# ARCHITECTURE TO MAXIMIZE PREDICTIVE ACCURACY OF FACE RECOGNITION SYSTEMS USING SVM

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***Abstract:*** **Security system are basically part of security issues related to our work environment, it is mandatory. Some of the well-known application areas of face recognition are Biometric, Information security, Law Enforcement and Surveillance, Smart Cards, Access Control. Support Vector Machine (SVM) is a classification and regression prediction tool that uses machine learning theory to maximize predictive accuracy while automatically avoiding over-fit to the data. Support Vector machines can be defined as systems which use hypothesis space of a linear functions in a high dimensional feature space, trained with a learning algorithm from optimization theory that implements a learning bias derived from statistical learning theory. It is also being used for many applications, such as hand writing analysis, face analysis and so forth, especially for pattern classification and regression based applications.**

***Keywords*** **- Face recognition, Principal Components Analysis (PCA), Support Vector Machine (SVM), Gabor features, Linear Discriminant Analysis, Classification, and Regression.**

## I. INTRODUCTION

Face recognition has become an important issue in many applications such as security systems, credit card verification and criminal identification. For example, the ability to model a particular face and distinguish it from a large number of stored face models would make it possible to vastly improve criminal identification. Even the ability to merely detect faces, as opposed to recognizing them, can be important.Face recognition is one of the well-known problems in the field of image processing. In face recognition problem, a given face is compared with the faces stored in a face database in order to identify the person, who have the given face. The purpose is to find a face in the database, which has the highest similarity with the given face.

Face recognition is one of the most relevant applications of image analysis. Face recognition is a relevant subject in pattern recognition, neural networks, computer graphics, image processing and psychology [9].Their methods were based on the Principal Component Analysis. Their goal was to represent an image in a lower dimension without losing much information, and then reconstructing it.The most evident face features were used in the beginning of face recognition. It was a sensible approach to mimic human face recognition ability. There was an effort to try to measure the importance of certain intuitive features (mouth, eyes, and cheeks) and geometric measures (between-eye distance, width-length ratio).

## II.MOTIVATION BEHIND THE WORK

The security of information and physical property has been one of the problems of modern days. Face recognition approaches to identification and verification of applications. The human ability to recognize faces is remarkable. We can recognize thousands of faces learned throughout our lifetime and identify familiar faces at a glance even after years of separation. Unfortunately, developing a computational model of face recognition is quite difficult, because faces are complex, multidimensional, and meaningful visual stimuli. A face recognition system trained on a particular set of faces may fail to recognize a slightly modified face. But the increasing need for surveillance-related applications, especially due to drug traffic and terrorist activities, has a great impact on the growth of interest in the field of face recognition. That is why we decided to make a face recognition system. Face recognition has become an interesting problem due to its increasingly large areas of applications.

## III. PROBLEM STATEMENT

Aim of this paper is to recognizing face images using the Gabor filter concept (used to detect the feature of the face image) and Support Vector Machine (used for prediction or learning) which is supervised learning method used for classification and regression.

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 much harder to get a representative sample of those which do not.

## IV. PROPOSED SOLUTION TO THE PROBLEM

We avoid the problem of using a huge training set for non-faces by SVM. This “bootstrap” method reduces the size of the training set needed. Corresponding to neural network training is relatively easy in SVM. There is no local optimal problem in SPM like in the neural network. SVM scales relatively well to high dimensional data and the trade-off between classifier complexity and error can be controlled explicitly.

In the proposed approach a first step of extracting essential features of the face detection is performed by applying the Gabor's representation on the image database. The advantage of this representation is that it allows us better spatial-frequency features localization. For the separation of features obtained by the Gabor filter bank, we use an SVM classifier. The features extraction step consists in transforming the input raw data into meaningful information. Thus, we obtain a reduction of the decision space which may accelerate the processing time. The Gabor filters provide a simultaneous representation in spatial and frequency domain. This representation is an optimal tool used for the purpose of local features extraction. It is efficient because it produces the same operating principle of simple cells in visual cortex of the mammal’s brain and also properties in multi-directions, optimal for measuring local spatial frequencies. Based on these advantages, the Gabor representation is widely used in applications of image analysis and applications of face recognition [4], [5] and extraction of features such as facial expressions.

In this solution we are using two most important techniques i.e. first approach is feature selection and second based on feature extraction. For these two techniques we are using two best suited approaches named as Gabor filter as play role of essential feature selection. And Support Vector Machine as play ideal task of feature extraction on the basis of supervised learning.

## V. WORKING ARCHITECTURE OF FACE RECOGNITION SYSTEM

In this paper,architecture is presented which provides a well-defined framework. And the components of architecture are: Acquisition databases,Normalization,Feature detection using Gabor filter,Templates Generation using SVM,Training of image using supervised learning,testing of image using template matching.

Face recognition system broadly based on two comparisons:

**1. Verification:**

This is where the system compares the given individual with who that individual says they are and gives a yes or no decision.

**2. Identification:**

This is where the system compares the given individual to all the other individuals in the database and gives a ranked list of matches.

The architecture diagram of face recognition system is shown in Figure 5.1 which consists following phases to perform the task:

- **Acquisition databases:** In this phase focus on data acquisition i.e. image of face through the device databases.The input can be recorded video of the speaker or a still image.More than one camera can be used to produce a 3D representation of the face and to protect against the usage of photographs to gain unauthorized access.
- **Normalization:** Removing the background (i.e. unused data) from image. This is also known as pre-processing of face image.Some facialrecognition approaches use the whole face while others concentrate on facial components and/or regions(such as lips,eyes etc.).
- **Feature detection using Gabor filter:** This phase is basically used for the feature selection using Gabor filter (New approach for human feature identification using holistic grey-level information). The appearance of the face can change considerably during speech and due to facial expressions.
- **Templates Generation using SVM:** In this template generation feature extraction play important role. Unique data is extracted from the sample and a template is then created.
- **Training of image using supervised learning:** In training phase the BioID creates a prototype called face print for each person.A newly recorded pattern is pre-processed and compared with each face print stored in the database.

NOTE:The BioID Face Database dataset consists of 1521 gray level images with a resolution of 384x286 pixel. Each one shows the frontal view of a face of one out of 23 different test persons. For comparison purposes, the set also contains manually set eye positions.

- **Testing of image using template matching:** The template is then compared with a new sample.As comparisons are made,the system assigns a value to the comparison using a scale of one to ten.If a score is above a predefined threshold,a match is declared.
- **Identification of image:**The system decides the features extracted from the new samples are a match or a non-match.

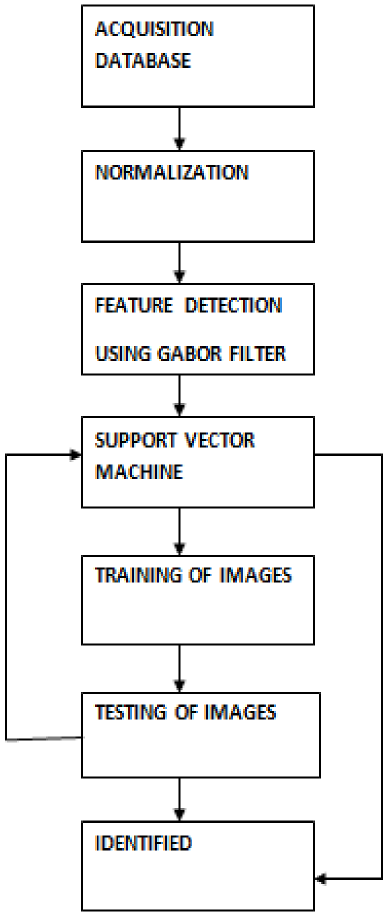


**Figure 5.1: Architecture diagram of face recognition system using SVM**

## VI.FACE RECOGNITION TECHNIQUES

There are various techniques available for the face detection. Some of techniques are artificial neural network, support vector machine (SVM) etc. SVM (Support vector machine) has a better empirical performance and uses structural risk minimization while convention neural network technique uses empirical risk minimization. SVMs were developed to solve the classification problem, but recently they have been extended to solve regression problems. There are various methods are available to reduce the dimensionality of images discuss below:

### A. FACE RECOGNITION CAN BE CLASSIFIED INTO TWO DIFFERENT CLASSES

1. Feature Based (Geometric)
2. Template Based (Photometric)

### 1. FEATURE BASED TECHNIQUES

#### 1.1 Principal Components Analysis (PCA)

PCA, commonly referred to as the use of eigenfaces, is the technique pioneered by Kirby and Sirivich in 1988. With PCA, the probe and gallery images must be the same size and must first be normalized to line up the eyes and mouth of the subjects within the images. The PCA approach is then used to reduce the dimension of the data by means of data compression basics and reveals the most effective low dimensional structure of facial patterns. This reduction in dimensions removes information that is not useful and precisely decomposes the face structure into orthogonal (uncorrelated) components known as eigenfaces. Each face image may be represented as a weighted sum (feature vector) of the eigenfaces, which are stored in a 1D array.

The PCA approach typically requires the full frontal face to be presented each time; otherwise the image results in poor performance. The primary advantage of this technique is that it can reduce the data needed to identify the individual to 1/1000th of the data presented.

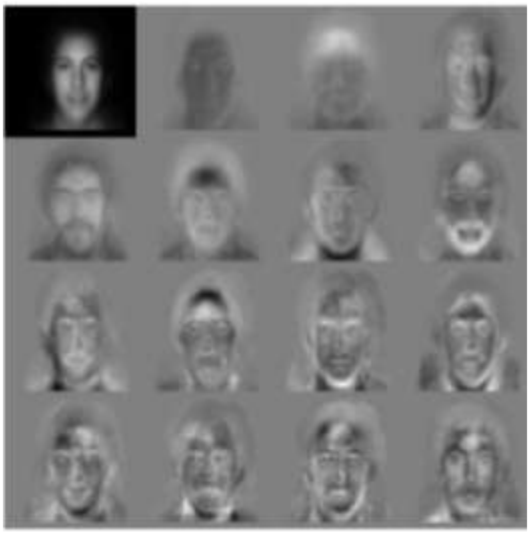

**Figure 1.1: standard eigenface: feature vector are derived using eigenfaces**

### 1.2 LDA (Linear Discriminant Analysis)

LDA is a statistical approach for classifying samples of unknown classes based on training samples with known classes. This technique aims to maximize between-class (i.e., across users) variance and minimize within-class (i.e., within user) variance. In Figure below where each block represents a class, there are large variances between classes, but little variance within classes. When dealing with high dimensional face data, this technique faces the small sample size problem that arises where there are a small number of available training samples compared to the dimensionality of the sample space.

**Figure1.2: Example of Six Classes Using LDA**

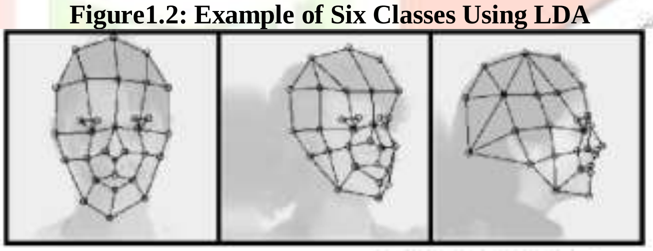

**Figure 1.2: Elastic Bunch Map Graphing**

- **Gabor filter**

This is a new approach for human feature identification using holistic grey-level information. We employ Log-Gabor wavelets to extract the phase information, i.e. feature-codes, from the 1D gray-level signals. Thus each feature is represented by a unique feature code or (phase template). The query feature images (ear, nose, mouth, eye and etc) are compared with those in the database using Hamming distance. The minimum Hamming distance obtained from the rotation of feature template is used to authenticate the user. Our project on two different public features databases achieve promising results and suggest its utility in feature-based authentication.

- **Log Gabor Filter**

Face recognition method based on Principal Component Analysis (PCA) and Log-Gabor filters. The main advantages of the proposed method are its simple implementation, training, and very high recognition accuracy. For recognition we used 5151 face images of 1311 persons from different sets of the FERET and AR databases that allow analyzing how recognition accuracy is affected by the change of facial expressions, illumination, and aging.

- **Discrete Wavelet Transform**

Discrete wavelet transform (DWT) is a well-known signal analysis tool, widely used in feature extraction, compression and de-noising applications. In Discrete Wavelet Transform, the most prominent information in the signal appears in high amplitudes and the less prominent information appears in very low amplitudes. The wavelet transforms enables high compression ratios with good quality of reconstruction. The Discrete Wavelet Transform (DWT), which is based on sub-band coding, is found to yield a fast computation of Wavelet Transform. The one dimensional wavelet decomposition is first applied along the rows of the images, and then their results are further decomposed along the columns.

Machine Learning is considered as a subfield of Artificial Intelligence and it is concerned with the development of techniques and methods which enable the computer to learn. In simple terms development of algorithms which enable the machine to learn and perform tasks and activities. Machine learning overlaps with statistics in many ways. Over the period of time many techniques and methodologies were developed for machine learning tasks.

## 2. TEMPLATES BASED (PHOTOMETRIC)

### 2.1 Support Vector Machine

Support vector machines (SVMs) are a set of related supervised learning methods used for classification and regression. They belong to a family of generalized linear classifiers. In another terms, Support Vector Machine (SVM) is a classification and regression prediction tool that uses machine learning theory to maximize predictive accuracy while automatically avoiding over-fit to the data. Support Vector machines can be defined as systems which use hypothesis space of a linear functions in a high dimensional feature space, trained with a learning algorithm from optimization theory that implements a learning bias derived from statistical learning theory. SVM becomes famous when, using pixel maps as input; it gives accuracy comparable to sophisticated neural networks with elaborated features in a handwriting recognition task.

SVMs are linear classifiers that maximize the margin between the decision hyperplane and the examples in the training set. So, an optimal hyperplane should minimize the classification error of the unseen test patterns. This classifier was first applied to face detection. It is also being used for many applications, such as hand writing analysis, face analysis and so forth, especially for pattern classification and regression based applications.

### 2.2. Neural Network

A neural network is first and foremost a graph, with patterns represented in terms of numerical values attached to the nodes of the graph and transformations between patterns achieved via simple message-passing algorithms. Certain of the nodes in the graph are generally distinguished as being input nodes or output nodes, and the graph as a whole can be viewed as a representation of a multivariate function linking inputs to outputs. Numerical values (weights) are attached to the links of the graph, parameterizing the input/output function and allowing it to be adjusted via a learning algorithm.

A neural network (NN), is a mathematical model or computational model that is inspired by the structure and/or functional aspects of biological neural networks. A neural network consists of an interconnected group of artificial neurons, and it processes information using a connectionist approach to computation. Neural networks have found a wide range of applications, the majority of which are associated with problems in pattern recognition and control theory.

## VII. CONCLUSION AND FUTURE WORK

Some of important conclusion of this paper is shows that SVM gives the best global minimum marginal prediction of solutions. SVM are based on statistical learning theory. They can be used for learning to predict future data [10]. SVM are trained by solving a constrained quadratic optimization problem. SVM, implements mapping of inputs onto a high dimensional space using a set of nonlinear basis functions. SVM can be used to learn a variety of representations, such as neural nets, splines, polynomial estimators, etc. but there is a unique optimal solution for each choice of the SVM parameters [3]. This is different in other learning machines, such as standard Neural Networks trained using back propagation [11]. In short the development of SVM is an entirely different from normal algorithms used for learning and SVM provides a new insight into this learning. The four most major features of SVM are duality, kernels, convexity and sparseness [1].

Support Vector Machines acts as one of the best approach to data modeling. They combine generalization control as a technique to control dimensionality. The kernel mapping provides a common base for most of the commonly employed model architectures, enabling comparisons to be performed [8]. In classification problems generalization control is obtained by maximizing the margin, which corresponds to minimization of the weight vector in a canonical framework. The solution is obtained as a set of support vectors that can be sparse. The minimization of the weight vector can be used as a criterion in regression problems, with a modified loss function.
The future scope is to collect samples of data from some more organizations, develop the proposed model and if possible validate them. In this proposed approach we can add some more parameters to improve the accuracy in prediction of software reliability. Implementation of model and Validate them.

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