International Journal of Modern Trends in Engineering and Research
www.ijmter.com
e-ISSN No.:2349-9745, Date: 2-4 July, 2015

Illumination Invariant Face Recognition

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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. 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. here the system is developed in which face recognition is done under varying illumination (lighting) conditions.
Local directional number pattern (LDN) is the descriptor which is used here to extract the features from the face image. The LDN produces the compact code which extracts the useful features of the face. The face image is divided into several regions and then for each region LDN is computed and then the histogram of each region is taken for the sake of comparison. Then all the histograms are concatenated to form a feature vector. The LDN thus perform the best under the varying illumination conditions for the correct face recognition.

Keywords- Face recognition, Gabor filter, LBP (Local Binary Pattern), feature extraction, FRM (Face recognition method).

I. INTRODUCTION

Now a day's face recognition has gained the at most attention for the image analysis. During the past several years face recognition has become an emerging technique in the wide range of commercial and law enforcement applications and also the availability of feasible technology makes it much more attractive. Face recognition involves the recognition of a person, his/her identity based on the geometrics or statistical features which are derived from the face [9]. The face recognition system recognizes the face based on this features. But sometimes while recognizing the face the system has to go under some circumstances which affect the performance of the system and in turn the recognition rate of the system. The circumstances include the problem of variation such as pose, expression, illumination [4]. Such type of problems must be avoided so as to correctly recognize the face and thus avoid the fraudulent use of the face recognition system.
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 REVIEW

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

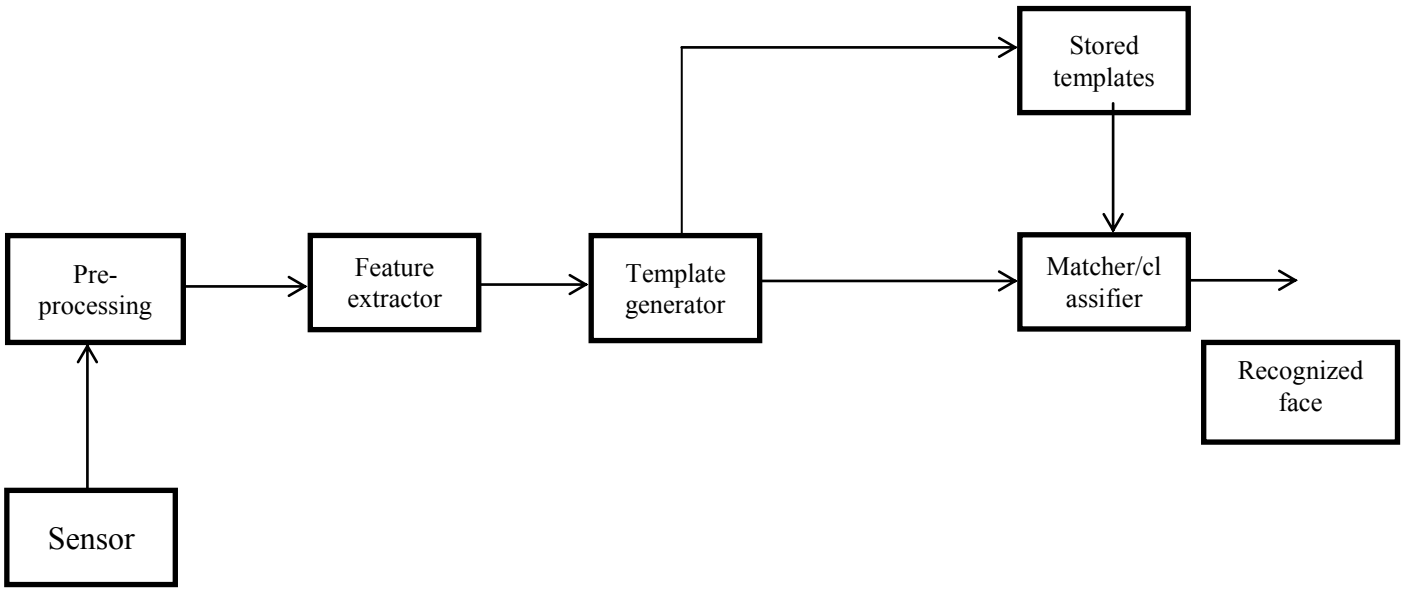

Fig. 01 Block diagram of illumination invariant face recognition

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

A. *Sensor:* The sensor is the simple camera use to capture the images.

B. Pre-processing: Pre-processing is used to enhance the visual appearance of images and to improve the manipulation of datasets. Pre-processing is a common name for operation with the images at the lowest level of abstraction both input and output are intensity images. The

aim of pre-processing is the improvement of the image data that suppresses unwanted distortions or enhances some image features important for further processing. As shown in the block diagram the sensor used here is camera to capture the input image. This image is pre-processed to separate out the face from the background and then normalize the face image so that all the face images in the database will be of equal size.

C. *Feature Extractor:* Feature extractor where the LDN algorithm is applied on the face image to get a LDN image. From this image the features are extracted in the form of histogram of pixels with different intensities. This histogram is taken by dividing the whole image into 3*3 i.e. 9 parts. In this way we have formed a feature vector.

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

E. *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.

F. *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 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 removes the background and only the part of face is available.

Then the features are extracted using an LDN (Local Directional Number Pattern) 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.

Testing phase:
In the testing phase the face image to recognize 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 and then the image is made to pass through the Gabor filter. The Gabor filter here plays a major role for the smoothing of image where noise is reduced to produce less pixilated image. 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 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.

Figure 2. Database

From these images of five persons three person's images are taken for testing purpose and two are taken for the training 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).

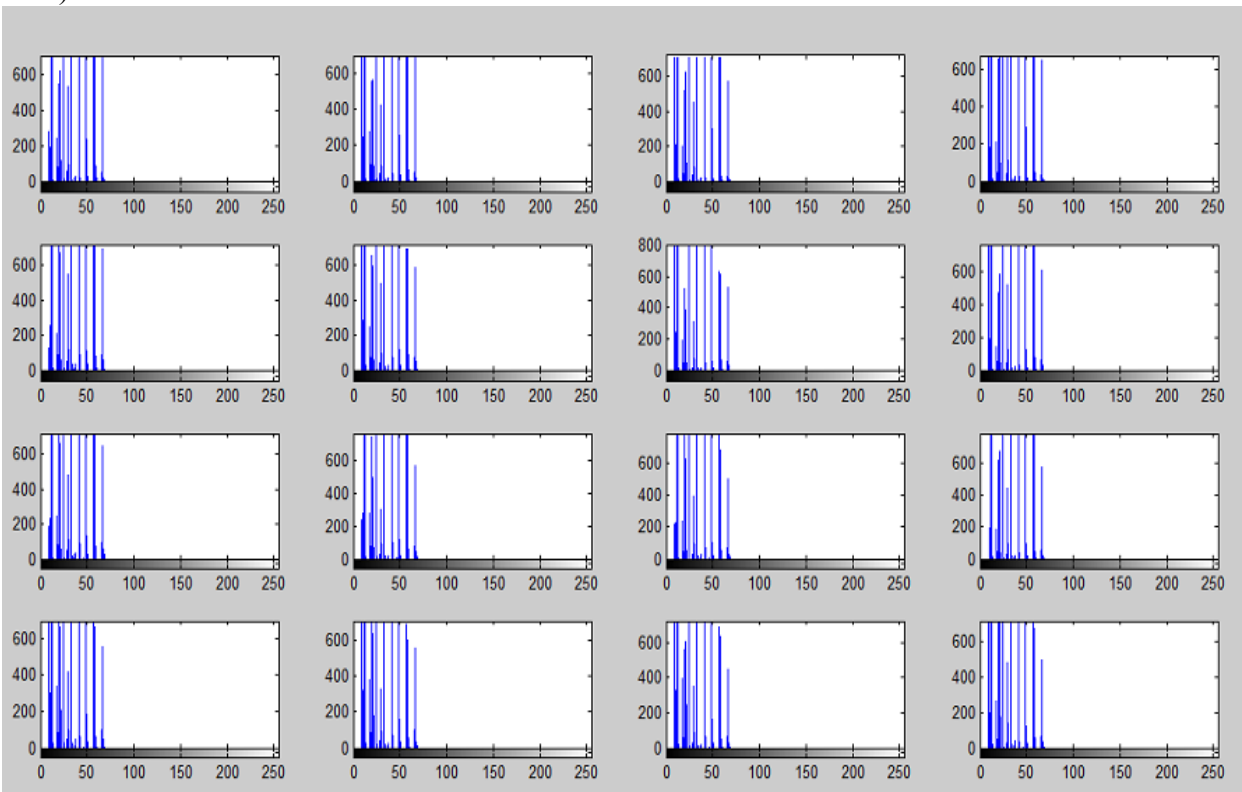

Fig 03: Histogram plot of an LDN images

CONCLUSION

In this paper we introduced the way to tackle the problem related to the illumination during the face recognition. For the correct recognition of the face under the varying illumination condition how the LDN effectively works is described here.

The outcome of the system is in the form of recognition rate i.e.

$$\text{Recognition rate} = \frac{\text{Number of persons recognized correctly}}{\text{Total observations performed}}$$

Which depends on the image of the person is recognized correctly or not.
Therefore from the above experiments the recognition rate is

$$\text{Recognition rate} = \frac{\text{Number of persons recognized correctly}}{\text{Total observations performed}}$$

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