Face Recognition Using Local Binary Pattern (LBP) Features

Report submitted for the partial fulfillment of the requirements for the degree of
Bachelor of Technology in
Information Technology

Submitted by

Asmita Biswas
(IT/2014/060)
(11700214022)

Under the Guidance of
Mr. Hiranmoy Roy
(Asst. Prof., Department of IT)

RCC Institute of Information Technology
Canal South Road, Beliaghata, Kolkata – 700 015
[Affiliated to West Bengal University of Technology]

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……………………………….
Asmita Biswas

Department of Information Technology
RCCIIT, Beliaghata,
Kolkata – 700 015,
West Bengal, India

Approval

This is to certify that the project report entitled “**Face Recognition Using Local Binary Pattern (LBP) Features**” prepared under my supervision by ***Asmita Biswas (IT/2014/060)*** be accepted in partial fulfillment for the degree of Bachelor of Technology in Information Technology.

It is to be understood that by this approval, the undersigned does not necessarily endorse or approve any statement made, opinion expressed or conclusion drawn thereof, but approves the report only for the purpose for which it has been submitted.

………………………………………..	……………………………………….
Dr. Abhijit Das	Mr. Hiranmoy Roy
Associate Prof and HOD,	Asst. Prof, Department of IT
Department of IT	

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INTRODUCTION

Face recognition rises from the moment the machine start to became more and more intelligent and had the advance of fill in, correct or help the lack of abilities and senses. Machine has a wide range of recognition purposes which use think such as fingerprints, Iris Scans. Despite the fact that these method of identification can be more a accurate, face recognition always remains a major focus of research because of it's non-invasive nature and because it's people primary method of person's identification.

The face is an important part of who you are and how people identify you. Except in the case of "**identical twins"** the face is arguably a person's most unique physical characteristics. While humans have the innate ability to recognize and distinguish different faces for millions of years, computers are just now catching up.
For Face Recognition there are two types' comparisons:

- The first is Verification. This is where the system compares the given individuals with who that individual says they are and gives yes or no decision.
- The second is Identification. This is where the system compares the given individuals to all the other individuals in the database and gives a ranked list of matches.

Fig 1: Identification of face

Face recognition is an interesting and challenging problem, and impacts important applications in many areas such as identification for law enforcement, authentication for banking and security system access, and also personal identification among others .The Face recognition field is active research area because of surveil lance, Pass port, ATM etc.

This project mainly consists of three parts, namely face representation, feature extraction and classification. Face representation represents how to model a face and determines the successive algorithms of detection and recognition. The most useful and unique features of the face image are extracted in the feature extraction phase. In the classification the face image is compared with the images from the database. In our research work, we empirically evaluate face recognition which considers both shape and texture information to represent face images based on Local Binary Patterns for person independent face recognition. The face area is first divided into small regions from which Local Binary Patterns (LBP), histograms are extracted and concatenated into a single feature vector. This feature vector forms an efficient representation of the face and is used to measure similarities between images.

THE PARADIGM OF THE FACE RECOGNITION

Despite of the fact that at this moment already numerous of commercial face recognition systems are in use, this way of identification continues to be an interesting topic for researchers. This is due to the fact that the current systems perform well under relatively simple and controlled environments, but perform much worse when variations in different factors are present, such as pose, viewpoint, facial expressions, time (when the pictures are made) and illumination (lightening changes) [8]. The goal in this research area is to minimize the influence of these factors and create robust face recognition system.

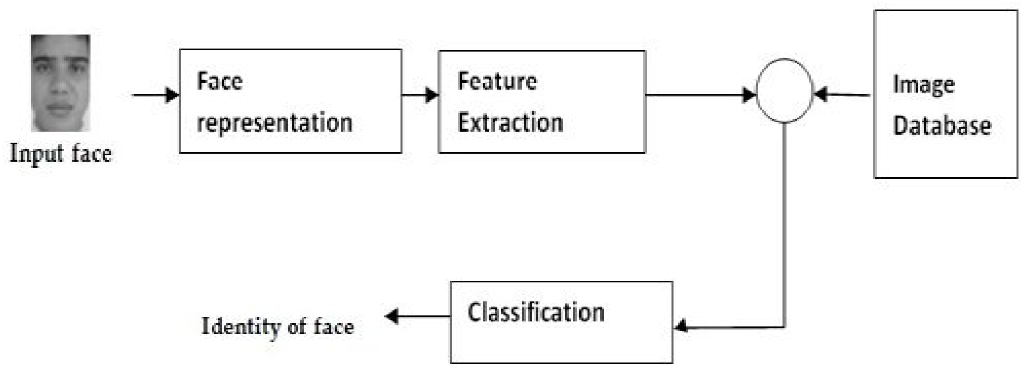

Fig 2 : Principle of an identification process with face recognition

The process of person identification by using face recognition can be split into three main phases (figure 1.1). These are face representation, feature extraction and classification [6]. Face representation is the first task, that is, how to model a face. The way to represent a face determines the successive algorithms of detection and identification. For the entry-level recognition (that is, to determine whether or not the given image represents a face), the image is transformed (scaled and rotated) till it has the same 'position' as the images from the database. In the feature extraction phase, the most useful and unique features (properties) of the face image are extracted. With these obtained features, the face image is compared with the images from the database. This is done in the classification phase [7, 9]. The output of the classification part is the identity of a face image from the database with the highest matching score, thus with the smallest differences compared to the input face image. Also a threshold value can be used to determine if the differences are small enough. After all, it could be that a certain face is not in the database at all.

PROBLEM DEFINITION

In this implementation the face image is divided into 3x3 sub-regions from which the features are extracted using the Local Binary Pattern (LBP) over a window, fuzzy membership function and at the central pixel. The LBP features possess the texture discriminative property and their computational cost is very low. By utilizing the information from LBP, membership function, and central pixel, the limitations of traditional LBP is eliminated. The bench mark database like ORL and Sheffield Databases are used for the evaluation of proposed features with SVM classifier. For the proposed approach K-fold and ROC curves are obtained and results are compared.

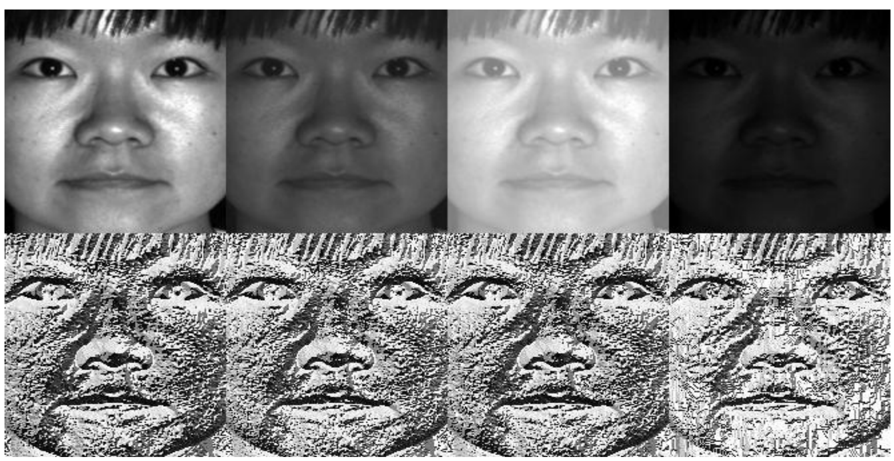

Fig 3: Local Binary Pattern

LITERATURE STUDY

1. In the Appearance-based schemes, two of the most popular techniques are Principal Component Analysis (PCA) and Linear Discriminant Analysis.

- **PCA**: Principle Component Analysis is one of the holistic approaches. This is one of the statistical approaches based on unsupervised learning method. In which the Eigen vectors are computed from the covariance matrix. PCA model the linear variations in high dimensional data. PCA preserves the global structure of the image in the sense the image can be completely reconstructed with PCA. It does the guarantees dimensionality reduction by projecting the n-dimensional data onto the r (r << n) dimensional linear subspace .The objective here is to find a set of mutually orthogonal basis functions that capture the directions of maximum variance in the data. Since PCA is used for the dimensionality reduction, hence it can be used for image compression. We can find many holistic approaches in the literature like kernel PCA, 2D-PCA Complex PCA etc .

- **LDA:** Linear Discriminant Analysis, L is called supervised learning algorithm method. The Fisher faces method he build in the concept of LDA. LDA builds the projection axis in such a way that the data points belonging to same class are nearer. and projection points are for the interclass. LDA encodes the discriminating information in a linear separable space using bases which are not necessarily orthogonal unlike in the case of PCA. As the face samples involve high dimensional image space, the Eigen-faces approach is likely to find the wrong components that leads to poor recognition. on the other hand, the Fisher faces are computationally expensive.

2. BASIC LBP AND ITS VARIANTS:

In this section brief concepts of basic LBP and its Variants are discussed The basic LBP was proposed by and some of its variants are Tan and Trigg's proposed Local Ternary Pattern (LTP) uses three levels (+1, 0,-1), these three level are obtained by quantizing the difference between a central pixel and its neighboring pixel gray. Some of the variants of LBP, are derivative based LBP, Sobel-LBP, Uniform LBP, Rotation invariant LBP , Multi-dimensional LBP , dominant LBP, center-symmetric LBP and Transition LBP, have been proposed .

2.1. BASIC LOCAL BINARY PATTERN:

LBP concept is applied to area like face recognition , dynamic texture recognition and shape localization . The Local Binary Pattern (LBP) method is widely used in 2D texture analysis. The LBP operator is a non-parametric 3x3 kernel which describes the local spatial structure of an image. It was first introduced by Ojala et al who showed the high discriminative power of this operator for texture classification. At a given pixel position (xc; yc), LBP is defined as an ordered set of binary comparisons of pixel intensities between the centre pixel and its eight surrounding pixels. The decimal values of the resulting 8-bit word (LBP code) leads to 28 possible combinations, which are called Local Binary Patterns abbreviated as LBP codes with the 8surrounding pixels. The basic LBP operator is a fixed 3x3 neighborhood.

If the gray value of the center pixel is Ic and the gray values of his neighbors are Ip, with n = 0, ..., n − 1, than the texture T in the local neighborhood of pixel (xc, yc) can be defined as:

$$T = t(I_C, I_0, \ldots\ldots\ldots I_{n-1}) \qquad (1)$$

Once these values of the points are obtained is it also possible do describe the texture in another way. This is done by subtracting the value of the center pixel from the values of the points on the circle. On this way the local texture is represented as a joint distribution of the value of the center pixel and the differences:

$$T = t(I_c, I_0 - I_c, \ldots\ldots\ldots\ldots I_{n-1} - I_c) \qquad (2)$$

Since t(Ic) describes the overall luminance of an image, which is unrelated to the local image texture, it does not provide useful information for texture analysis. Therefore, much of the information about the textural characteristics in the original joint distribution is preserved in the joint difference distribution (Ojala et al. 2001):

$$T \approx (I_0 - I_C, \ldots\ldots\ldots\ldots I_{n-1} - I_c) \qquad (3)$$

Although invariant against gray scale shifts, the differences are affected by scaling. To achieve invariance with respect to any monotonic transformation of the gray scale, only the signs of the differences are considered. This means that in the case a point on the circle has a higher gray value than the center pixel (or the same value), a one is assigned to that point, and else it gets a zero:

$$T \approx (s(I_0 - I_C), \ldots\ldots\ldots s(I_{n-1} - I_c)) \qquad (4)$$

Where ,

$$s(x) \leftarrow \begin{cases} 1, if \ldots\ x \geq 0 \\ 0, if \ldots\ x < 0 \end{cases}$$

In the last step to produce the LBP for pixel (xc, yc) a binomial weight 2n is assigned to each sign s(In − Ic). These binomial weights are summed:

$$LBP(x_c, y_c) = \sum_{n=1}^{8} s(I_n - I_c)2^n$$

Where Ic corresponds to the gray value of the centre pixel (xc; yc), In to the gray values of the

8 surrounding pixels $LBP(x_c, y_c) = \sum_{n=1}^{8} s(I_n - I_c)2^n$ and function s is defined as,

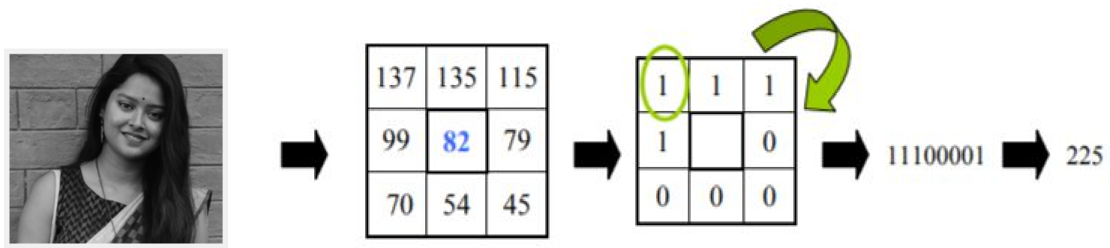

Fig 4. The basic Local Binary Pattern (LBP) operator

Later the LBP operator was extended to use neighborhoods of different sizes. In this case a circle is made with radius R from the center pixel. P sampling points on the edge of this circle are taken and compared with the value of the center pixel. To get the values of all sampling points in the neighborhood for any radius and any number of pixels, (bilinear) interpolation is necessary. For neighborhoods the notation (P, R) is used. Figure 1.4 illustrates three neighbor-sets for different values of P and R.

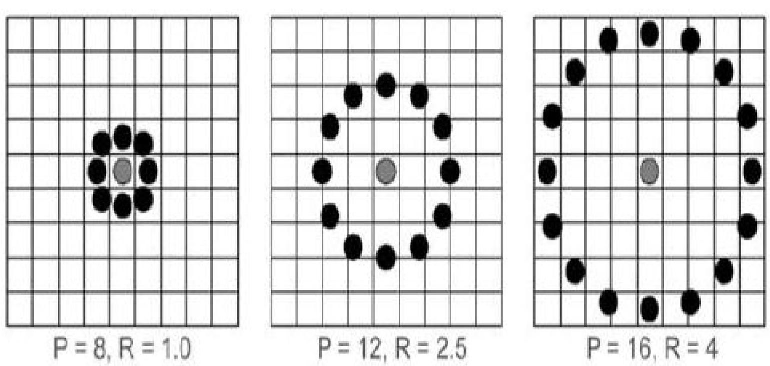

Fig 5 : Circularly neighbor-sets for three different values of P and R

2.2. UNIFORM LBP

Uniform LBP binary patterns, proposed by T.Ojala et. al have certain fundamental properties of texture. In this implementation they have considered if the frequency of occurrence exceeds 90% then they call it as uniform patterns. The frequency considered here is the transition from zero to one and one to zero.

2.3. MULTY-BLOCK LBP (MB-LBP)

As in the case of basic LBP the central pixel is taken as threshold and neighbouring pixel is assigned values. In the case of MB-LBP the same procedure is adapted. They consider the rectangular box as the reference. For this reference rectangular box the average value is computed and this average value will be acting as threshed, and the neighbouring blocks are assigned the value based on threshold.

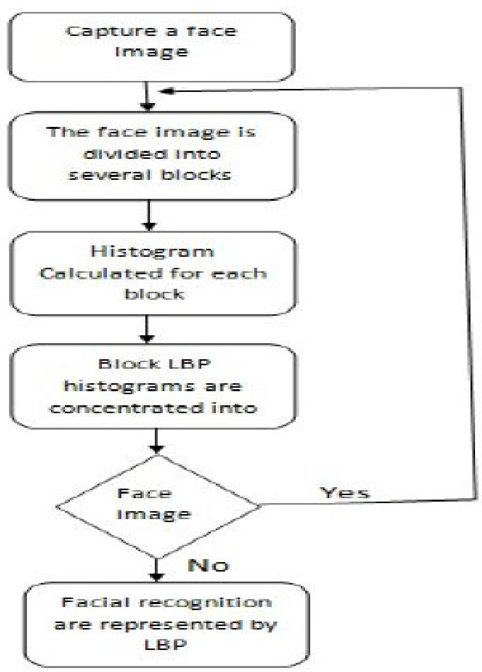

Fig 6 : Flowchart of the LBP Process Flowchart of the Proposed System

3. PROPOSED METHOD

Uncertainty appears in the gray values of images. Instead of considering the whole image and their gray values, we divide the image into sub images of size 3x3 (enclosed in the window) and extract local information using LBP method. We consider non overlapping sub images. We compute a membership function for each window using S-Membership Function, Z-Membership Function, Gaussian Membership Function, the New proposed membership Function and Root Mean features. For all the features we use central pixel to compute the final feature, the reason being the central pixel value is lost once we obtain the LBP feature. Let $\mu_{i,j}$ be the membership value of the window using any of the above

method the size of the membership will be 3x3 when we get this from the 3 x3 window. The procedure is explained in the later part of this section. Let S be the 3 x 3 window in the image domain. Let Hw be the information set obtained from the window, that is the element by element product of the S and $\mu_{i.j}$ denoted as Hw = S .X$\mu_{i,j}$, where .X

represents the element by element multiplication.After element by element multiplication, we get 3 x3 matrix. we take the sum as given below.

$$H_w^s = \sum_{i=1}^{w} H_w \qquad (5)$$

where H_w^s is the information set obtained after the summation. Once we obtain the H_w^s

, next we compute the LBP code the example is as given in Fig. 1. In order to take account of the information from the neighbourhood pixels (information sources), we compute the LBP value for the window. This is given by:

$$Lw = LBP(xc; yc) \qquad (6)$$

We convert the LBP code to the decimal value. Let the value of LBP from a window be denoted by Lw. The New membership function based feature is given by:

$$F_w^k = H_w^s \times L_w \times I_c \qquad (7)$$

where Ic represent the centre pixel in the window. The New membership function is computed from the information of local structural details like average of the window and maximum in the window under consideration. The New membership function is given by

$$\mu_{i,j} = \frac{\left| I_{i,j} - I_{avg} \right|}{I_{\max}} \tag{8}$$

where I_{ij} represent the normalized intensity value which we will obtain by dividing the maximum in the image. I_{avg} is the average in the window under consideration and I_{max} is the maximum in the window under consideration. Algorithm 1 describes various steps involved for the computation of features using various membership functions for a given image.

3.1. <u>The Root Mean Square Feature</u>

This feature depend upon the two parameters on is the fuzzifer and the central pixel value and the LBP code. The fuzzifer developed by Prof.Hanmandlu has the scope to expand the fuzzy set.The fuzzifer f_h^2 (9) in is devised by Hanmandlu et al. in [6] and it gives the spread of attribute values with respect to the chosen reference . It is defined as

$$f_h^2 = \frac{\sum_{i=1}^{w} \sum_{j=1}^{w} (I_{ref} - I_{ij})^4}{\sum_{i=1}^{w} \sum_{j=1}^{w} (I_{ref} - I_{ij})^2} \tag{9}$$

Iref can be taken as average or minimum or maximum from the window under consideration. It may be noted that the above fuzzifer gives more spread than is possible with variance as used in the Gaussian function.

$$F_w^k = \left(\sqrt{I_c^2 + f_h^2} \right) \times I_c \times L_w \tag{10}$$

The contribution of this method is that it eliminates the shortcoming of LBP approach which ignores the central pixel value and it considers information of both central and neighbourhood pixels.

RESULT

Fig 7 : Result of LBP Implementation

SOFTWARE REQUIREMENT SPECIFICATION (SRS)

<table>
<tr><th colspan="5">64-Bit MATLAB, Simulink, and Polyspace Product Families</th></tr>
<tr><th>Operating System</th><th>Processors</th><th>Disk Space</th><th>RAM</th><th>Graphics</th></tr>
<tr><td>Windows 10</td><td>Any Intel or AMDx86-64 processor</td><td>2GB for Matlab
4-6 GB for typical installation</td><td>2GB</td><td>No specific graphics card is needed</td></tr>
<tr><td>Windows 8.1</td><td>AVX2 instruction set up support is recommended</td><td></td><td>With Simulink 4 GB is required</td><td rowspan="2">Hardware accelerated graphics card supporting OpenGL 3.3 with 1 GB GPU memory is recommended.</td></tr>
<tr><td>Windows 7 service Pack 1</td><td rowspan="2">With Polyspace 4 cores is recommended</td><td rowspan="2"></td><td rowspan="2">With Polyspace 4 GB per core is recommended</td></tr>
<tr><td>Windows Server 2016</td><td></td></tr>
<tr><td>Windows Server 2012 R2</td><td colspan="4"></td></tr>
<tr><td>Windows Server 2012</td><td colspan="4"></td></tr>
<tr><td>Windows Server 2008 R2 Service Pack 1</td><td colspan="4"></td></tr>
</table>

Table 1: SRS for MATLAB

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