean simple distance measurements can be used for classification. The proposed system uses basic analysis of components to extract classifications of distances different from features such as Euclidian Distance, Manhattan Distance, and Mahalanobis Distance. The technique used here involves generating the "positive face", displaying the training data in the face region used with the predetermined classification method, dropping it in the face region and comparing the training data,

3.1 Steps Involved

The different steps for calculating the eigenface are as follows. A. Data Preparation A two-dimensional face image can be represented as a one-dimensional vector device by connecting each row (or column) to an elongated vector. We denote the vector N size (= column x rows of the image) representing the image set in which the sample was taken, assuming Γ1, Γ2, Γ3 .... ΓM, subtract the average. To be calculated, it is subtracted from the original face (Γ i) and the results stored in the variable.

$$\Psi = \frac{1}{M}\sum_{n=1}^{M}\Gamma_n$$

$$\Phi_i = \Gamma_i - \Psi$$

C. Calculate the co-variance matrix In the next step the covariance matrix A is calculated according to:

In the next step, the heterogeneous matrix is calculated according to

$$A = \Phi^T\Phi$$

B. Calculation of eigenvalues and eigenvalues of the dispersion matrix In this step we need to compute the eigenvalues of the self vectors (eigenvectors) Xi and λi. E. Eigen mode calculation

$$[\Phi]X_i = f_i$$

:

Xi is an eigenvector and fi is a unique surface. Classification of faces New images are converted to their eigen face components. The obtained weights are weight vectors TT k:

$$\Omega_k = \Omega_k^T(\Gamma_k - \Psi)$$

Where k = 1,2,3,4 and kT k = [1122 .... MM] The Euclidean

distance between two weight vectors (d, i, jj) provides a similarity scale between the corresponding images i & j.

Various Distance metrics

Let X and Y are vectors specific to n lengths. Next, we can compute the next space between these vectors

Mahalanobis Distance

The Mahén Nobis space is defined as the area where sample changes are along each dimension. Consequently, vector transformation from image space to feature space is performed by dividing each factor of the vector by the corresponding standard deviation. This transformation provides a dimensionless space with changes in units of each dimension. If there are x and y curves in the unconverted PCA space, the corresponding vectors m and n are in the Mahalinobis space. First, λi = σ 2 is defined. Here, arei is the e-pa value, σ 2 i is the amount of change along these dimensions, and σ i is the standard deviation. Next, the relation between the vectors is defined

$$m_i = \frac{x_i}{\sigma_i} \quad n_i = \frac{y_i}{\sigma_i}$$

$$d(x,y) = \sqrt{\sum_{i=1}^{k}(m_i - n_i)}$$

Where λi is the i th Eigen value corresponding to the i[th] Eigenvector

Manhattan Distance

Also known as the L1- norm or the Manhattan Distance or the City Block Distance. It is defined as follows:

$$d(x,y) = |x - y| = \sum_{i=1}^{k} |x_i - y_i|$$

$$d(x,y) = ||x - y||^2 = \sum_{i=1}^{k} (x_i - y_i)^2$$

Euclidean Distance

ALSO L2-norm or Euclidean Distance

Decision on the test

After calculating the distance between the two unique vectors, the nearest training image is returned to the test image assigned as the result of the query. If the subject of the test image and the subject of the training image closest to the given test image are the same, it is said that a correct match has occurred, otherwise it is considered an incorrect match. The above policy will be tested across the following databases and results will be displayed.

Codes

The face recognition system here can extract facial features and compare them with the current database. The face discussed here for comparison is still a face. The project code is in the code.tar.gz folder. The README.txt file contains procedures for grouping and executing the system. This code is written in MATLAB.

Database

The face recognition code created for the two standard databases was tested. A total of about 1200 face images were used for 78 people tested using various variations and configuration variables in the project. The database is described in the next section.

The Yale Face Database B

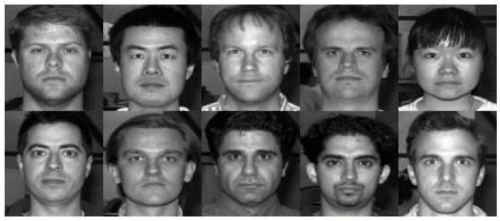


Figure 2: Sample images from Yale Face Database B

The Yale B database used contains 386 initial PGM formats and 856 grayscale faces. [9] The resolution of the image is 168 (width) × 192 (height) pixels. There are 31 themes in the eyeglassed light center, happy, light left, no glasses, nature, light, sad, sleepy, surprised, and wink: 31 themes for pictures, each expression of face and different shape. Sample images, by special arrangement, the file name of the image of the label in this database refer to the situation and lighting details. It is shown in Figure 5. The first part of the filename begins with the primary name "yaleB" followed by a two-digit number followed by a two-digit number to indicate the number object and the situation. The rest of the file name deals with the azimuth and elevation directions for the direction of the individual light sources. Belong to topic 3 in the direction of the light source for the camera axis, for example the image yale B 0 3 P 0 6 A + 0 35 E + 40. Pgm visible situation 6, and the azimuth angle 35 ° (A + 0 35) and the high 40 ° (E + 40) . Here, the positive azimuth indicates that the light source, which means that it was left, was on the right side of the topic, negative. The positive height is above the horizontal line and the negativeness is below the horizontal line. A complete description of the Internet's state and lighting is provided by the database. [10] The obtained image was taken with the camera Sony XC-75 with 8 bit (grayscale) (with linear response function) and stored in PGM raw format.

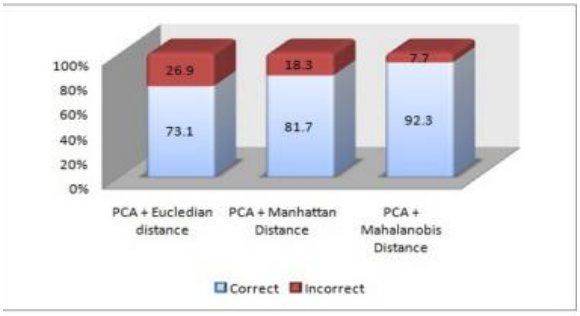
3.2 The AT & T Database of Faces (ORL)

"Face AT & T database" was formerly "face ORL database" [11]. The image consists of 40 different themes and 10 images per subject. In some subjects, the images are taken at different times, the lighting is different depending on facial expressions (open / closed eyes, not smile / smile), face details (eyeglasses / without glasses). All images were captured on a dark homogeneous background with vertical

vertical position (with some tolerance for some lateral motion) subjects. A preview image of the face database can be obtained on the official website. Figure below shows a typical preview of the images of four different topics. The file is in PGM format and can be easily displayed on the LINUX system using the default image viewer. Each image is 92 (width) × 112 (height) pixels, 256 gray levels per pixel. The image is organized into 40 directories (one for each subject) and contains sX format names. Here X is the subject (1 to 40). In each of these directories, there are ten kinds of images of the subject including the name of Y. pgm. Here, Y is the image number (1 to 10) of the subject.

IV. RESULTS

The results of running the codes on the two databases are described below in Figure



The Yale Face Database B

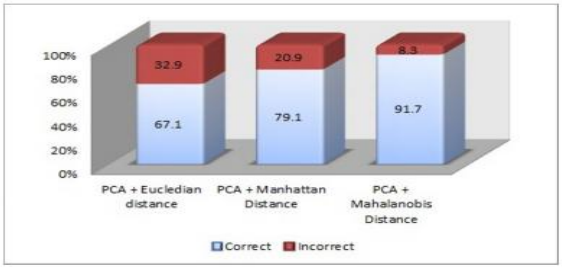
The results of running the codes on the Yale Face Database B are described below in Figure and Tablw

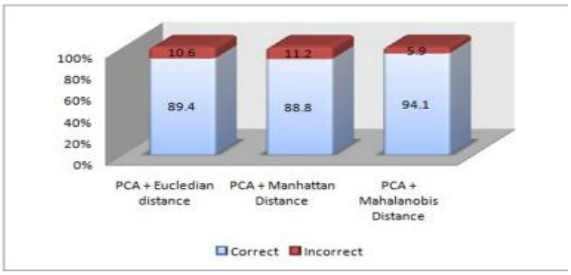
Method Used	Correct	Incorrect	Recognition accuracy
PCA + Eucledian distance	574	282	67.1%
PCA + Manhattan Distance	677	179	79.1%
PCA + Mahalanobis Distance	785	71	91.7%

AT& T Face Database

The results of running the codes on the AT& T Face Database are described below in Figure and Table

Method Used	Correct	Incorrect	Recognition accuracy
PCA + Eucledian distance	286	34	89.4%
PCA + Manhattan Distance	284	36	88.8%
PCA + Mahalanobis Distance	301	19	94.1%





4.1 A Real-time Application: Process time

We measured the system processing time provided. In the windows operating system (10.04) with 2.4 GHz Core 2 duo processor and 4 GB memory, the 1200 image database contains 168 x 192 pixels consisting of 78 subjects under different lightning environments, expressions In other Yale B databases, MATLAB of the proposed system using the Mahalanobis distance is 2 seconds for facial training and 3 seconds for all database images after training, within 0.2 seconds Respond to individual face recognition queries. The system completed the query stream of 900 test images in 3 seconds, taking into account the 3 ms query time slot.

V. CONCLUSION

This face recognition project gave me the opportunity to find out many of the common methods used for face recognition. Detailed literature surveys gave positive and eight negatives from many relevant identification and differentiation systems. In addition, we also learned that by combining two or more Teckins, the accuracy of the system can be greatly improved. In this project we developed a PCA-based face recognition system that extracts features and uses them to match different spatial matrices. The spaces used are Eucledian Distance, Manhattan Distance and Mahalanobis Distance. Results were presented for all three. The results clearly show that recognition systems based on Mahalanobis distance exert better performance than conventional Eucledian-based workbooks. The code runtime is also fast and the response time is less than 0.2 seconds

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