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FEATURE EXTRACTION USING TIPCA TECHNIQUE ALONG WITH THE COMBINATION OF K-NN CLASSIFIER

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ABSTRACT

Face Recognition has becoming the most challenging and interesting area in all applications. It is one of the best biometric techniques. Feature Extraction is the major problem in face recognition. Researchers developed many best feature extraction techniques. The existing papers have followed SVM and KNN Algorithms. But since it requires more classification accuracy of the image, this paper shows how the Transform Invariant PCA technique provides better accuracy when used with K-Nearest Neighbor classifier. The experimental result shows the comparative analysis of the TIPCA algorithm with the combination of the KNN classifier algorithm.

Keywords: feature extraction, principal component analysis (PCA), support vector machine (SVM), face recognition.

INTRODUCTION

In today's world security becomes the most important issue in every application. Security based new technologies were being introduced every day. But still hackers find a small loop and make fraud lent attacks such as credit card scam, password hacking, finger print scams etc. Due to these holes in technology it becomes an advantage for the hacker. Biometrics helps to overcome the problems stated above. Based on behavioural and physiological characteristics, Biometrics automatically verifies a person's identity[1]. There are many types of biometric system and one of them is Face recognition. It is one of the best biometric technique when compare to other techniques like password access, PIN verification, finger print method and retina scan [2]. Face recognition technology is an ongoing process since 1960's.Even though there are many security techniques but sometimes in some situation it fails. The survey said that in 2010 a New Zealand hacker and computer security expert named Barnaby Jack proves that the security is becoming very weak in his Black Hat Security Conference. In that presentation he exploited two ATM machines to make them dispense cash without withdrawing from bank account [3]. The author did it by remote administration access, and the use of default passwords. He demonstrates this jackpotting the ATM cash lively. This is the best example for Password/PIN access scams.

Face Recognition helps to overcome these types of hacking methods. Statistics says that this face recognition system will be more useful in Law Enforcement and Justice Surveillance, governments sectors nowadays. It helps them in the way of investigation of crimes, identifying criminals in child abuse cases, etc [4]. Face Recognition System also mainly used in airports [2] so that if any terrorists wants to tampering the places. This shows the identification of known terrorists. Face Recognition is accurate and allows for high verification. It never requires any interaction with user [1]. Face recognition technology is the least invasive and fastest biometric technology.

WORKING OF FACE RECOGNITION

Face Recognition simply recognize a human face from a database and verifies whether the given face matches or not.

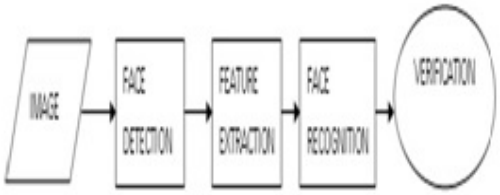

Figure-1. Flow structure of face recognition.

It analyzes the characteristics of a human face through digital sources. It measures the overall facial features like the distance between the eyes, nose, mouth, and edges of jaw[5]. Approximately every human has 80 nodal points in their face. Nodal points are used to measure the variables of human face.

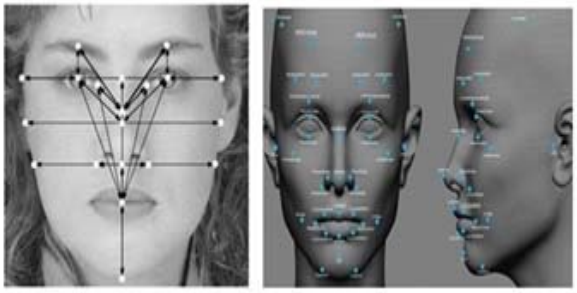

Figure-2. Nodal points in human face.

Over the past few decades many feature extraction algorithms and classifiers have been developed.[6] Most used techniques for feature extraction are PCA, Eigen face method, linear discriminant analysis (LDA).In this paper we review the TIPCA technique along with K-Nearest Neighbour classifier to obtain better classification accuracy. Compare to previous feature

extraction techniques this algorithm helps to overcome the issues in accuracy rate.

FEATURE EXTRACTION

Feature Extraction is one of the processes in face recognition. Once the detection process has completed, the next step is to extract the features from the face. Feature Extraction helps to reduce the dimensions of the image. In the given set of features we have to transform the input image. It helps to remove the noise over the images. This technique also enhances the system in various poses, illuminations and lighting conditions. Feature Extraction is classified into two processes namely analytic and holistic methods. The analytic methods measure the geometric features of the face such as eyes, nose, mouth, and the relationship with each other. The holistic method is used to analyze the global properties of the face. It directly operates on intensity of the pixel array representation of faces[7].

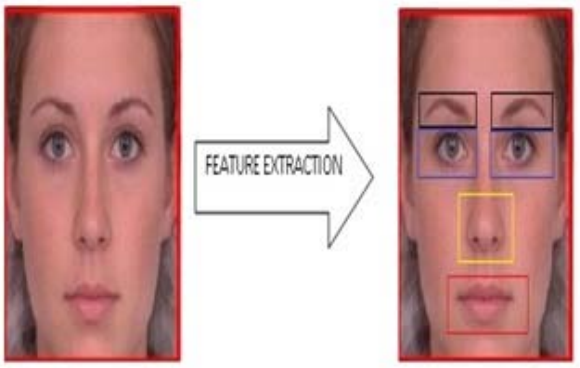

Figure-3. Example for face feature extraction.

EXPERIMENTAL METHODS

In this paper the method used is TIPCA algorithm for feature extraction.

TIPCA – A Review

TIPCA technique is used to accurately characterize the intrinsic structure of the human face[13]. To minimize the mean square error between the aligned image and their reconstructions it aligns the image ensemble and creates an optimal Eigen space.[13] The main advantage of using TIPCA algorithm is, it automatically learns the Eigen face bases. The first phase of TIPCA technique is aligning the images and second phase is to extract the features from the faces in the training set. And finally recognition has to be done.We apply TIPCA in the database to get the feature vector using the following method[14].

Suppose there are N patterns and each pattern has I training images of p x q structure.

- The database should be arranged in the matrix form where each column will represent an image.
- Compute covariance matrix with the help of Eigen values and Eigen Vectors.
- Sort the Eigen vectors.
- Extract the Eigen values.
- Then compute Feature vector for each image.

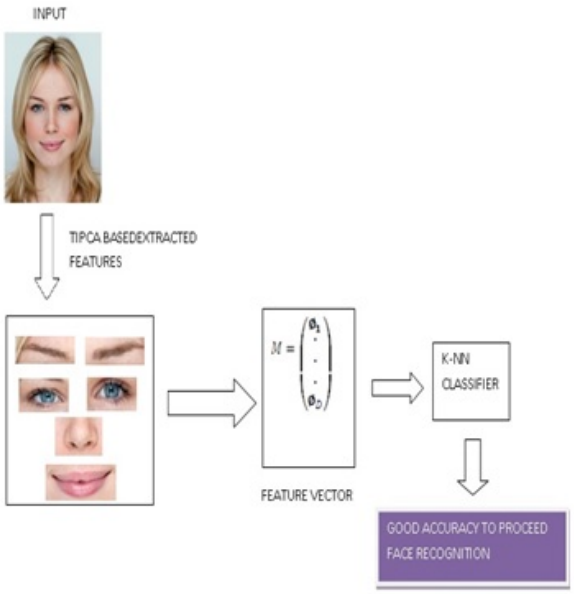

Figure-4. Working of TIPCA with K-NN.

TIPCA based image alignment

First step is to learn the eigenfaces. Here the image dimension should be compressed and reconstructed [13].

$$I = \mu + \sum_{j=1}^{m} a_j \varphi_j + e$$

μ is the average for the image, $\emptyset_1, \ldots, \emptyset_m$ are the sequenced images derived from ensemble training images. e represents the noise components[13].In training images the mean square error between input and their reconstructions should be reduced.

$$\arg\min \frac{1}{N} \sum_{i=1}^{N} \left(\min \left\| I^i - \mu + \sum_{j=1}^{m} a^i \varphi_j \right\| \right)$$

Then the transformed image should be represented in linear form as

$$I(W(x); P)) = \mu(x) + \sum_{j=1}^{m} a_j \varphi_j(x) + e(x)$$

After representing the parameters, the transform-invariant eigenfaces are learned based on a modified principle that minimizes the mean square error between transformed patterns and their reconstructions.

$$\arg\min_{\mu, \varphi_j, P} \sum_{i=1}^{N} \{ \min_{p^i, a^i} \sum_{x} [e^i(x)]^2 \}$$

$$where\ e^i(x) = I^i\left(W(x;p^i)\right) - \left[\mu(x) + \sum_{j=1}^{m} a_j^i \varphi_j(x)\right]$$

TIPCA performs the gradient optimization on the transform parameters and the coding parameters. Transform parameters are represented by p_i and the coding parameters are represented by a_i.[13]

$$J(x) = \left[\nabla\varphi \frac{\partial W}{\partial p_1^i}, \ldots, \nabla\varphi \frac{\partial W}{\partial p_k^i}, \varphi_1(x), \ldots, \varphi_d(x)\right]$$

Next TIPCA should increase the parameters of the image.

$$\Delta q = -\left[\sum_x J^T(x)J(x)\right]^{-1} \sum_x J^T(x)e^i(x)$$

TIPCA based feature extraction

Feature Extraction encodes the image by identifying the most expressive features in the face. The Eigen vectors are denoted by $\varphi_1, \ldots, \varphi_d$.Small Eigen values are assumed to reduce the noise from the face. In order to achieve the transform invariant property, feature extraction should be done in two phases [13].

1) Align the image by selecting the dimension m.
2) Apply the aligned image to the leading dimensions d.

$$a_i = \sum_x \varphi_i^T(x)\left[I\left(W(x;p)\right) - \mu(x)\right], \quad i = 1, \ldots, d$$

K-NN CLASSIFIER TECHNIQUE

Applying K-NN classifier approach after feature extraction

K-Nearest Neighbor algorithm is used for classification in face recognition[15].It helps to reduce the dimension of the trained image after applying the algorithm. This will give a better result in accuracy rate, variations and poses. It chooses the nearest value from the image for classification[16]. This algorithm stores the available case values and then classifies new cases.

Algorithm to improve accuracy

1. Along with the new sample a positive integer N should be specified.
2. Select the K entries in the database which are closest to the new sample
3. Find the most classification of these entries by specifying the value as
   a) If K=1, then select the nearest neighbor pixel.
   b)If K > 1, then select the most frequent neighbor.
4. Using the Euclidean formula we have to find the distance:

$$D = \sqrt{\sum_{i=1}^{k} [(a_i - b_i)^2]}$$

RESULTS AND DISCUSSION

The below mentioned graph represents the accuracy of the existing system. With the nearest neighbor classifier the overall classification accuracy is 62%..Linear, Polyomial, Sigmoid and the Radial basis functions are the four different function used for SVM classifier. The performance when used with SVM classifier is around 65%.But when we test the illumination the accuracy with K-NN classifier is 65% and SVM is 68%.And the results when tested with variations of expressions are around 59% and 62%.The comparison results were shown in the table and the graph below.

Table-1. Comparison between KNN and SVM.

KNN	SVM
62	65
65	68
59	62

From Table-1, We have shown that the comparison between KNN and SVM classifiers accuracy when used with various feature extraction algorithms.

This algorithm when combined with the TIPCA provides best performance in terms of accuracy as mentioned below in the tables and graph.

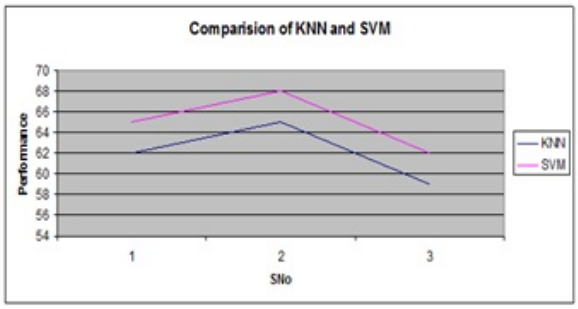

Figure-5. Experimental results for the comparison between SVM and KNN Classifiers.

Table-2. Summary of classification Accuracy when KNN is used with TIPCA algorithm.

KNN	SVM	TIPCA	TIPCA+KNN
62	65	66	70
65	68	69	72
59	62	63	67

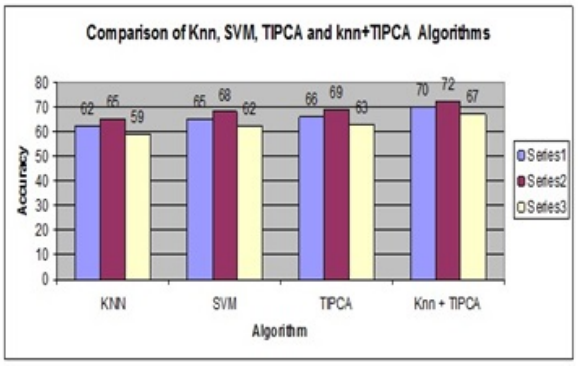

Figure-6. Experimental results for improvement in the accuracy when TIPCA is used with KNN classifier.

From this, the paper has chosen the k-nn algorithm and integrated with the TIPCA algorithm to enhance the effectiveness of the face recognition. K-NN algorithm creates neighbours and TIPCA performs best in extraction. Combination of these algorithms provides more accurate results as mentioned above.

CONCLUSIONS

In facial recognition systems, classification algorithms play a vital role to accurate the results. It assigns the sample to the class, which is nearest neighbour for that test sample. The accuracy is completely based on the training set used by the classification algorithm. The SVM and KNN algorithm were able to provide a nominal accuracy value. This paper discussed about TIPCA algorithm for extraction process and K-NN algorithm for classification of the test sample and provides comparative results of all these algorithms. The combination of this algorithm can helps to identify the face more accurate than any other algorithms.

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