

Kunal kawale  
Computer Engineering Department  
KJCOEMR  
Pune, India

Chinmay Gadgil  
Computer Engineering Department  
KJCOEMR  
Pune, India

Mohanish Khunte  
Computer Engineering Department  
KJCOEMR  
Pune, India

Ajinkya Bhuruk  
Computer Engineering Department  
KJCOEMR  
Pune, India

Prof. Ranjana M.Kedar  
Computer Engineering Department  
KJCOEMR  
Pune, India

## Face Recognition using Laplacianfaces

### Abstract

Security of a system is an important issue considered in 21<sup>st</sup> century. Face Recognition is proven to be the best tool considering the security aspect. A system can recognize and catch criminals and terrorists in a huge crowd, but some contend that it is an extreme invasion of privacy. The proposed system is an appearance-based face recognition system known as “*Laplacianface face recognition system*”. In this method, using Locality Preserving Projections (LPP), the face images are mapped into a face subspace for analysis.

**Keywords :** *Security, Laplacianface, Locality Preserving Projections, Face Recognition*

## 1. INTRODUCTION

Various techniques are present for the face recognition. The reliable technique among present techniques is appearance-based technique. In appearance based technique, "MATRIX" is considered. The Method represents an image of size  $n \times m$  pixels by a vector in an  $n \times m$  dimensional space. There are two techniques used for this purpose 1) Principal Component Analysis (PCA) 2) Linear Discriminant Analysis (LDA).

The Principal Component Analysis (PCA) is the technique that is used in an image recognition process and compression process. It is an eigenvector method. It is used to describe face images in terms of a set of basic functions, or eigenfaces.

The Linear Discriminant Analysis (LDA) is a powerful face recognition technique that overcomes the limitation of Principle component analysis technique by applying the linear discriminant criterion. It is a supervised learning algorithm. Discriminant Analysis is used for the classification purpose where images are projected from two dimensional spaces to 'n' dimensional spaces where n is number of classes of images.

## 2. LITERAURE SURVEY

Biometric-based techniques have emerged as the most promising option for recognizing individuals in recent years since, instead of authenticating people and granting them access to physical and virtual domains based on passwords, PINs, smart cards, plastic cards, tokens, keys and so forth, these methods examine an individual's physiological and/or behavioral characteristics in order to determine and/or ascertain his identity. Passwords and PINs are hard to remember and can be stolen or guessed; cards, tokens, keys and the like can be misplaced, forgotten, purloined or duplicated; magnetic cards can become corrupted and unreadable. However, an individual's biological traits cannot be misplaced, forgotten, stolen or forged.

Face recognition is used for two primary tasks:

- Verification (one-to-one matching): When presented with a face image of an unknown individual along with a claim of identity, ascertaining whether the individual is who he/she claims to be.
- Identification (one-to-many matching): Given an image of an unknown individual, determining that person's identity by comparing (possibly after encoding) that image with a database of (possibly encoded) images of known individuals.

Face recognition is a specific and hard case of object recognition. The difficulty of this problem stems from the fact that in their most common form (i.e., the frontal view) faces appear to be roughly alike and the differences between them are quite subtle. Consequently, frontal face images form a very dense cluster in image space which makes it virtually

impossible for traditional pattern recognition techniques to accurately discriminate among them with a high degree of success

### 3. BRIEF DESCRIPTION

In daily life, security plays a vital role. Face Recognition system is a reliable solution and easiest method to implement. The proposed face recognition system uses Locality Preserving Projection (LPP) algorithm by which each face image in the image space is mapped to a low dimensional face subspace. For implementing the system “MANIFLOD STRUCTURE” can be considered.

**Manifold structure:** - For learning Manifold, LPP is the best method used. Before LPP method, generally for face recognition system PCA method was used. The structure used in PCA method is known as *Euclidian Structure*.

Manifold structure deals with constructing a graph. It constructs the graph considering the neighborhood points which is used in the algorithm of proposed face recognition system.

The paper discusses proposed system which provide a reliable way of recognizing the faces from given database. It is the expert system which is based on the Laplacianfaces algorithm. The algorithm includes 4 steps.

The algorithm for face recognition system is as follows:

#### 3.1 PCA Projections:

PCA is an eigenvector method designed to model linear variation in high-dimensional data. PCA performs dimensionality reduction by projecting the original  $n$ -dimensional data onto the  $k$  ( $\ll n$ )- dimensional linear subspace spanned by the leading eigenvectors of the data's covariance matrix. Its goal is to find a set of mutually orthogonal basis functions that capture the directions of maximum variance in the data and for which the coefficients are pair wise de-correlated. For linearly embedded manifolds, PCA is guaranteed to discover the dimensionality of the manifold and produces a compact representation. Turk and Pentland use Principal Component Analysis to describe face images in terms of a set of basis functions, or “eigenfaces”.

Project the image set  $\{x_i\}$  into the PCA subspace by throwing away the smallest principal components. For getting Laplacianfaces the matrix of PCA is used, which will be useful for the mathematical calculation. The matrix is denoted as  $W_{pca}$ .

#### 3.2 Construction Of Nearest Neighbor Graph:

Let  $M$  denotes a graph with  $k$  nodes. Consider  $i^{\text{th}}$  node corresponds to the face image  $X_i$ .  $X_i$  and  $X_j$  are sets of face images respectively. Now draw the edge between nodes  $i$  and  $j$ , If  $X_i$  and  $X_j$  are close then the neighbor graph is nothing but the approximation of local manifold structure. Though it increases the complexity of an algorithm but it is still better.

### 3.3 Elect The Weights:

If nodes  $i$  and  $j$  are connected together for constructing neighborhood graph then,

$$S_{ij} = e^{-\|x_i - x_j\| / t}$$

Where,

$S_{ij}$ - Source Matrix or required matrix.

$X_i$  and  $X_j$ - Set of face images.

$t$ - Suitable Constant

$S_{ij} = 0$ , if  $i$  and  $j$  are not connected with each other.

### 3.4 Eigenmap computation:

Computation of eigen values and eigenvector is must for the final Laplacian Matrix.

$$XLX^T W = \lambda XDX^T W$$

Where,

$L = D - S$  and is a Laplacian Matrix.

$D$ - Diagonal Matrix.

$T$ - Transform Matrix

Let  $w_0, w_1, \dots, w_{k-1}$  be the solutions of equation (1), ordered according to their eigen values,

$0 \leq \lambda_0 \leq \lambda_1 \leq \dots \leq \lambda_{k-1}$ . These eigen values are equal to or greater than zero, because the matrices  $XLX^T$  and  $XDX^T$  are both symmetric and positive semi-definite. Thus, the embedding is as follows:

$$x \rightarrow y = WT x$$

$$W = W_{PCA} W_{LPP}$$

$$W_{LPP} = [w_0, w_1, \dots, w_{k-1}]$$

## 4. IMPLEMENTATION

The proposed face recognition system will be implemented using java. For the implementation purpose four modules are:

- Read and Write Image.
- Resizing Of Images.

- Implementation of Laplacianfaces.
- Recognition Module.

For recognizing purpose, the image is given as an input to the system. The Graphic user interface of system should contain three frames one for an input of image, second for the image which is to be compared and third is for the result of the comparison of two images, which is output. After taking certain image as an input, resizing module is used for resizing the image. As the face of an image is the only part on which the system concentrates than the other image parts after the resizing module, implementation and recognition module is used.

As the system uses java it is platform independent. It can be used on any operating system. Install Java Developer Kit in the system, a short requirement of the system. The system works on five main logics, PCA, LPP, Manifold structure, Construction of Neighborhood graph, and Eigenmap computation. PCA projection method is used for getting PCA matrix. For learning Locality projections and manifold learning of LPP is necessary. For constructing a neighbour graph, study of manifold is required and for computing Laplacian matrix, mathematical model is used which is the constructed neighborhood graph and eigenmap computation.

## 5. CONCLUSION

**“Face Recognition system using Laplacianfaces”** fulfills the need of security. This Recognition system ensures the safety of the nation.

## 6. ACKNOWLEDGEMENT

First and foremost, we would like to thank our guide Prof. Ranjana M. Kedar, for her guidance and support. We will forever remain grateful for the constant support and guidance extended by guide, for completion of project report. Through our many discussions, she helped us to form and solidify ideas. The valuable discussions we had with her, the penetrating questions she has put and the constant motivation, has all led to the development of this project. We are also thankful to our family members for their encouragement and support in this project work.

## REFERENCES

- [1] M. Belkin and P. Niyogi, “Laplacian Eigenmaps and Spectral Techniques for Embedding and Clustering”, Advances in neural information processing system 15, Vancouver, British Columbia, Canada, 2001.
- [2] M. Belkin and P. Niyogi, “Using Manifold Structure for Partially Labeled Classification”, Advances in neural information processing system 15, Vancouver, British Columbia, Canada, 2002.
- [3] M. Brand, “Charting a Manifold”, Advances in Neural Information Processing Systems, Vancouver, Canada, 2002.
- [4] Y. Chang, C. Hu and M. Turk, “Manifold of Facial Expression”, *Proc. IEEE International Workshop on Analysis and Modeling of Faces and Gestures*, Nice, France, Oct 2003.