© 2017 IJEDR | Volume 5, Issue 2 | ISSN: 2321-9939

Illumination Invariant Face Recognition using Local Directional Number Pattern (LDN)

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Abstract **-This paper introduces a system in which the face recognition is carried out with the help of the local feature descriptors under the varying illumination conditions. As today face recognition is a very active area of research, a system which carries out the robust face recognition is needed to be developed. Face recognition is used in various fields of security and access control, surveillance military etc.**

Local directional number pattern (LDN) is the descriptor which is used here to extract the features from the face image. The LDN code is computed by convolving the original image with the mask to extract the edge response images, from this images the most positive and most negative directions are taken to encode the information. The six bit binary code is then generated to give an LDN image. The face image is then divided into several regions and then for each region LDN is computed and the histogram of each region is taken. Then all the histograms are concatenated to form a feature vector.

Here the parameter used for evaluating the performance of the proposed system is recognition rate. This can be defined as number of person identified correctly divided by total number of persons in the test database. Number of experiments is carried out using different database-PIE, YALE, ORL. Numbers of face images from the original database are divided into training and test database. For the experiments carried so for, the recognition rates obtained for these masks are more than 70%. It is expected that the results may further improved by dividing the LDN image into more number of sections.

Keywords- Face recognition, LDN (Local Directional Number Pattern), feature extraction, FRM (Face recognition method).

I. INTRODUCTION

Today there is no area of technical endeavor that is not impacted in some way by digital image processing. Image processing allows the use of more complicated algorithm and hence can offer both more advanced and complex performance at simple tasks. Also, today face recognition is one of the well known techniques and it is being used in various fields. But there are certain circumstances or barriers in recognizing the face which can get an impostor into. Such circumstances include variation in pose, expressions and illumination condition under which the face is captured.

Thus, to make the face recognition system robust against such circumstances is the main motto here.

Here we deal with the illumination problem of the face i.e. recognizing the face in the different lightning conditions. The system is to be developed such that it recognizes the face in the different lightning conditions that is what called as illumination [3]. So we can say that we have to develop the system which avoids the varying illumination and the system so called is the illumination invariant system. The problem of illumination variation has involved hundreds of scientists to find an ultimate solution to this problem and the solution remains elusive. The system which deals with such a problem is developed here [4].

II. LITERATURE SURVEY

Face recognition has made significant advances in the last decade, but robust commercial applications are still lacking. Current authentication/identification applications are limited to controlled settings, e.g. illumination changes, with the user usually aware of being screened and collaborating in the process. Real-World face recognition in unconstrained scenarios is still a major challenge for biometrics [1]. The reasons are manifold. Among them is the fact that gallery (stored) enrolled face images are usually captured in controlled settings, using a predefined arrangement of subjects and capture devices, whereas the probes (test images) are captured in quite different settings.

The performance of any Face Recognition system is adversely affected by changes in the facial appearance caused by variation in lighting and pose [3]. The illumination variation problem is one of the well-known problems in face recognition in uncontrolled environment. Existing survey of methods for illumination invariant recognition can be found in [4]. An extensive and up-to-date survey of the existing techniques to address this problem is presented. This survey covers the passive techniques that attempt to solve the illumination problem by studying the visible light images in which face appearance has been altered by varying illumination, as well as the active techniques that aim to obtain images of face modalities invariant to environmental illumination.

Recently, local matching features have gained much attention in the field of recognition. The recognition task is performed very efficiently by using the local approaches. The main concept behind using the local matching methods is to first locate the various features on the face and then classify the faces by comparing and combining the local statistics.

In the literature there are many holistic methods which are used to deal with such problems for example in LBP [2] few number of pixels are used for recognition which limits its accuracy and also it discards most of the information of the neighborhood pixels. And thus it becomes sensitive to noise. In this paper, the Local Directional Number Pattern (LDN) descriptor is used which gives more information of an image and thus is more stable and also it is insensitive to the lightning changes. The LDN is a six bit binary code assigned to each pixel in a face image that shows the texture and the intensity transitions of an image [1]. In LDN the pattern is created by computing the edges using a compass mask. The kirsch compass mask is used here. This mask operates in the gradient-space and thus our method becomes robust against illumination, and noise due to smoothing.

III. SYSTEM METHODOLOGY

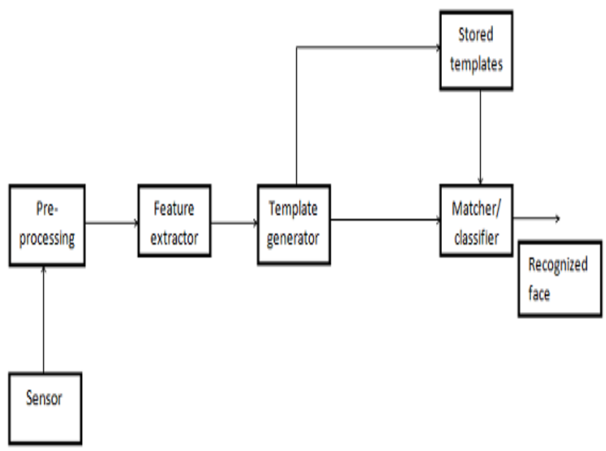

Fig. 01 Block diagram of illumination invariant face recognition

The block diagram of the illumination invariant face recognition is as shown. The function of each block is detailed below:

1. *Sensor*: In the sensor the images from different databases is taken for the testing and training purposes. The databases used are PIE, YALE and ORL database.

2. ***Preprocessing*:** As shown in the block diagram after the different images from the databases are taken the pre-processing is carried out which means here the LDN (Local Directional Number Pattern) code computation is applied on the different databases to find out the LDN image.

1

3. ***Feature Extractor**:* After obtaining the LDN image the features are extracted from the image in the form of the histogram of pixels with different intensities. This histogram is taken by dividing the whole image into 4*4 i.e. 16 parts. In this way we have formed a feature vector.

2

4. ***Template generator**:* Template is generated by concatenating all the histograms. This template represents PDF (Probability Density Function).

3

5. ***Stored templates**:* The output of the template generator is given to the stored templates or also we can call it as the database to store the templates in it of the processed image. These templates are then used for matching purpose.

4

6. ***Matcher/Classifier**:* The minimum distance between the template of the input image and the stored template will represent the closest match and that will be the recognized face image. The matching is performed with the chi square dissimilarity measure. This measure between two feature vectors, F_1 and F_2 is of length N is defined as :

$$\chi^2(\mathrm{F}_1, \mathrm{F}_2) = \sum_{i=1}^{N} \frac{(\mathrm{F}_1(i) - \mathrm{F}_2(i))^2}{\mathrm{F}_1(i) + \mathrm{F}_2(i)}.$$

The corresponding face of the feature vector with the lowest measured value indicates the match found.

The illumination invariant face recognition system works in two phases the training phase and the testing phase: The results at each stage are described below:

A. Training phase:

Initially the image is captured by the sensor which is nothing but a camera and the output is an image taken by the camera.

Then the preprocessing is done on that image and as mentioned the preprocessor gives the LDN image.

Then the features are extracted from an LDN (Local Directional Number Pattern) image whose output is then given to the template generator.

The template generator generates the template of images i.e. the code of the images which is then given to the database where it is stored. Now the database contains many such images for detection purpose.

B. Testing phase:

In the testing phase the face image to be recognized is taken first. Then the test image is given to the preprocessor where again the preprocessing is carried out and then the image is applied to the re extractor where features are extracted using LDN.. The output of feature extractor which is a filtered face image is then given to template generator. Than the images from database content is compared with this testing image.

Based on the minimum distance between two images the output is taken which is our recognized image.

IV EXPERIMENTS

We performed several experiments on the different images of the face by taking the different databases. The PIE, ORL and YALE database is taken. The five face images of five different persons is taken under different lightning conditions and then LDN is computed for those images, finally the histogram is image is taken by dividing the image into 4*4 matrix.

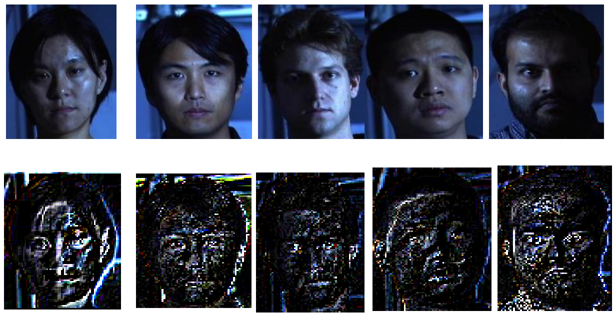

Fig. 02 Sample images and their computed LDN images

From these images of five persons three person's images are taken for training purpose and two are taken for the testing purposes. Depending upon the minimum distance between the training and the testing images the match is found and the person is recognized. The histogram of the images is show below. The histograms of the different images of each person are concatenated to get the final histogram of the image. The histogram is the plot of intensity of the image (x-axis) and no. of pixels (y-axis).

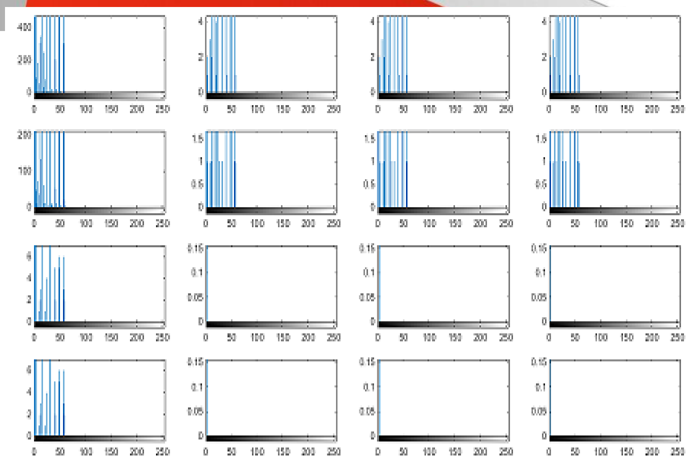

Fig.03 Histogram of the LDN images

After getting this histogram the testing of images is performed in the testing phase. The result for testing is shown below:

Test image **Equivalent image**

From the experiments carried out for the different databases are tabulated as shown below:

TABLE I

Databases **PIE**	Total No. of faces	Identified faces	Recognition rate= No. of persons identified correctly/Total No. of faces
Expt 1	5	17	85%
Expt 2	8	36	90%
Expt 3	10	46	92%

Recognition Rate of ORL Database

TABLE II

Recognition Rate of PIE Database

Databases **ORL**	Total No. of faces	Identified faces	**Recognition rate**= No. of persons identified correctly/Total No. of faces
Expt 1	10	9	90%
Expt 2	20	18	90%
Expt 3	30	28	93.33%

TABLE III

Recognition Rate of YALE Database

Databases **YALE**	Total No. of faces	Identified faces	**Recognition rate**= No. of persons identified correctly/Total No. of faces
Expt 1	15	12	80%
Expt 2	30	27	90%
Expt 3	45	41	91.11%

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