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Face Recognition Using PCA and LDA Algorithm

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Abstract

Security is an important concept in all areas. In computer science, biometrics is used for identification as well as for authentication to provide or control access. Lot of biometric recognitions are available among various biometrics, the face recognition is one of the best approach. For extracting the features of face images the combination of both Linear discriminant analysis and Principal Component Analysis algorithms are used. The ORL database has been used for visible facial images, and CASIA dataset has used for IR facial images. As a result, these combinations of an algorithm provide high recognition rate as well as more security.

Keywords: Linear Discriminant Analysis, Principal Component Analysis

I. INTRODUCTION

Face recognition is used for identifying or verifying the person. Some facial recognition algorithms identify facial features by extracting landmarks, or features, from an image of the subject's face. For example, an algorithm may analyze the relative position, size, and/or shape of the eyes, nose, cheekbones, and jaw.[2] These features are then used to search for other images with matching features.[3] Other algorithms normalize a gallery of face images and then compress the face data, only saving the data in the image that is useful for face recognition. A probe image is then compared with the face data.[4] One of the earliest successful systems[5] is based on template matching techniques[6] applied to a set of salient facial features, providing a sort of compressed face representation. Recognition algorithms can be divided into two main approaches, geometric, which looks at distinguishing features, or photometric, which is a statistical approach that distills an image into values and compares

the values with templates to eliminate variances. Popular recognition algorithms include Principal Component Analysis using eigenfaces, Linear Discriminate Analysis, Elastic Bunch Graph Matching using the Fisherface algorithm, the Hidden Markov model, the Multilinear Subspace Learning using tensor representation, and the neuronal motivated dynamic link matching.

Another emerging trend uses the visual details of the skin, as captured in standard digital or scanned images. This technique, called skin texture analysis, turns the unique lines, patterns, and spots apparent in a person's skin into a mathematical space.[3] Tests have shown that with the addition of skin texture analysis, performance in recognizing faces can increase 20 to 25 percent. [3]

II. VISIBLE AND IR IMAGE FACE RECOGNITION

An Infrared image of a human being's face represents its unique thermal properties which can be used for recognition of his face. The IR images have advantages than visible light images, and used to improve the success rate of techniques used in face recognition of human beings. IR images do not vary in extreme lighting conditions, even if there is complete darkness. These facial images are less affected if there is a change in facial expressions or poses. [12]

Recognition of visible images affects if the illumination conditions varies. Variations in the facial images of one person due to variations in illumination are more than the variations due to change in the identity of a person. Recognition of faces using infrared (IR) images has become an area of growing research. Thermal Infrared images are invariant to changes in illumination, and helps for identification of individuals under different lighting conditions even in complete darkness. [13]

Thermal face recognition helps to identify the faces of persons if there is no control or little control on light conditions. The benefit of using thermal IR imagery on visible imagery is due to the fact, the light in the Infrared range is emitted but not reflected. IR emissions from the skin, independent of illumination, are its intrinsic feature. Thus, thermal IR sensors capture images that does not change when illumination changes. The within-class variations

in IR imagery are also less than in visible light images. The IR range has been found to be more advantageous than the visible range for detection of face, disguised faces, and recognition of face in poor light conditions.

III. RINCIPAL COMPONENT ANALYSIS

Principal Component Analysis (PCA) is a technique of reducing the dimensions, used in compression of data and recognition tasks. It is a Karhunen-Loeve Transformation also known as Eigenspace projection. Kirby and Sirovich[2] used PCA technique for representation of faces and Turk and Pentland[3] extend this technique to recognize the faces. It is a statistical method having applications in fields like image compression and recognizing faces, and is used to find patterns in high dimensional data. In PCA technique, the testing and training images should be of the similar size and normalized also. Then the PCA approach is applied to reveal a low dimensional structure of image by reducing the dimension of the data. By this reduction in dimensions of data only the information which is not useful is removed and it the structure of face into orthogonal (uncorrelated) components, which are not correlated. These components are known as Eigen faces [9].

In this subspace, each face image may be described and represented as a weighted sum of the orthogonal components. The weighted sum is known as a feature vector and each facial image is stored in a 1D array. A testing image is compared with images in database by calculating the distance between their feature vectors. In PCA approach, there is a requirement of the full frontal face image otherwise it gives poor performance. The feature of this technique is that it is able to reduce the data to 1/1000th of data presented needed to identify the individual. The central idea PCA is the dimensionality of data, which consists of large number of interrelated variables and retains maximum variation in the data set, as much as possible. It is the used if a strong correlation exists between the variables. The basis vectors represent the direction in which maximum variation exists in training vectors and are known as eigenvectors, Each vector can be considered as a feature. These vectors are also termed as eigenfaces. The possibility of eigenfaces' number is equal to the images' number in the training set. But it is not feasible to consider all the eigenfaces, so a face can also be represented as the approximation of the best eigenfaces according to the large value of eigenvalues, and these eigenvalues represents the maximum variation in the set of face

images. Then the eigen vectors are sorted in decreasing order of their corresponding eigen values. The eigenvector having largest eigen value represents the maximum variation in the image.

The first Eigen image is the mean image, and the remaining eigen images represents the variations in images from this mean image. The image of a face is projected onto the face space. In the face space, the face is expressed by coefficients of its eigenface. A facial image of having large input vector is computed by using its small weight vector. Original face can be reconstructed having small error, because the the images that need to be compared and other for the images to whom the images will compared namely ,testing set and training set. The training database contains images of 40 persons, having 9 facial images with different expressions of a single person. That is, the training database consists of 360 images. First of all, training of the recognition system is done by selecting the training database, in which there are 40 folders, corresponding to 40 different individuals. Each folder contains 9 facial images with different expressions or poses, of the same person. The database is selected for training, features are extracted and saved and training time is dimensions of the image space are very large as compared to the face space.

IV. LINEAR DISCRIMINANT ANALYSIS

Linear Discriminant Analysis (LDA) is a classification technique used successfully in many pattern recognition problems statistically. It was developed by Ronald Fisher, who was a professor of statistics at University College London, and the technique also called Fisher Discriminant Analysis (FDA). The idea behind LDA is to separate the input samples belonging to different groups. This technique attempts to increase the ratio of the matrix determinant of the between class scatter to the matrix determinant of the within class scatter. Fisher discriminant combines images belonging to the similar class and differentiates images belonging to different classes. Then the images are projected from 2-D space to D dimensional space, where D is equal to different classes of input images.

V. METHODOLOGY

The main challenge in the problem of face recognition system is the variation within the class (intra-class) due to changes in facial expressions, pose, variation in illumination,

which sometimes exceed variation between the classes(inter-class).In other words, different persons looks almost similar in the same pose and one person appears different when viewed in different poses. Similarly, different persons appear almost similar in the same illumination and the same person appears different in different illuminations. Collect a dataset of images, Visible as well as IR images. For each dataset, Form a mean image of dataset, which will be used for making a database. After forming the mean image, next is to apply PCA technique to extract the eigen features and on concept of that, eigenfaces will be formed. On these eigen based images, LDA concept will be applied, which will help to reduce the complexity of feature detection. These features are saved as the database for classification process. Next, same steps will be followed for extracting the features from testing image with different variations. The extracted features are then subtracted from database features A threshold difference is defined to match the faces. Image is recognized as the one which gives the difference less than or equal to the threshold value.

Testing images are compared with the images of training database, to find out how many probe images are matched with the gallery images. Testing or Recognition tine and the recognition rate are calculated.

TABLE 1

S.No.	**System**	**% Recognition Rate**	**Training Time Per Model**	**Testing Time Per Model**
1.	PCA	83	6.52 Sec	2.73sec
2.	LDA	83	7.44 Sec	3.12 Sec
3.	Propose	92.5	39.2 Sec	2.3 Sec

	d Method			

The same procedure is followed on Near Infrared (NIR) Images, and the results are:

TABLE 2

% Recognition Rate	Training Time	Testing Time
97%	39.2 sec	2.3 sec

VII. CONCLUSION

Combining both PCA and LDA techniques will provide strong identity and we will get improved results when compared to other algorithms. The recognition rate for this biometric type will be 97%.

For future work we are trying to combine more than one biometrics for recognition it will provide more security.

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