Abstract: Biometric based recognition systems are now being widely used in many applications. This is because the traditional methods of human identification poses a lot of problems when security is concerned. Among the various biometric characteristics face based recognition systems are widely used because of its many advantages like easy acquisition and contains different unique features. In this paper a face recognition system based on LBP (Local Binary patterns) and LTP (Local Ternary patterns) features is proposed. Face images with different expressions are taken into consideration. K-NN classifier is used for the comparison of template of the test image with the database images. It is found that the KNN classifier provides good recognition rate with different poses in comparison to Euclidean distance. The simulation results are obtained for the Japanese database. 

Keywords: Face recognition, Local Binary Patterns, Local Ternary Patterns, KNN classifier, Euclidean distance.

1. Introduction

Biometrics is an important field of study and lot of research work is currently being carried out in this area mainly because of its unique nature with reference to humans. Identification based on traditional methods making use of passwords, Id cards etc. are now becoming obsolete because of its various disadvantages. People unknowingly share their passwords or forget them, misplace ID cards and when this is the case with thousands of people, cost is unnecessarily involved in its replacement. All such problems are rarely present or very much reduced when biometrics dealing with physiological or behavioural characteristics of an individual is used in identification of a person[1]. The Aadhar system introduced in the country has a great impact in each person’s life. It is now made compulsory that every citizen in India must avail this facility to march towards digitization. When everything goes well in near future this system is going to be used widely in day today life. Any type of data transactions by an individual will be possible only based on the Aadhar. This not only identifies a person using the twelve digit UID but has associated with it the biometric features of an individual. One of biometric characteristics used in the Aadhar is the face. Also face is the widely used biometric for identification of a person by any other individual. It could be easily acquired without any disturbance to the person concerned. One of the main challenges in face recognition is changes in the face images under different emotional conditions which reduces the recog

2. Biometric system

A biometric system is essentially a pattern recognition system that acquires biometric data from an individual, extracts a salient feature set from the data, compares this feature set against the feature set(s) stored in the database, and takes a decision based on the result of the comparison [2]. The basic block diagram of a biometric system is shown in figure1.

![Fig. 1 Block diagram of a biometric system](image_url)

1. Data acquisition module: The raw data from the individual may be obtained by using an appropriate sensor, camera or a scanner. This module must be capable of acquiring good quality images for the biometric system to provide good performance.

2. Pre-processing: The function of this module is to assess the quality of the raw data obtained from the previous stage. Any reprocessing algorithm may be applied on the raw data in order to enhance its quality so that it is suitable for feature extraction.

3. Feature extraction module: Next a suitable algorithm is applied on the pre-processed image to extract the features (a compact representation of the pre-processed image) that can be used to uniquely identify a person. The extracted features are stored as templates in the database.

4. Matching module: For a given test or a query image, the features are extracted and then compared with the stored templates in the database to measure the level of closeness between template and the extracted features. Decision is then made as whether the individual or the user is a genuine (authorized or enrolled user) or an impostor (unauthorized user) depending on the observed closeness measure.

5. Database module: The feature set extracted from the raw biometric data (i.e., the template) is stored in the database along with some additional information (such as name, Personal Identification Number (PIN), address, etc.) representing the user.
Any biometric system has two modes of operation. They are 1) Enrolment mode and 2) Identification/Verification mode. In the enrolment phase a user provides his characteristic from which features are extracted and stored in the database as master templates for as many images captured from single person. In the identification phase the biometric data is captured, features extracted and this test template is compared with the master template in the database to confirm the identity of the person. Identification involves one-to many and verification one to one comparison. The rest of the paper is structured as follows: section 3 describes some of the recent related works. Section 4 described proposed method about the techniques used for feature extraction. And matching. The experimental results are described section 5. Finally, concluding remarks are provided in Section 6.

3. Related works
Face recognition is now currently used in large number of applications. Some of the recent works in face recognition is presented here. Md. Abdur Rahim et.al [3] have made use of LBP for face recognition. The image is divided into K2 regions and the LBP code is computed and compared with the database images for recognition. Tao Song et.al [4] have proposed a method to deal with illumination problems in face recognition. A pair of illumination insensitive components are obtained from a gradient face image and XOR operation is performed to obtain Local gradient XOR patterns which is a histogram based descriptor. The method has achieved good results. The author in [5] have proposed LBP using PDF of pixels in mutually independent colour channels for face recognition which is robust to homogeneous illumination and planar rotation. In [6] the authors have proposed a method for 3D face registration and recognition. Correlation parameters are used for pose correction. CA features are extracted and ensemble classifier is used to fuse features from different regions of the face. Results show good performance in registration and recognition accuracy. Yuehui Sun in [7] has proposed an expression invariant 3D face recognition. The algorithm computes minimum-distortion mapping between two 3D face by the Generalized Multidimensional Scaling (GMDS). Both full and partial parts matching are computed for finding the least distortion embedding of one 3D face into another during GMDS. The algorithm is tested on The FRGC v2.0 dataset and shows good results. Though lot of works has been carried out in face recognition and high recognition rate is achieved, they suffer from problems like high threshold, more number of training images and computational complexity.

4. Proposed Work
In this work, the LBP and LTP algorithms are used in face recognition with different facial expressions. Each face image is taken and filtered using the fspatial function in the MATLAB. The filtered image is next registered using the eye co-ordinates and then face image is cropped with a size of 32*32 pixels. The cropped image is subjected to histogram equalization. From the pre-processed image, the features are calculated using LBP and LTP and stored in the database. The same process is repeated for the test images and finally compared with the database image using K-NN classifier.

LBP and LTP algorithms are used here for the estimation of texture features which are invariant to illumination and pose variations. The main step is to reduce the amount of these features in each sub image and then compute an expression invariant 3D face recognition. Correlation parameters are used for pose correction. CA features are extracted and ensemble classifier is used to fuse features from different regions of the face. Results show good performance in registration and recognition accuracy.

The LBP 8 bit code is generated for each of the sub images and concatenated to form the feature vector. The mathematical representation of the LBP is given below:

\[ LBP = \sum_{b=0}^{7} S(P_n - P_c)2^b \]

\[ S(z) = \begin{cases} 
1, & z \geq 0 \\
0, & z < 0 
\end{cases} \]

The main disadvantage of the LBP is that they are more sensitive to noise also causes smooth weak illumination gradients. This problem is resolved in LTP which code the pixel value to a 0, 1 or -1 based the threshold value K. With Pc the centre pixel and Pn the neighbouring pixel the code is generated as explained in LTP code generation.

**Fig. 2** LBP code generation

**Fig. 3** LTP code generation

In this way, each threshold pixel has one of the three values. Neighbouring pixels are combined after thresholding into a ternary pattern. Next the upper and lower patterns are generated as shown in Fig. 3.
KNN classifier

KNN algorithm is one of the simplest algorithms that can be used for classification problems. The nearest neighbour classifier works based on simple nonparametric decision [11]. The test image is compared with each image in the training set by computing the distance between two feature sets. The nearest neighbour is one which has the minimum distance.

Any distance metric such as the Euclidean $D_1(x,y)$, city block distance $D_2(x,y)$ or cosine distance $D_3(x,y)$ can be used and in the proposed work Euclidean distance is used. KNN uses the K nearest closest samples of the training set with respect to the test image. Now the samples in training set belongs to a known class $C_i$. The test image is said to belong to one of the classes based on the majority of votes among the K samples.

$$D_1(x,y) = \sqrt{\sum_{i=1}^{N} |x_i - y_i|^2}$$  \hspace{1cm} (6)

$$D_2(x,y) = \sum_{i=1}^{N} |x_i - y_i|$$  \hspace{1cm} (7)

$$D_3(x,y) = 1 - \frac{\sum_{i=1}^{N} x_i y_i}{\|x\| \|y\|}$$  \hspace{1cm} (8)

5. Results and discussion

The proposed work is implemented using MATLAB on the Japanese Female Facial Expression (JAFFE) Database. This database contains 213 images of 7 facial expressions (6 basic facial expressions + 1 neutral) posed by 10 Japanese female models. During the training phase or the enrolment phase 3 training images per person are used. One image representing anger, fear and happy states for each person are used in this phase. Thus a total of 30 face images of the 10 persons are used for feature extraction and stored in the database. A few sample images from the database is shown in fig.4 for different expressions. The outputs obtained after filtering process is shown in fig.5 and the cropped image for feature extraction in fig.6 and in the testing or identification phase all the 213 images have been used. The table 1 below shows the results of the recognition rate for different face expressions for both LBP and LTP using KNN classifier. The results have been compared for face matching using Euclidean distance and it is observed that KNN classifier provides better performance.

<table>
<thead>
<tr>
<th>Images</th>
<th>Recognition Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Euclidean distance(1)</td>
</tr>
<tr>
<td></td>
<td>LBP</td>
</tr>
<tr>
<td>Anger</td>
<td>85.2</td>
</tr>
<tr>
<td>Disagree</td>
<td>80.0</td>
</tr>
<tr>
<td>Fear</td>
<td>83.4</td>
</tr>
<tr>
<td>Happy</td>
<td>86.2</td>
</tr>
<tr>
<td>Sad</td>
<td>84.8</td>
</tr>
<tr>
<td>Surprise</td>
<td>84.2</td>
</tr>
</tbody>
</table>

Fig.4 Sample images with different expressions

Fig.5 filtered image

Fig.6 Segmented image

Fig.7 Comparison of LBP and LTP
In this work LTP and LBP algorithm for face recognition using KNN classifier is proposed. With minimum number of training images the proposed algorithm is found to provide good performance even when images with different face expressions are given as test images. The classifier is found to provide better classification when compared to the distance metric based system.

REFERENCE


