Face Recognition by SVM Using Local Binary Patterns

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***Abstract* - Authentication of the objects of interest plays a vital role and applicability in security sensitive environments .With Pattern recognition to classify patterns based on prior knowledge or on statistical information extracted from the patterns provides various solutions for recognizing and authenticating the identity of objects or persons. Identifying faces/objects of interest requires to take samples for training the classifier and classifying the input probe images with better recognition rate depending on the classification features. Facial recognition accuracy decreases when illumination of image is changed and with Single Sample per Person, where only one training sample is available does not give best matching results. In this paper, we present a model which works by taking different sample images and extracting Local Binary patterns, constructing the normalized histograms for training the SVM classifier and then classifying input probe images using Binary and Multiclass Support Vector Machines.**

Keywords: Normalized histograms, SVM Classifier, Feature Extraction, and Local Binary Pattern.

I. INTRODUCTION

With various biometric modalities available such as physiological or behavioral traits of humans, Face recognition stands out as one of the most popular biometric identification techniques [1].With nonintrusive nature of face recognition, where a system is supposed to recognize an uncooperative face in uncontrolled environment without the notice of the subject. Usually face recognition methods are classified into a) holistic matching methods, in which the whole detected positive sample face images act as an input to the recognition system b) feature based, in which some local features such as eyes, mouth and nose are extracted and the feature statistics are given input to the recognition system c) hybrid methods which make use of both local features as well as the some regions of face for the recognition process. Two main key steps in face recognition steps are feature extraction and classification with various methods available in both extraction and classification. A face recognition system with the input of an arbitrary image will search in database to output probe images identification. Various techniques for face recognition were presented and currently lot of research work involving detection, feature extraction and recognition of face images being presented by researchers [3]. Principal component analysis (PCA) which efficiently represents face image by a small number of coefficients corresponding to the most significant Eigen values and because of no consideration for the separability of various classes PCA is more suitable for image reconstruction. Fisherfaces approach (Fisher Discriminant Analysis) [4] expressively provides the discrimination among classes. This involves finding a base of vectors which maximizes the ratio of between-class difference to within class difference. With artificial neural network (ANN) for face recognition, single layer network WISARD [5] separate network for each stored individual is created to define the matching procedure of enrolled images. With neural networks Lawrence et al [6] provided hybrid neural network approach which combines image sampling, a self-organizing map (SOM) neural network, and a CNN. In this SOM is used for dimensionality reduction with mapping from high dimensional sub-image space to a lower dimensional discrete space. Convolution network applied to feature detection and classification contains iterative convolution and down sampling layers.

Extraction of patterns from the image sets provides the way out for classification with different. Local Binary patterns [7] provide way for face recognition. Local pattern is extracted by binarising the gradients of center point to its 8 neighboring points pixel wisely and patterns are used as features for classification Each face image is divided into several sub-regions and within each sub-region, the histogram is calculated. Through some

distance measurement, histograms are compared for recognition purpose. Feature extraction from face image has gone through various times of work. Local features against environmental variations like Local Binary Patterns (LBP), wavelet analysis, Bag of features, HOG features possess good characteristic of spatial-frequency localization to detect and recognize facial geometric structure.

Support Vector machines have been applied extensively in feedforward networks [8].With applications ranging from face recognition, to time series prediction and in medical image diagnosis SVMs have successfully provided the good success rates.

Intuitively, given a set of points belonging to classes, SVM finds the hyperplane that separates the largest possible fraction of points of the same class on the same side, while maximizing the distance from either class to the hyperplane.

The organization of the paper is done as follows. Section 3 presents Proposed Model. Section 4 Presents Implementation results. In last section conclusion of work is presented.

II. PROPOSED MODEL

The proposed scheme has been divided into two main modules 1) the feature Extractor: includes preprocessing and local binary pattern extraction of face images 2) classifier: includes learning methods and classification of face images using SVM classifier.

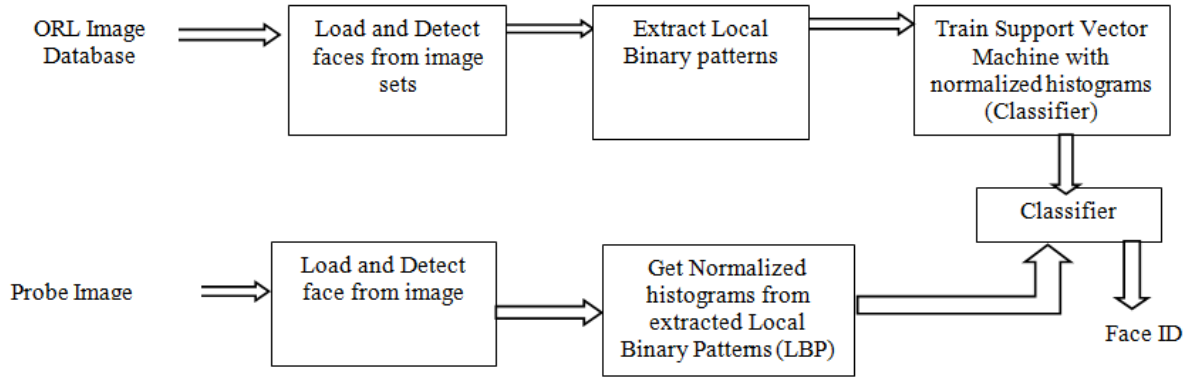

Fig. 1 Proposed Model

The Proposed model consists of following phases

A. Feature Extraction:

Feature extraction remains key step in any recognition system where images are collected which may include both positive as well as negative images. Discarding of negative images limits the extraction to well defined purpose for feature selection and extraction. Principal component Analysis (PCA) can be used to approximate the original data with lower dimensional feature vectors.

By taking Binary values of addressable units of images i.e. image pixels and then taking binary values, these are labelled by thresholding each pixel of an image with summation of 3x3 neighborhood and using these calculated values. Then the histogram of the labels can be used as a texture descriptor. LBP is more robust to pose changes because it relies more on histogram of the pattern in a region. LBP can tolerate small pose variations and achieve perfect recognition rate when the rotations are less than 15°. With at most two bit wise transitions from 0 to 1 or vice versa in circular binary string, a Local Binary Pattern is called uniform pattern. Then histograms are normalized which are used for training the Support Vector Machines (SVM). Feature Extraction is done for the test face images as well for the training image set.

Algorithm for Local Binary patterns

Input -: image Set Img
For i:= 1 to Length(Img)
Compute labelled index C_j where to extract features
$S_j \leftarrow C_j$
$S_{jk} \leftarrow$ LBPExtraction(S_j)
$S_{jk} \leftarrow$ PCA_image (S_{jk})
End for
Output -: LBP patterns

B. Support Vector Machine Classification:

1) Binary classification:

Pattern recognition classification by maximum separating margin can be done by Support Vector Machines. SVM works by finding the decision surface or hyperplane that has maximum distance to the closest points in the training set which are termed support vectors. Twice, this distance receives the important name of 'margin' within SVM's theory. The optimal separating hyperplane maximizes the margin of the training data.

Starting with a training set of points $x_i \in$ ImgSet , i=1,2,3,….N where each point belongs to one of two classes identified by the label $y_i \in \{-1,1\}$ the task of SVM is to find the hyperplane that maximizes the distance of support vectors belonging to two different classes. For a given sample set (x_i, y_i) ,the linear discriminant function of d- dimension space f(x)= β.x + b, where β is weight vector and b as a bias.

In particular, for the canonical hyperplane, the numerator is equal to one and the distance to the support vectors is: Distance $_{\text{distance support vector}} = 1/\|\beta\|$ .With Margin equal to twice the distance to the closest examples. $M=2/\|\beta\|$ gives the best support vectors.

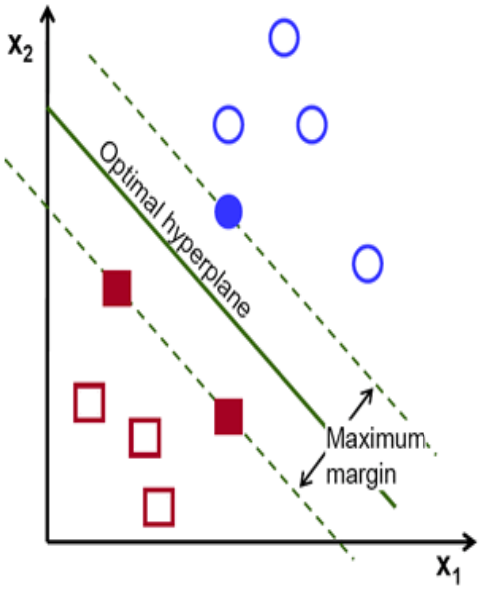

Fig. 2 SVM for two classes

Optimal Separating Hyperplane can be evaluated with following constrained quadratic programming problem:

Minimize $_{\beta, b} L(\beta) = 1/2\|\beta\|^2$ with the condition of $y_i(b + \beta^t x) \geq 1$

Here normalized histograms of local binary patterns of face images can be used for calculating the support vectors for classification. Every normalized histogram with representation in

d-dimensional space can be used for training the SVM classifier with more reliability on histogram specification of given face images used for training and testing the classification of positive face images.

2.2.2 Multi Class Classification

Face recognition is a multiclass classification problem. There are two basic strategies for solving n class problems with SVM: one against one and one against all. Various nonlinear discriminate

In one against all, all n SVMs are trained with feature vectors. Each SVM separates as single class from all other classes.

In the pairwise approach that is one against one approach n (n-1)/2 SVMs are trained. Each SVM separates a pair of classes. With representation of classifiers using trees, each node represents a separate classifier. This tree has no more than n-1 layers and exactly n leaves. Each node in the tree has two inputs and one output.

Various Nonlinear discriminate SVM can be constructed using different kernel functions. Kernel polynomial $K(x, xi) = [(x\ xi) + 1]^d$ with corresponding SVM is a classifier of polynomial of degree d .Using Sigmoid function K(x , xi)= $tanh$(v(x x) +c) presents a classifier where SVM is multi-layer perceptron and by using radial basis function $K(x, xi) = \exp\{|x - xi|/\sigma^2\}$ the SVM is a Gaussian RBF classifier.

Classification of input face starts by calculating local binary patterns .Normalized histograms are calculated from these patterns. Histogram Specification makes it possible for multiclass matching with input calculated histogram for classification with multiple constructed SVMs. These are used for calculating support vectors of

the face image. Classification of an input point starts at the bottom layer. For each node in the binary tree layer, the pairwise SVM's classifier is computed and the result of the classification (the winning class) assigned to the output node. The same procedure is repeated for the next layer until the top node is reached. At the top node only two classes remain and the final classification is determined by the SVM corresponding to these two classes [8]. We call this classification scheme bottom-up decision tree as the classification is carried out from the bottom of the tree to the top.

The Normalized histograms of calculated Local Binary Patterns (after PCA dimension reduction) of the incoming face image go through the binary tree from the bottom upwards. A winner class label between a pair (two children of a node) goes up level in the tree. After several rounds of pairwise comparison, a unique class appears on top of the tree.

III. EXPERIMENTAL RESULTS

In this paper, experiments were performed on ORL database ORL is a face database of 40 individuals, 10 face images for everyone. 5 images among the 10 images of every one were taken to compose training samples and the rest 5 ones compose test samples. With limitation of Single Image of Single Sample (SISP) accuracy of recognition remains very low, images of first individual was taken and marked as positive samples, the all images of other training samples as negative samples. Input Samples both positive and negative were taken to train a SVM classifier to get corresponding support vectors and optimal hyperplane. Both positive samples and negative samples were taken as input samples to train a SVM classifier to get corresponding support vectors and optimal hyperplane. The SVM was labeled as SVM1. In turn we get the SVM for every individual and labeled as SVM2, SVM40 respectively.

Face images of unknown identity is compared with the already enrolled face images with their local binary patterns used for classification. Local Binary patterns as support vectors provide way for matching them with already enrolled image local binary patterns. In general, many feature vectors needs more computing time but gives more accuracy. Normalized histograms were obtained from local binary patterns which were used to test the match with already enrolled histograms used for training the SVM.

Fig. 3 Probe Images

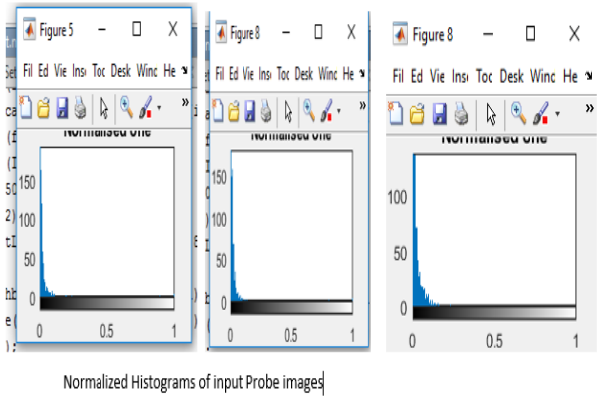

Fig. 4 LBP feature extraction and resultant normalized histograms

FDA, LDA and HOG features were used for classification with comparative recognition or classification rate results were reported.

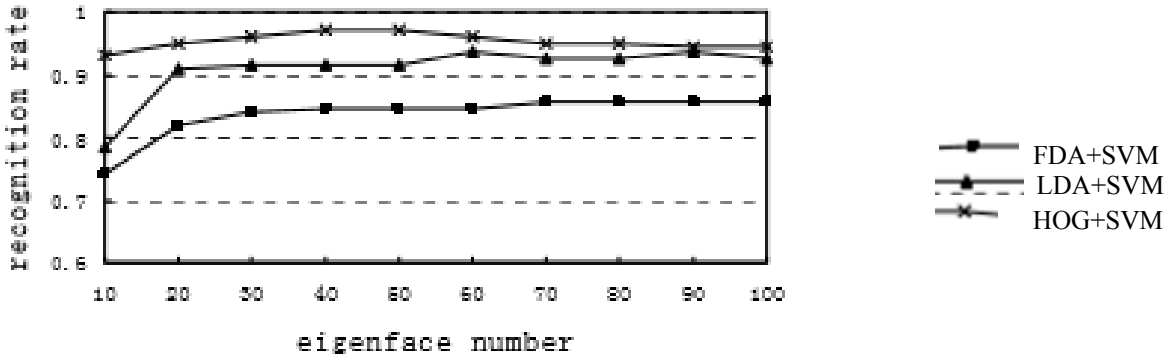

Fig. 5 Comparison of FDA, LDA and HOG with SVM [9]

Calculated local binary patterns are put in classifier as vectors treated as support vectors .These patterns are given input to SVM classifier for matching with already trained local binary patterns. Although various samples were taken for validating the accuracy of classifier but only single screenshot of working MATLAB implementation of the work is presented. Particular SVM is returned if it gives the best matched result for the input face image and labelled Class label is returned if same normalized histograms are there otherwise no class label is returned. For 3rd given image no class label.

IV. CONCLUSION

Face images can be seen as a composition of micro-patterns which can be well described by LBP. We exploited this observation and proposed a simple and e□cient representation for face recognition. In this paper we calculated the Local Binary patterns of input probe image and then calculated the normalized histogram which when given to SVM Classifier trained with Local Binary pattern Histograms for classification returns the face ID if the same normalized histogram is observed using SVM classifier otherwise it returns no face ID. For implementation MATLAB was used to get the results of recognizing the face images from ORL database. Although we clearly showed the simplicity of LBP-based face representation extraction and its robustness with respect to facial expression, aging, illumination and alignment, some improvements are still possible. For instance, using HOG, BURST, and BagOfFeatures various different possible feature classifications models can be presented and used for object recognition. A possible direction is to apply a dimensionality reduction to the face feature vectors and use other recognition techniques to increase the accuracy rate.

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