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Comparative Analysis of Rotation Invariant Pattern and Uniform Pattern in MMLBP Technique for Face Recognition

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Abstract

Recognizing humans based on one or more physical or behavioral traits is referred as Biometrics. Comparing to the traditional methods to authenticate persons, biometric plays a vital role in the area of human recognition. In the field of biometric, face and palm print recognition seeks more attention for the researchers. The failure of recognition is minimum and also the implementation is easier than more other techniques. In this paper we concentrated on face recognition with Local Binary Pattern(LBP), it is simple and fast to recognize face than more other algorithms. Uniform LBP is used to extract features to recognize the face to authenticate the persons. The "non-uniform" patterns are clustered into one pattern due to this lot of information lost. In order to overcome the heavy data which loss in non-uniform patterns a modified multi-scale LBP histogram algorithm is proposed. Hence, the useful non-uniform information is utilized without any training step with entire information without any data loss. We also compare the mapping methods, rotational invariant pattern and uniform with rotational invariant patterns and .hence evaluate the performance of the mapping methods.

Index Terms- *LBP, multiscale, face recognition , Modified Multiscale Local Binary Pattern, Uniform pattern, Rotation invariant Pattern.*

INTRODUCTION

Many recent events, such as hacking the network and terrorist attacks are exposed most serious weakness in security systems. Various government agencies are now motivated to improve the system accuracy and increase the system [21]. To extract a template biometric uses Raw data which is easier to process and store the data, but it need lot of information. Since the information are more it can be used in various applications which requires security or access control by knowing the person who really he/she is. Face recognition technology is one of the best methods in the field of biometrics. It works as a unique identifier to recognize the human being. Face input is given by the digital video camera and various characteristics of a person's face is analyzed. According to the input image, system measures the overall face structure with help of various parameters like distance between the eyes, mouth, nose and chicks. After measuring these parameters the entire information are stored in the database. Password-based or Badge type authentication schemes may fail but more or less Biometrics represents a valid principle for authentication. Even though biometrics has more advantage it also has many disadvantages. If we consider Iris scanning it is very reliable but may be intrude. Fingerprints are accepted, but it is not fit for non-consentient people. When we compared to above mentioned techniques face recognition is more advantage than many other techniques. As shown in the fig.1. Face recognition system provide a new idea which is known as "Visitor Management System". Now-a-days in many organization effective management system prevents form intrusion. Human based visitor management system cannot give complete solution. To ensure high level of security in visitor management system face recognition is highly used. In visitor management system using face recognition method the face is identified and visitor id is provided which can also be used as visitor id card after taking print from the generated card. Face recognition is important for the applications like human computer interaction, video surveillance, face tracking and face recognition. The objective of face detection is to determine whether or not there is any face in the image, and if any, then to specify the face location. The goal of facial feature localization is to detect the presence and location of features, based on the locations of faces which are extracted by any face detection method. There are several challenges associated with face and facial feature detection and can be attributed by the following factors [1].

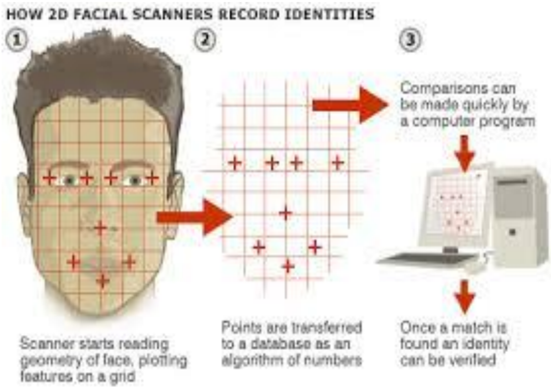
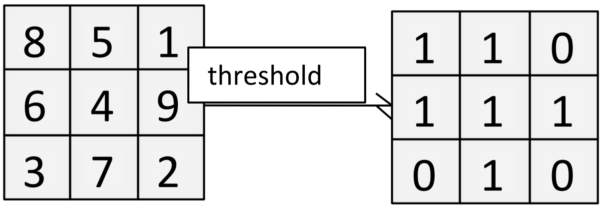


Fig.1 *Visitor Management System*

Intensity: There are three types of intensity- color, gray, and binary. Pose: Face images vary due to the relative camera-face pose (frontal, +45,-45 degrees slanting profile), and some facial features such as an eye may become partially or fully occluded.
Structural components: Facial features such as beards, mustaches, and glasses may or may not be presented.
Image rotation: Face images directly vary by different rotations.
Poor quality: Image intensity in poor-quality images, such as blurred images, distorted images, and images with noise.
Facial expression: The appearance of faces depends on a personal facial expression.
Unnatural intensity: Cartoon faces and rendered faces from 3D model have unnatural intensity.
Occlusion: Faces may be partially occluded by other objects such as hand, scarf, etc.
Illumination: Face images may vary due to the position of light source.

LOCAL BINARY PATTERN(LBP)
Each pixel is labeled by original LBP operator by considering threshold of 3 × 3 neighborhood of each pixel with centered value and the result is considered as binary operator. Binary is converted into decimal. Fig 1 represents the basic LBP based on the operator, every pixel is labeled with LBP code. The 256-bin histogram of the labels contains the density of each label and can be used as a texture descriptor of the considered region. The procedure of extracting LBP features for facial LBP approach can obtain the relationship among the original LBP operator [10].

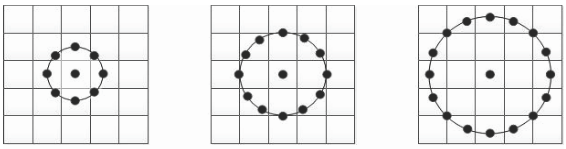


Binary pattern: 11010101

Fig.2. *Fundamental LBP operator*

LBP [10] is a gray-scale texture operator that characterizes the local spatial structure of the image texture. Given a central pixel in the image, a pattern code is computed by comparing it with its neighbors:

Where gc is the gray value of the central pixel, gp is the value of its neighbors, P is the total number of involved neighbors and R is the radius of the neighborhood. Suppose the coordinate of gc is (0, 0), then the coordinates of gp are (R*cos(2πp/P),R*sin(2πp/P)). Fig. 1 gives examples of circularly symmetric neighbor sets for different configurations of (P,R). The gray values of neighbors that are not in the center of grids can be estimated by interpolation.



(P=8, R=1.0) (P=12, R=2.0) (P=16, R=3.0)

Fig 3: *Circularly symmetric neighbor sets for different (P, R).*

$$H(k) = \sum_{i=1}^{N} \sum_{j=1}^{M} f(\mathrm{LBP}_{P,R}(i,j),k), k \in [0,k]$$

$$0,\text{otherwise}^{1,x=y}$$

$$f(x,y) =$$

Where K is the maximal LBP pattern value. The U value of an LBP pattern is defined as the number of spatial transitions (bitwise 0/1 changes) in that pattern

$$U(\mathrm{LBP}_{P,R}) = |s\langle g_{p-1} - g_c\rangle - s\langle g_0 - g_c\rangle| + \sum_{p=1}^{p-1} |s\langle g_p - g_c\rangle - s\langle g_{p-1} - g_c\rangle|$$

For example, the LBP pattern 00000000 has a U value of 0 and 01000000 has a U value of 2. The uniform LBP patterns refer to the patterns which have limited transition or discontinuities (U≤2) in the circular binary presentation [10]. It was verified that only those "uniform" patterns are fundamental patterns of local image texture [10]. In practice, the mapping from, PR LBP to 2, u PRL BP (superscript "u2" means that the uniform patterns have a U value of at most 2), which has P*(P-1)+3 distinct output values, is implemented with a lookup table of 2P elements. The dissimilarity of sample and model histograms is a test of goodness-of-fit, which could be measured with a nonparametric statistic test. In this study, the dissimilarity between a test sample S and a class model T is measured by the chi-square distance:

$$D(S,T) = \sum_{n=1}^{N} \frac{(S_n - T_n)^2}{(S_n + T_n)}$$

Where N is the number of bins,
Snare the values of the sample,
Tn are model images at the n th bin.

MAPPING METHODS

Uniform Pattern: A local binary pattern is called uniform if the binary pattern contains at most two bitwise transitions from 0 to 1 or vice versa when the bit pattern is considered circular. The patterns 00000000 (0 transitions), 01110000 (2 transitions) and 11001111 (2 transitions) are uniform. The patterns 11001001 (4 transitions) and 01010011 (6 transitions) are not uniform.

$$\mathrm{LBP}_{P,R}^{u2} = \begin{cases} I(\mathrm{LBP}_{P,R}) & \text{if } \mathrm{U}(\mathrm{LBP}_{P,R}) \leq 2, I(z) \in [0,(p-1)p+2) \\ (P-1)P+2 & \text{Otherwise} \end{cases}$$

Where,

$$U(\mathrm{LBP}_{P,R}) = |s\langle g_{p-1} - g_c\rangle - s\langle g_0 - g_c\rangle| + \sum_{p=1}^{p-1} |s\langle g_p - g_c\rangle - s\langle g_{p-1} - g_c\rangle|$$

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Uniform patterns are used to compute LBP histogram which is used to separate bin form every uniform pattern and all non-uniform patterns are assigned to single bin. For texture images, (8,1) neighborhood uniform patterns provide less than 90 percent of bit and (16,2) provide 70 percent. We have found that 90.6 percent of the patterns in the (8, 1) neighborhood and 85.2 percent of the patterns in the (8, 2) neighborhood are uniform in case of preprocessed ORL facial images.

Rotation Invariant Local Binary Pattern:
When an image is rotated in plane, the neighborhoods, $g_p$around the centre pixel,g_c will be rotated in the same direction. This rotation effect will result in different $\mathrm{LBP}_{P,R}$value. Circular bit-wise right shift operator (ROR)(:) is used to remove a rotation effect in the iteration of P times which is used to find minimal decimal value in binary pattern. The rotation invariant LBP as mentioned in [11] is defined. As

$$\mathrm{ROR}(\mathrm{LBP}_{P,R}(x,y), i)|$$

$$\mathrm{LBP}^{ri}{}_{P,R}(x,y) = \min\{\square|\square|i \in [0, p-1]\}$$

From fig 4a the original 3×3 neighborhood with threshold at the value of center pixel is introduced. Fig(4b) provides output of pixels in threshold multiplied with binomial weights. Fig (4c) provides corresponding pixels. Fig (4d) shows entire result.

Finally, the values of the eight pixels are summed to obtain the LBP number (169) of this texture unit. By definition LBP is invariant to any monotonic gray scale transformation. The texture contents of an image region are characterized by the distribution of LBP.

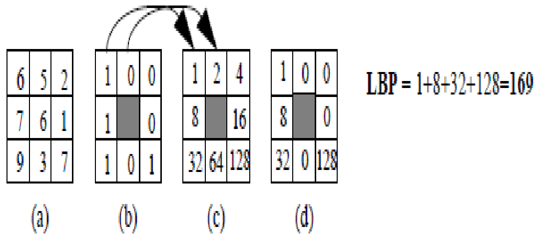

Fig.4. *Computation of Local Binary Pattern (LBP).*

LBP rotation invariant versions of LBP is shown in Fig (5). In Fig (5a), binary values of threshold neighborhood are mapped with 8-bit clockwise or counterclockwise. An arbitrary number of binary shifts are then made (Fig. 5 c), until the word matches one of the 36 different patterns (Fig. 5 d) of '0' and '1' an 8-bit word can form under rotation. The index of the matching pattern is used as the feature value, describing the rotation invariant LBP of this particular neighborhood.

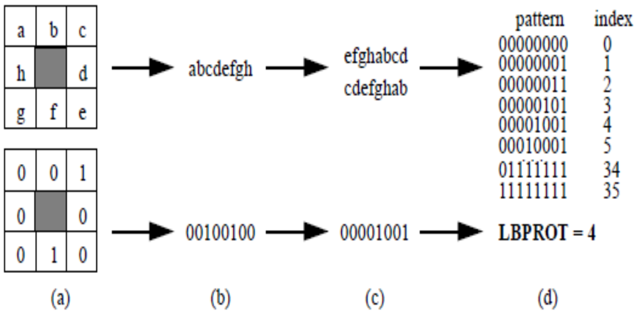

Fig.5. *Computation of LBPROT, rotation-invariant version of LBP.*

RESULTS AND DISCUSSION

There are two kind of experiments are conducted in this Paper, one of them is according to varying class and another one is according to varying Training data set on our proposed method.

EXPERIMENT-I

Conducted by according to varying training and testing data set, initially we are taken 5 images for testing and remaining 5 for training like this way decrease the training samples and increase the test samples.

EXPERIMENT-II

Conducted by according to varying the class initially 5 class are taken for measure the performance of the system and then increase the class up to 40 class for evaluate the performance of the system.

DATABASE USED

Database of face used for this project is "The ORL Database of Faces". There are ten different images of each of 40 distinct subjects .For some subjects, the images were taken at different times, varying the lighting, facial expressions and facial details such as glasses or without glasses.

Table I. *Comparison of Recognition rate of Various mapping methods of LBP*

Class	MMLBP-Uniform	MMLBP-ROR	LBP
5	96	100	92
10	96	96.0000	90
15	97.3333	94.6667	92
20	93	91.0000	89
25	94.4000	91.2000	91.2000
30	94	91.3333	91.3333
35	94.2857	91.4286	92
40	94.5000	91	91.2821

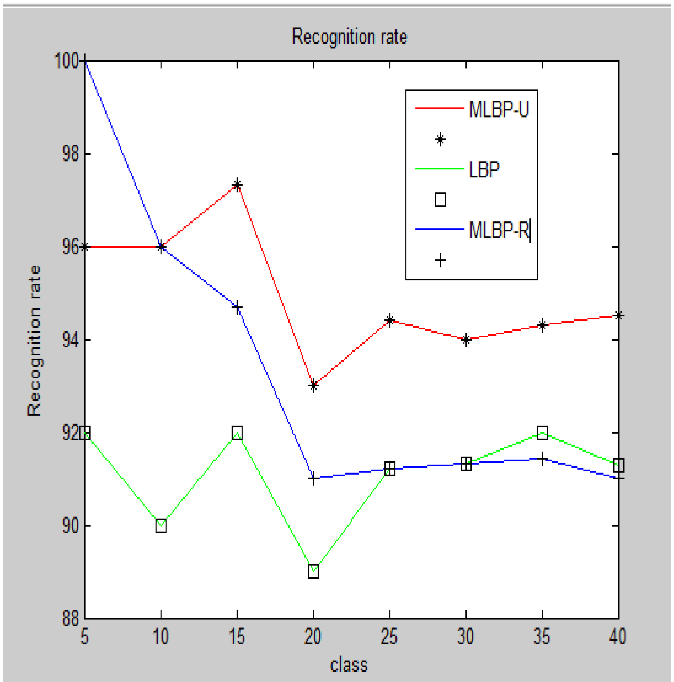

Fig 6. *Comparison of Recognition rate of various mapping methods of LBP according to different class*

Table II. *Comparison of Recognition rate of various mapping methods of LBP according to different Training sets*

Training set	MMLBP-Uniform	MMLBP-ROR	LBP
1	72.9345	61.9444	69.2308
2	86.1842	75.9868	79.8077
3	90.6015	78.5741	84.2491
4	93.4211	88.1579	89.7436
5	94.5000	91	91.2821

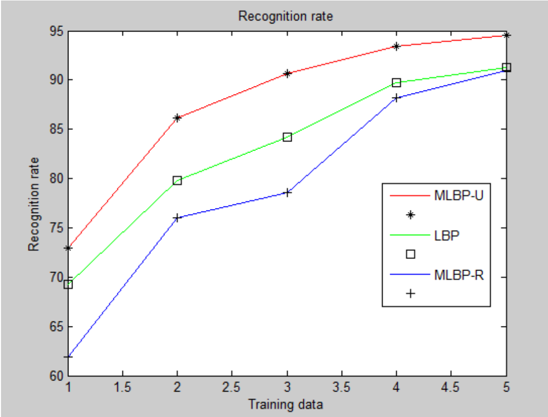

Fig 7. *Comparison of Recognition rate of various mapping methods of LBP according to different Training sets*

CONCLUSION

For the past twenty years Face recognition plays an important role in various applications like secure transactions, surveillance, security and for access control in buildings. The mentioned applications usually work in controlled environment and with help of various recognition algorithms the recognition accuracy is highly achieved.

Due to simple and high accuracy face recognition may be highly applicable in the applications like smart environments, in which computers and machines are highly to helpful to assist. To achieve a large spectrum face recognition must be easy to implement and more reliable than any other techniques and it must fit naturally within the pattern.

That Local binary pattern mapping methods like uniform pattern and rotation invariant pattern, that rotation invariant pattern initially give high accuracy then before we may increase class that will not provide sustain accuracy but uniform pattern will provide stable high accuracy for huge class so uniform pattern mapping technique is best for face recognition application by using local binary pattern.

The future smart environments must use the same modalities as that of humans with same limitations as that of humans. These above mentioned goals need to be achieved, however there no end in the technology improvement.

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