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# Face Recognition System Using Local Ternary Pattern and Signed Number Multiplication

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***ABSTRACT*****:** *This paper presents a novel approach to face recognition. The task of face recognition is to verify a claimed identity by comparing a claimed image of the individual with other images belonging to the same individual/other individual in a database. The proposed method utilizes Local Ternary Pattern and signed bit multiplication to extract local features of a face. The image is divided into small non-overlapping windows. Processing is carried out on these windows to extract features. Test image's features are compared with all the training images using Euclidean's distance. The image with lowest Euclidean distance is recognized as the true face image. If the distance between test and all training images is more than threshold then test image is considered as unrecognised image or match not found .The face recognition rate of proposed system is calculated by varying the number of images per person in training database.*

***KEYWORDS:*** *Face Recognition, Face Recognition rate, Euclidean's distance, Local Ternary Pattern, Sign Bit Multiplication.*

## I. INTRODUCTION

Face recognition is a task which human can perform effortlessly but it is extremely difficult for machines. Over the last few decades the face recognition technology is extremely popular area of research. Comparing with other biometrics, the most superiority of face biometric is its non-intrusive nature. One more advantage is that image can be taken from a long distance which is not possible in other bio metric approaches. Therefore Face Recognition (FR) Technology is one of the fastest growing biometric fields [1].

Identification and verification are two main tasks of face recognition system. In identification task the test image (unknown face) of a person is compared with all the images in train (known faces) database. The verification task performs acceptance or denial of claimed identity. The goal of verification is to find whether the given two images are of same person or not. Developing a precise face recognition system is a difficult task because faces are complex, multidimensional and susceptible to changes with time and environment. It becomes still more challenging if a person is in disguise.

In this research paper we are proposing a naval method to recognize faces .Using Local ternary pattern, signed number multiplication feature extraction is done. Euclidean classifier is used to recognise the test image. This approach gives high face recognition rate. It also provides least difference between intra class and maximum difference between inter class. Face recognition system is used in numerous applications such as bank card identification, mug shorts searching, security monitoring and surveillance. It is also used in immigration, election commission and counter terrorism etc.

This paper is organized as follows. Section II discusses face recognition approaches. Section III discusses the proposed method. Section IV discusses the feature extraction. Section V discusses recognition of face using Euclidean classifier. Section VI presents the experimental results on applying our methodology to standard database. Section VII presents the face recognition rate of proposed system. Section VIII presents the face recognition rate compared to other approaches. Finally section IX presents main conclusions of this work.

## II. LITERATURE REVIEW

Face recognition approaches on still images is broadly grouped into two categories: Holistic and feature based. In feature based method geometric characteristics of faces are compared like shape of eyes, nose, chin and mouth etc [2]. In Holistic approach Global features of input facial image is extracted. The Linear discriminant analysis (LDA), Eigen-face is examples for holistic approach. The short coming of Principal Component Analysis (PCA) [3] and Independent Component Analysis (ICA) [4] is that they are very sensitive to changes in illumination which yields poor recognition rate. Gabor filter method is quite expensive. The Local Binary Pattern (LBP) [5] used for face recognition has robust performance even in uncontrolled environment. In LBP for each window size is 3X3, the central pixel is considered as threshold the neighbouring eight pixels gives binary code. It's very simple to implement LBP but very sensitive to noise and illumination change and gives wrong code.

## III. PROPOSED METHOD

This paper proposes a navel method for extraction of features using Local Ternary Pattern (LTP) and signed bit multiplication, which uses central pixel for feature computation. The extracted features are main component of the initial set of learning images (training set).Once the features of test images are extracted, the image is classified by comparing its feature vector with other train vectors in database using Euclidean classifier. If the minimum Euclidean distance of test image is more than threshold that means test image is not present in train database and displayed as match not found otherwise the train image which has minimum Euclidean distance is displayed as recognised image. Even in the presence of occlusion, pose variation, expression and illumination change face recognition technique should provide good recognition rate. The advantage of this approach is over other face recognition system is its simplicity, speed and sensitivity to small or gradual changes on face. The workflow process of face recognition system is shown in Fig. 1.

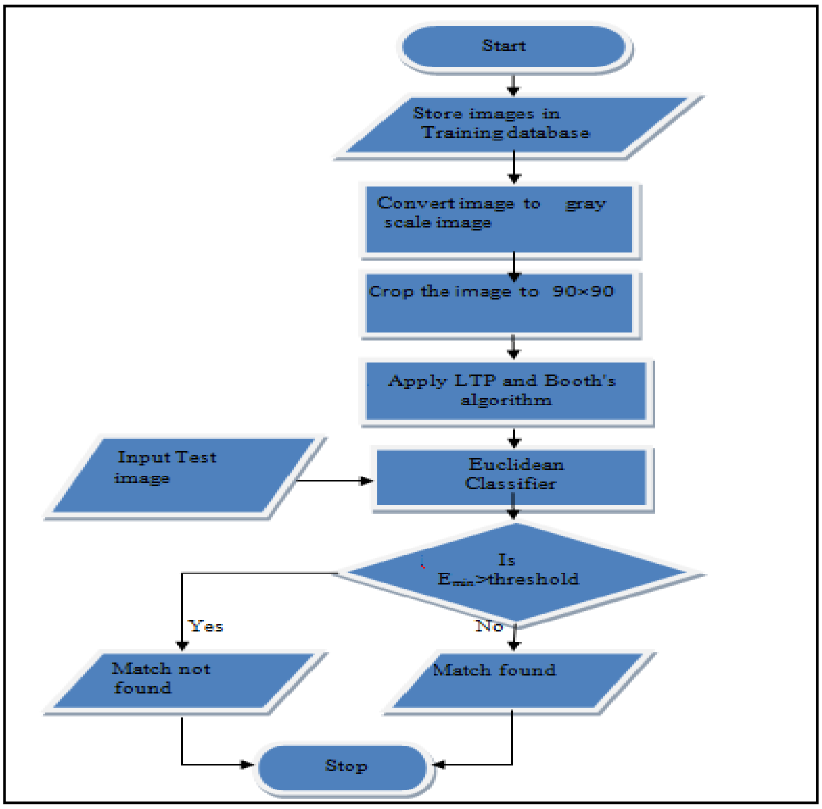


Figure 1: Workflow process of face recognition system

## IV. FEATURE EXTRACTION

Local Ternary Pattern (LTP) [6] and Booth's algorithm is used to extract features of an image. Either we can use colour images or gray scale images .We used the ORL face database. It consists of 400 images. Each image is of size 112X92, with 40 classes and each class has 10 images. The training database contains 225 images of 25 persons (9 images per person); a test database has 30 images different persons (25 known and 5 unknown). The images were taken at different times, lighting and facial expression. The faces are in upright position in frontal view, with slight left or right rotation. Each image is cropped to size of 90×90 before extracting features. Now each image is divided into 3×3 non overlapping windows. So now each image has 900 windows. LTP code is applied to each window. Let the micro pattern for 3×3 window be as shown in Fig. 2 having 9 different intensities. LTP uses threshold constant to threshold pixels into 3 values. Let t be the threshold constant. The gray values in a zone of width ±t around the central pixel are quantized to zero, the one above is quantized to +1 and the one below are quantised to -1

$$S = \begin{bmatrix} I_0 & I_7 & I_6 \\ I_1 & I_C & I_5 \\ I_2 & I_3 & I_4 \end{bmatrix}$$

Figure 2: Micro gray scale 3× 3 pattern

$$s'(i_p, i_c) = \begin{cases} +1, i_p \geq i_c + t, \\ 0, |i_p - i_c| < t, \\ -1, i_p \leq i_c - t, \end{cases} \quad (1)$$

Where $i_p$ is the neighbouring pixel with P ranging from 0 to 7. $i_c$ is the Central pixel value, $t$ is the threshold value ranges from 3 to 10. We have selected the threshold value t as 0.Here we find face as a smooth structure and choosing wrong values may lead to loss of information. So the equation 1 is modified as below

$$s'(i_p, i_c) = \begin{cases} +1, i_p > i_c, \\ 0, i_p = i_c, \\ -1, i_p < i_c, \end{cases} \quad (2)$$

Consider micro pattern as shown in Fig. 3

$$\begin{bmatrix} 90 & 95 & 80 \\ 75 & 82 & 82 \\ 255 & 100 & 60 \end{bmatrix} \rightarrow \begin{bmatrix} +1 & +1 & -1 \\ -1 & 0 & 0 \\ +1 & +1 & -1 \end{bmatrix}$$

Intensity Values in 3X3 window    corresponding LTP code

Figure 3: Illustration of the basic LTP operator.

If any of the texture pattern the central pixel information is not considered, we lose some of the information. The central pixel is 82 in the above example is taken as multiplicand. The values +1,-1, +1, +1,-1, 0,-1 and +1are considered as recode multipliers of Booth's algorithm. After multiplication the result gives the feature vector for one 3×3 window. In each image there are 900 windows, so the each image will result in feature vector of size 900.

The Booth's algorithm is used for signed bit multiplication .In 1959 this coding scheme was invented by Andrew Donald Booth. It is explained in detail with the following example [7]. Consider N-bit multiplier x. If x is negative number represent it in 2's compliment form. In multiplier include the implicit least significant bit i.e. $x_{-1}$=0. For each bit of $x_i$, for i running from 0 to N-1.Depending on the adjacent bits of x operations are performed. If $x_i$ and $x_{i-1}$ are equal the product (A and Q) are shifted right by one bit. If $x_i$=0 and $x_{i-1}$=1, then add 2's compliment of multiplicand to A and shift the product right by one bit. If $x_i$=1 and $xi_{-1}$=0, then add multiplicand to A and shift product right by one bit.

Let x=$1011_2$ be multiplier representing -5 in 2's compliment form .Assume implied zero as least significant bit. The number now becomes

1 0 1 1 0 Multiplier with implied 0
-1 +1 0 -1 Recoded multiplier bits

Let multiplicand be 6. Now 6×-5=30, x=1011, M=0110, -M=1010
$1011_2$×$0110_2$=$11100010_2$

TABLE I: Booth's Multiplication table for 6×-5=-30

| *Step* | *A* | *Q* | *$Q_{-1}$* | *Recoded multiplier* | *M= 0110* | *Action* |
|---|---|---|---|---|---|---|
| Initial | 0000 | 1011 | 0 | | | |
| 1 | 1010<br>1101 | 1011<br>0101 | 1<br>1 | -1 | | A=A-M<br>shift right |
| 2 | 1110 | 1010 | 1 | 0 | | shift right |
| 3 | 0100<br>0010 | 1010<br>0101 | 1<br>0 | +1 | | A=A+M<br>shift right |
| 4 | 1100<br>1110 | 0101<br>0010 | 1<br>1 | -1 | | A=A-M<br>shift right |

$11100010_2$=-30, in 2's compliment form.

Local ternary pattern and Booth's algorithm together are used to extract features in face recognition. There are 225 images in train data base. We generate feature vector for all these images.

## V. RECOGNITION OF FACE USING EUCLIDEAN CLASSIFIER

The last step is the classification of testing image. The testing image is converted into a vector using LTP and Booth's algorithm .If A and B are two vectors of length N, the Euclidean distance between them calculated using Euclidean distance as follows.

Euclidean distance:

$$d\,(A, B) = \sqrt{\sum_{i=1}^{N}(a_i - b_i)^2} = ||A - B|| \qquad (3)$$

If minimum distance between test and training faces is higher than thresh hold the test face is considered as unknown, else recognised image is displayed. It is very important to set the value threshold in program, if there is no threshold value the unknown image is displayed as one of the known images in database. Therefore it is necessary to set value of threshold in program. In the literature, there is no formula to set value of threshold. The most commonly method is first calculate minimum distance of each test image from all training images place that in a vector raster. Now threshold is taken as 0.8 times of maximum value of raster.

$$\text{Threshold} = 0.8 * \max\,(\text{raster}) \qquad (4)$$

## VI. EXPERIMENTAL RESULTS

The experiment is performed using ORL images of database using MATLAB. The training database contains 25X9=225 images of 25 persons (9 images per person). A test database consists of 30 images of persons out of which 25 are known and 5 are unknown. All the images are of dimensions of 112×92 size in jpg form and in an upright frontal position. All the images are of Gray scale however we can use colour database also. Some pictures from ORL data base are shown in Fig. 4

Figure 4: Some of face images from ORL system

The Test image number of a person is given as input to the program. The program will compare test image with all the training images. The image with lowest Euclidean distance is displayed as recognised face if the minimum Euclidean distance is less than threshold; otherwise it is displayed as unknown image.

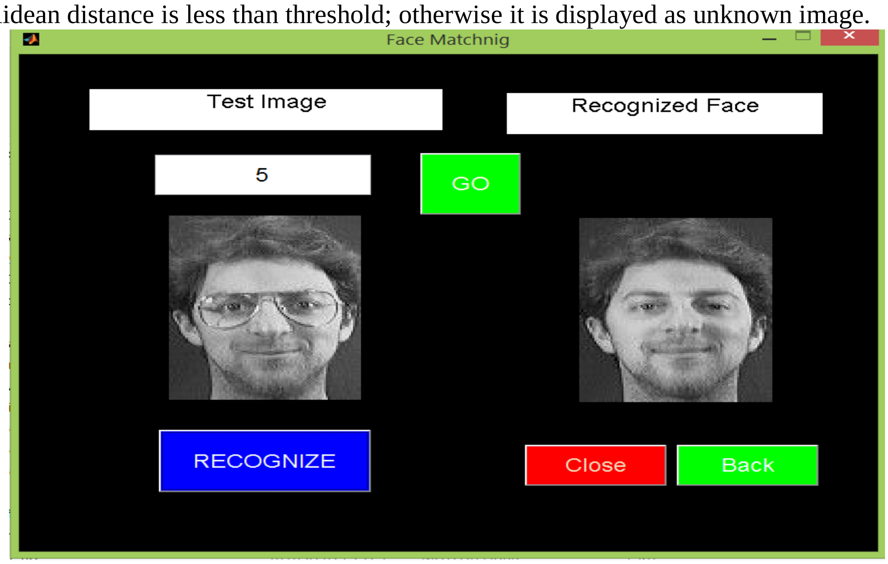


Figure 5: GUI of face recognition system

The first test is done for image number 5 which is present in training database. The Euclidean distance between test image and all the images in training data base is given in Fig. 6.The test image has minimum Euclidean distance less than threshold, so it is a known image. The Euclidean distance is minimum for training image number 43 as shown in Fig. 6.This means that test image corresponds to image number 43 from training data base and it is displayed in Fig. 5.

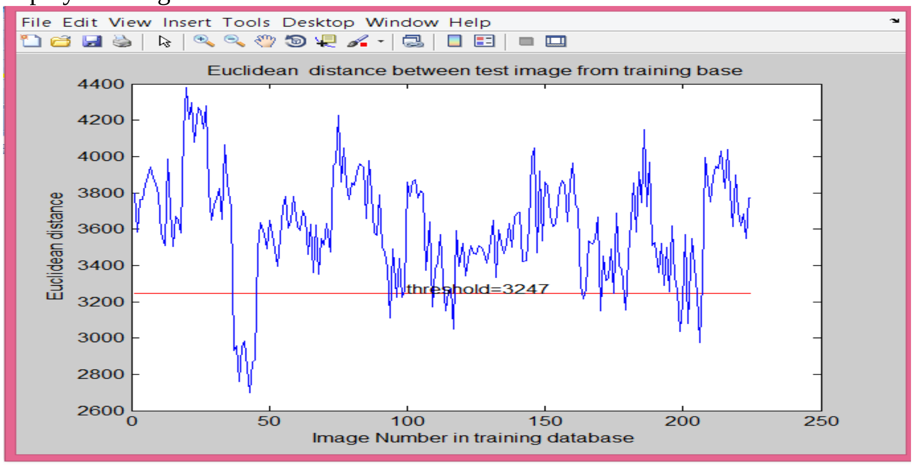


Figure 6: Euclidean distance of known test image from training database

The second test image number is 8 which is also present in database but with different expression as in Fig. 7. This also has minimum Euclidean distance less than threshold, therefore it is also a known image. The Fig. 8 shows the Euclidean distance of test image from the other images of training data base. The distance is minimum for image number 67 in training data base and that is displayed in Fig. 7.

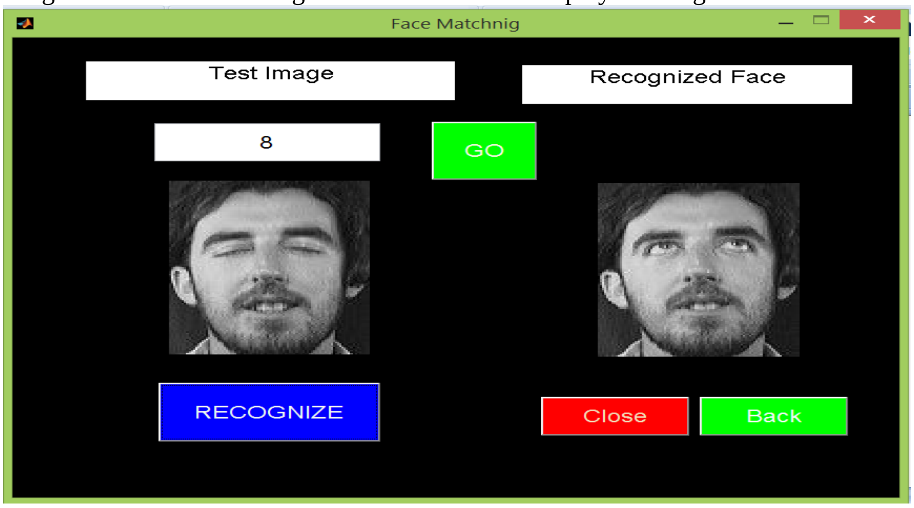


Figure 7: Recognised face with different expression

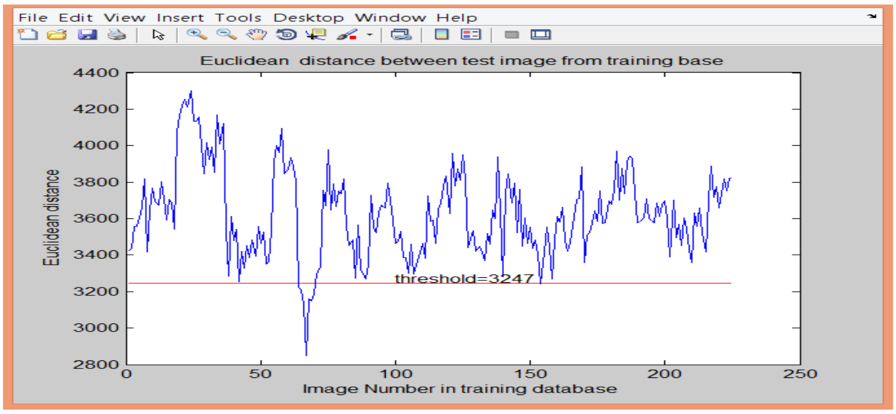


Figure 8: Euclidean distance of known test image from training database

The third test image is unknown image i.e. it is not present in train data base. The minimum Euclidean distance for this image greater than threshold as shown in Fig. 10. Therefore it is unknown face as shown in image in Fig. 9.

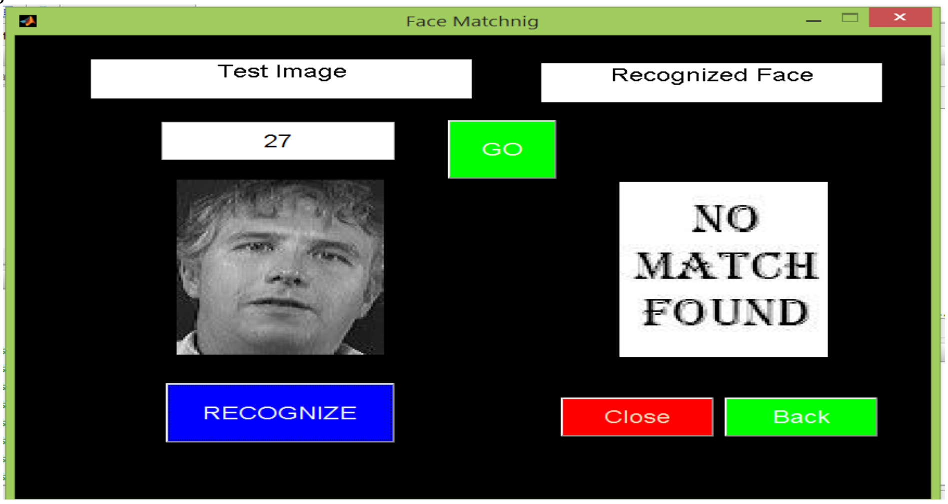


Figure 9: Image of unknown person

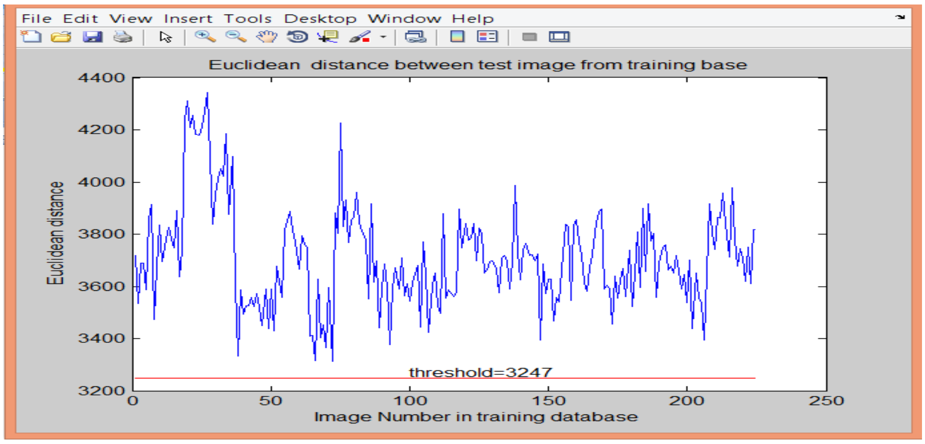


Figure 10: Euclidean distance of unknown test image from the training database.

## VII. FACE RECOGNITION RATE OF PROPOSED METHOD

We have conducted experiment using ORL database of 400 images . It gives face recognition rate of 90% as shown in Fig.11. The face recognition rate shows how many test images correctly match with the training images. It specifies the accuracy of face recognition system. In general only few images of person are available in training database, so it is necessary to note the effect of number of images per person on face recognition rate.

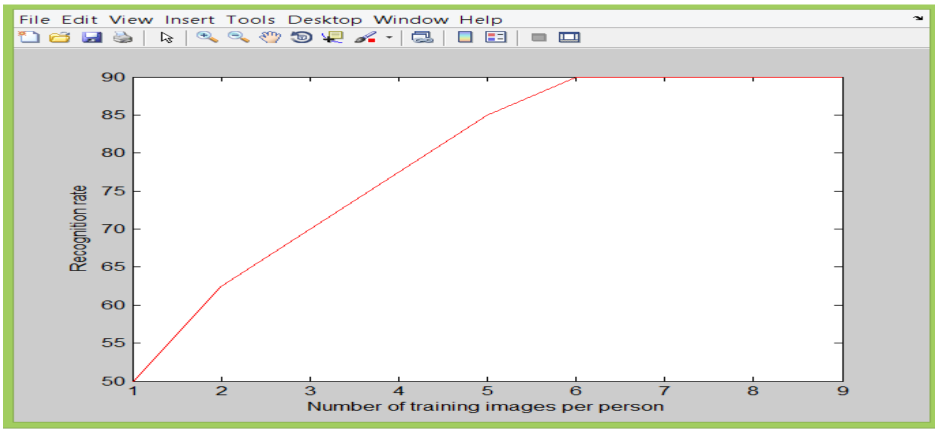


Figure 11: Face recognition rate Vs number of training images per person

If the number of images per person is 1 the face recognition rate is 50%. As the number of images in training database increases the recognition rate increases. If the images per person in training data base are 6 or more than that the face recognition rate is 90%

## VIII. COMPARISION WITH RELATED APPROACHES

Arindam Kar et.al have used PCA and have obtained the accuracy of 80.5[8], have reported the recognition rate on ORL database as 80.5% and with Independent Component Analysis (ICA) as 85%. Arindam Kar et. al [9] in another work have reported the recognition rate with Principle Component Analysis as 82.86%. Nisar et.al [10] have reported recognition rate of 63% on Locally Preserving Projection (LPP). In this approach we can obtain face recognition rate of 90%, if the number of training images per person is more than or equal to 6.The face recognition of related works is compared with the proposed method and it is shown in Chart 1.

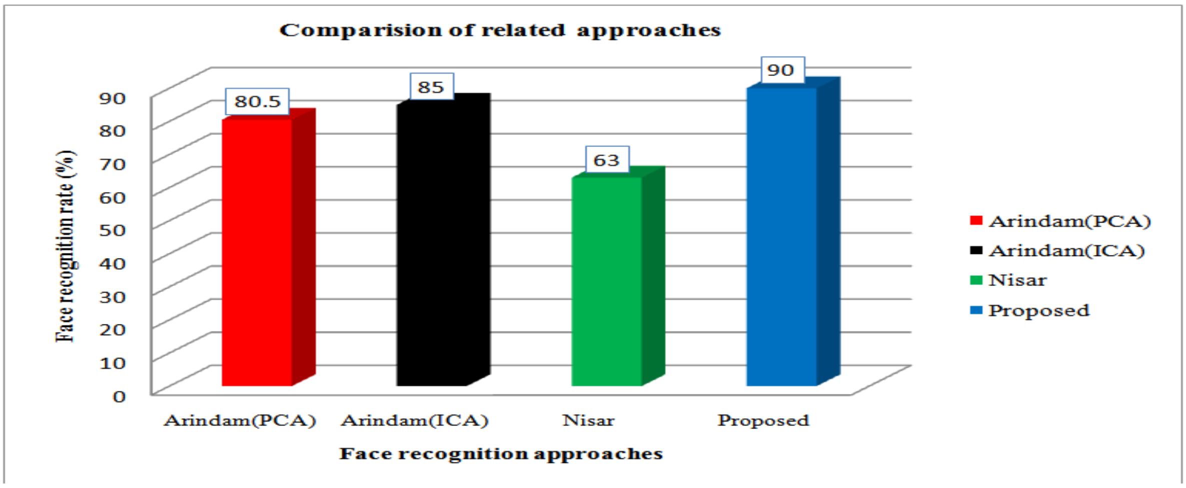


Chart 1: Comparison of related approaches

## IX. CONCLUSION

This paper presents new local texture descriptor using Local ternary pattern and signed bit multiplication for robust face recognition. The proposed is very efficient as it uses less number of features. The approach is efficient even images have variation in illumination, pose and expression. Pre processing on data set is not done which could improve performance. It is absolutely clear that compared to other work done the proposed system has high face recognition rate and it is more efficient. The proposed approach is limited to the images of human faces of vertical frontal views.

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