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Hybrid Feature Description with Probabilistic Neural Network for Adaptive Face Recognition with Angular Variance

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ABSTRACT: The features descriptors describe the data from the images in the form of the low level features, color based features, matrix quality or matrix representation thresholds, texture based feature or binary features over the input face database. The low-level feature descriptor has been utilized in the proposed model along with the Zernike Moments algorithm for the purpose of feature description. The Zernike moments feature has been used for the purpose of angular shift of the face samples in the input dataset. The Zernike moments describes the features by performing the evaluation over the given dataset in the form of angular shift of the face object in the horizontal and vertical domains. Also the low level features have been described over the input dataset to extract the important key points in the given image set. The fast retina key points (FREAK) over speeded up robust features (SURF) has been performed to obtain the low level features, which is further processed using the neural network for the feature classification and to produce the person recognition decision. The various experiments have been conducted over the input dataset and the results have been obtained in the various forms of statistical accuracy measures. The proposed model has been found efficient than the existing model in the terms of detection accuracy, which justifies the high performance of the proposed model in analysing and recognizing the faces.

KEYWORDS: Feature Descriptor, Speeded up robust features, Face Recognition, Neural network.

I. INTRODUCTION

In Image Processing, Face recognition is the fundamental feature to acknowledge completely different individual's. When there was not any system for face recognition, it was done by humans because at that time, a person was introduced to limited number of individual's .Now a days a person comes in contact with many more number of individuals due to increased mobility facilitated by new modes of transport [2].so it has become difficult to recognize all new faces. Hence there arose the need to find some system to recognize right individual. Early Chinese used fingerprints in business transactions to recognize humans.

Face detection Methods: Face detection is a computer technology that automatically determines the locations and size of human in digital pictures [1] .It perceives facial components and overlooks whatever else, for example, structures trees and bodies. Face detection is a popular feature used in biometrics, digital cameras and social tagging. There are various types of face detection is available such as skin color model, Viola Jones algorithm etc.

Skin color model for face Detection: Skin color model is employed to detect the skin region of the different images. This model has been divided into three namely RGB color space, YCbCr color model and HSV color model [4].
RGB color space: RGB color model has all colors that can be had by using primary colors-Red, Blue and Green. Its form is like a three dimensional cube with these colors. This is made use of by most of computer graphics. This color model is not fully successful in a number of image processing algorithms[3][4]**.**
YCbCrColor Space: This color space is used to mainly represent digital video information, In This model a color is represented by brightness in addition to two different signals. Y is the brightness component [3]. It is calculated as the

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weighted sum of RGB. By subtracting a reference from the blue component Cb can be computed. Similarly by minus a reference value from the red component can be determined.
"rgb2YCbCr" and "Ycbcr2rgb" are MATLAB functions for the transformations used during implementation [3].

HSV Color Space:HSV Color Space rests upon three color components. The color defining component is H, the hue component. S is the second component called saturation component and this component defines how pure the color is. The third component V. This color space is in the form of 3-dimensional hexacone. On a circular scale the value of H varies from 0 to 1.S also varies from 0 to 1. If the color purity is cent percent.it is represented by 1. Similarly the Values of V can change from o to 1."rgb2hsv" and "hsv2rgb" are MATLAB functions for the transformations used during implementation.

II. RELATED WORK

In [7] authors arepresent face recognition problem as a formidable problem in the field of image analysis. The security of information is increasingly becoming more and more difficult as well as significant .CCTV cameras are presently common in air ports, banks, ATM, offices and many other confidential locations .Face recognition is a biometric method employed 18 to identify a person from an image .The best face recognition system should have the ability to detect a face from an features of the image and then recognizing it notwithstanding the lighting, illumination aging, expression, rotation of image or pose. Their paper firstly describes the common methods like holistic method, feature extraction method and hybrid methods. In the second part are described the applications with instances in the third is described the future research direction in the field.In [8] authors arelearning displayed a procedure that aims designed and build a face recognition system. In the proposed system, viola jones algorithm is employed for detecting faces from a given image. Artificial Neural Network is utilized to recognize faces that have been detected from the given input image. When implemented the system can recognize faces with 87.05% accuracy. The system yields the best results if the distance between the camera and the person is about 150 cm yielding 87.59% accurate rate. The optimum lighting for this system is 480 lumens with an accuracy rate of 88.64%.For best results,the person must be directly facing the camera.In [9] authorsproposed an identical twins recognition system based on facial features using the geometrical moment. The applied geometrical moment is Pseudo –Zernike Moment (PZM) which is utilized as an element extractor in case of facial area of similar twins face – images. Ada Boost Approach is utilized to identify face area in a picture. The two data bases Twins Days Special and Iranian. Twin society that have scaled, sifted and rotated images of identical twins are used to test the suggested method .The efficacy of the suggested method recognize, identical twins is proved by the outcomes. The outcomes also depict that the method suggested is robust to rotation,scaling and varying lighting.In [10] authorspresented another algorithm for the face detection of identical twins that requires subtle differentiation. In this algorithm, local region pseudo Zernike Moments (PZM) are employed to extract features. Adaboost method is utilized to detect the facial area in the input image. This detected facial area is broken down into local spaces or regions. Geometric moments in the end to extract features of identical twins to these local spaces .Local region PZM is utilized as feature extractor for identical twins.In [24] authors have proposed an efficient algorithm to calculate the Zernike Moments very accurately at high orders. Zernike moments are very useful in image analysis as well as in pattern recognition because of their characteristic properties of rotation invariance and of orthogonality .But direct calculation of Zernike moments is very costly which curtails their utility especially at high orders. Efforts have been made to decrease the cost of computation by using quantized polar coordinate systems that also lessen the accuracy of these moments. To keep the accuracy stable, not any type of coordinate transformation is used and arbitrary precision arithmetic is used. In order to reduce the computational complication, the common terms in Zernike moments with different order and repetition are detected. The outcomes of the experiments reveal that the proposed algorithm is better in terms of accuracy than other algorithms .Also the proposed algorithm has comparable computational complexity when using large images and also in case of high order moments.In [25] authors haveproposed a brand new method for the classification of frontal face pictures. In this approach first of all Pseudo Zernike moment invariants (PZMI) are employed to extract features from the world wide information of the images. After that Radial Basis Function (RBF) Network is used for the classification of facial expressions on the basis of features extracted using PZMI. Pre-processing of the picture was done to increase their gray –level that serves to enhance the exactness of classification. The achieved rate of classification, using TAFFE database was found to be 98.33% which leads one to conclude classification.

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III. EXPERIMENTAL DESIGN

The Zernike moments algorithm has been utilized for the detection and analysis of the position shift of the given object in the given image containing the face images. The multi-level polynomial values have been calculated under this simulation in order to recognize the face on the basis of the radial polynomial features. The Zernike moments over the given 2-D plane works on the basis of summation of the procedural computation for the object position analysis. The following equation defines the radial polynomial calculation over the input image:

$$R_{nm}(\rho) = \sum_{s=0}^{(n-|m|)/2} c(n,m,s)\rho^{n-2s}, \qquad (1)$$

Where c is the variance calculated with the polynomial vectors, whereas n givens the radial degree and m gives the azimuth degree. The c is calculated with the following equation:

$$c(n,m,s) = (-1)^s \frac{(n-s)!}{s!((n+|m|)/2-s)!((n-|m|)/2-s)!}. \qquad (2)$$

Where n denotes the order of polynomial and the m denotes the order to repetition in the given equation. The value of n is always taken as the non-negative values which can be contain the zero. The primary conditions of the (n-|m|) and (|m|<=n) are tested in this simulation. The tested radial polynomials when satisfies the latter conditions, the repetitive index is returned and the value is returned to the user with the orthogonal properties calculated in the procedure.

Fast Retina Key Points: The fast retina key points (FREAK) method determines the binary features from the input image which are further utilized to calculate the similarity between the testing image and the training image.

FREAK is an important binary feature descriptor which can be applied over the hessian of Gaussians or overall difference of Gaussians. The FREAK is the major feature descriptor for binary feature based classification to compute the visual distance based upon the probabilistic or non-probabilistic classification:

$$d_{f,t}^2(u,v) = \sum_{x,y}[f(x,y) - t(x-u, y-v)]^2 \qquad (1)$$

Where the target image is given by *f* and the visual features are given by *t*. The object position are given as the (u, v) and the summation of the similarity between the two images is defined as (x, y).

IV. PROPOSED ALGORITHM

Proposed Face Recognition Model

The Proposed Methodology and flow chart of new face detection and Recognition system has described below:

Algorithm: Proposed Face Recognition Model

The steps of proposed algorithm of face detection and Recognition has following below:

- Load the image into run time memory.
- Acquire the image in the face detection program.
- Apply the pixel by pixel evaluation by slide window fashion and to recognize the similar pixel regions.
- To shortlist the similar pixel regions in the given image after the pixel by pixel evaluation and matching.
- Measure and mark the areas containing the similar pixel regions.
- Extract the face region and draw the bounded box around face region.

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- To extract the face region from the marked regions and obtain the FREAK features from the input file
- Pass on the extract feature to the recognized algorithm.
- Acquire the image containing the extracted face region (ROI).
- Test and Training image pre-processing.
- Face features extraction in the form of angle/degree of face and length and width of phase
- Apply correlation algorithm on the testing and training features.
- Apply fuzzy-logic to short-list the matching training samples according to the face feature extraction and matching.
- Apply pattern based neural network.

  a. Create the feed forward network of the neurons.

  b. Start the neural network training over the input training data.

  c. Compute the template similarity using the neural network.
- Compute the maximum matching sample and return in the decision logic.

V. RESULTS ANALYSIS

Elapsed Time: is defined as measurement of time completing an activity, duty or task. In other words, it is defined as difference between the finishing time and the starting time of the neural network.

Elapsed Time =Finishing Time –Starting Time.

Fig1:shows elapsed time graph of neural network. X-axes represent no of transactions and y-axes represent time in seconds. This graph shows two lines blue and red. Blue line show elapsed time of neural network .Red line represents mean time (average time) of elapsed time of the neural network. Some point of elapsed time is greater than average time of neural network and some point of elapsed time is below the average time of neural network.

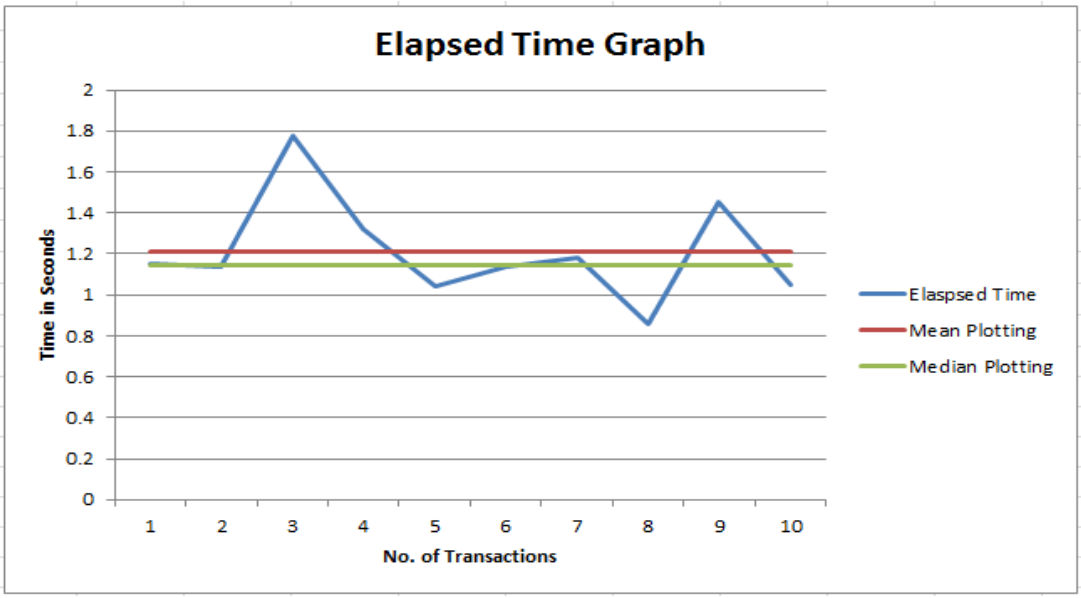

Fig1: Elapsed Time Graph for neural Network

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Angular based accuracy of system:

The table1shows the results obtained from the proposed model over the samples between non-zero angles of 60 degree and -60 degree. The higher accuracy of more than 95% has been achieved with all of the given samples, which is considered state-of-art performance of the proposed model.

Table 1: The angle based accuracy analysis of the face recognition system

Person / Angles	1	2	3	4	5	6	7
60	10	9	10	10	9	9	10
45	9	10	10	9	9	9	9
15	10	10	10	10	10	10	10
-15	10	10	10	10	10	10	10
-45	10	10	10	10	9	10	8
-60	9	10	9	10	10	8	9

The fig2 shows the results obtained from the proposed model in evaluating the non-zero angles between the 60 and -60 degrees. The proposed model has been consistently found higher than the 95% accuracy over all of the samples. At y-axis represent the number of correct samples and x-axis represent the sample ID. In bar graph to show the number correct sample out of 10 samplesfor a single person.

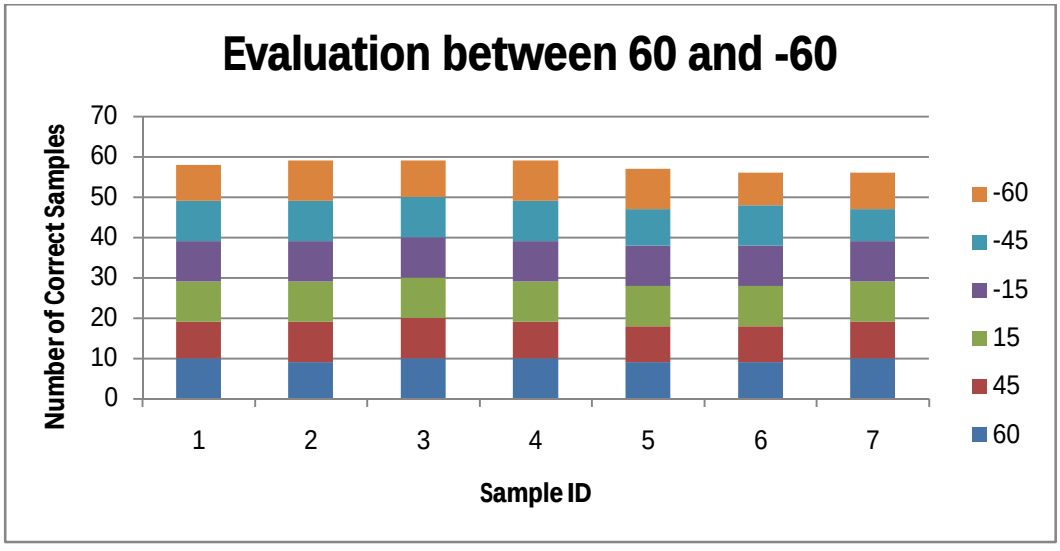

Fig2: The evaluation of the correct results between the non-zero angles of -60 to +60

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Table 2 has shown the effective results in the proposed model when individually evaluated in the terms of different angles or the testing samples. The proposed model has been found higher than the 92% is all of the transactions. The proposed model has been found higher than the average of the 95% in all of the transactions

Table 2: The total number of correct decision out of 60 in angle based accuracy analysis

Sample ID	60	45	15	-15	-45	-60	Overall Accuracy
1	10	9	10	10	10	9	96.67
2	9	10	10	10	10	10	98.33
3	10	10	10	10	10	9	98.33
4	10	9	10	10	10	10	98.33
5	9	9	10	10	9	10	95.00
6	9	9	10	10	10	8	93.33
7	10	9	10	10	8	9	93.33
Total	67/70	65/70	70/70	70/70	67/70	65/70	
Percentage	95.71	92.85	100	100	95.71	92.85	

The fig3 clarifies the number of samples per angle obtained from the results of the angular rotation. The proposed model has been found effective when evaluated over the number of samples in the angles defined at 0,90degree and -90 degree in each direction.At y-axis represent the number of correct samples and x-axis represent the sample ID. In bar graph to show the number correct sample out of 10 samples for a single person.

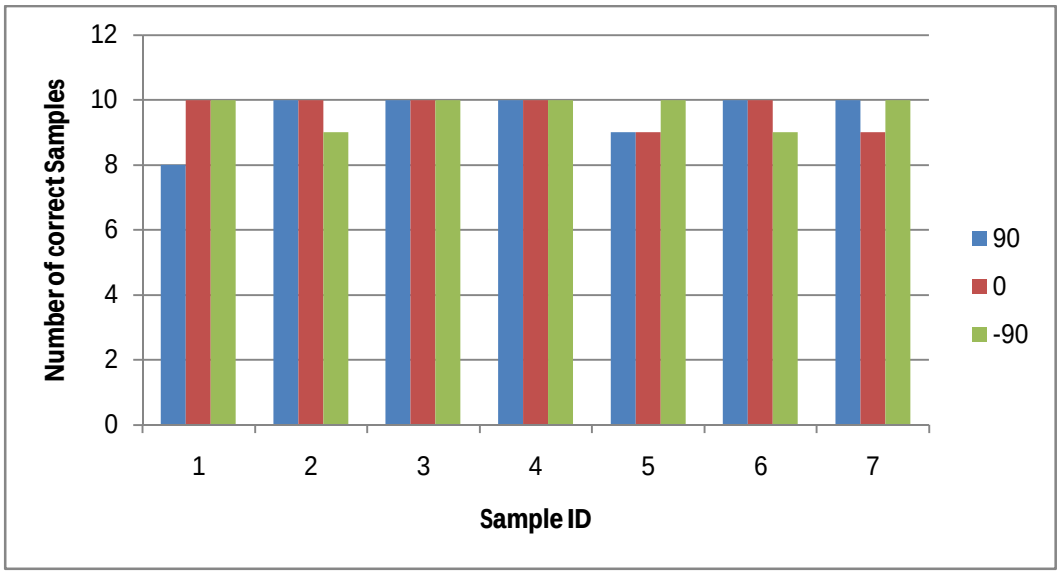

Fig.3: The number of samples presented graphically over angle of 0,90 and -90

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Comparison: Proposed technique show better result as compare to existing techniques, when we apply it on a large dataset of images. This technique allows recognition against pose variations and at any angle between -90 degree and +90 degree and provide better recognition rate. The comparison table of existing algorithms and proposed algorithm is as follows.

Table 3: Comparison of different algorithms

S. No	Algorithm	Database	Accuracy/Recognition rate
1	Viola-jones for face Detection and ANN for face Recognition	Face Pix Database	87.05%
2	Hybrid approach of face detection and recognition system using skin color model with Neural Network	Face Pix Database	94.64%

VI. CONCLUSION AND FUTURE WORK

The proposed work is based on face recognition system which will be helpful against poses and different angles of system. In this system skin color model is used for face detection, two methods are used for feature extraction which is Zernike Moments (ZMs) and FREAK to collect global features of image. Zernike Moments extract angle and amplitude of images and FREAK find similarities of images. Neural network is used for pattern classification and recognition with one input, one output and 10 hidden layers. Feature set extracted using ZMs and FREAK is used as the training set of neural network. Network will produce output for testing image from dataset and show identity of face. Neural network is an automatic system which can classify the training data according to target data, this classification is done by the hidden layers. When the results of proposed algorithm were compared with existing algorithms, it has found former performs better. FREAK is used in this algorithm to find more similar image. Proposed algorithm is trained and test on Face Pix database which contains 6956 face image of different 94 persons for face recognition, 74 face images of every person. Format of images is in .jpg. It was found that proposed system of face recognition provides better accuracy (94.64%) as compared to existing algorithm of Viola Jones for face detection and ANN for recognition (87.05%). Many techniques have been discussed in literature surveyed which provide good recognition rate for recognition but these all fail at many times in pose variation, makeup, light effects, age variation and other conditions. Future work will be done to improve the qualities of recognition system. Existing systems fail in low resolution images and system should be real time than images used for recognition. In future scope, Multi-detection and Recognition of new algorithm should be developed. Also new system would be used on real time application for authentication and security purpose. The proposed model can be enhanced to work with samples collected within low light. Also, the proposed model must be extended to refuse non-available samples in the training database to return the null result.

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