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An Improved Face Recognition Approach Using MC-SVM Classification with Hybrid Feature Extraction Technique

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Abstract: In order to recognize a face, many processes contribute to complete this process such as detection of a face, image processing, feature extraction, and classification. All these processes are executed in different ways. There are several techniques to carry out these tasks. Researchers have delved deeper into this field to study different techniques and their efficiency in terms of recognizing the face. A significant number of studies have been carried out to this end. Recently, a technique of feature extraction and face recognition algorithm was proposed in which PCA was used to extract the features: which is efficient but lacks in some aspects. Thus, in this paper, a novel approach is presented in which the concept of Region of Interest (RoI) is introduced to the input image. PCA feature extraction is replaced by implementing hybrid LBP-LPQ. These techniques offer various advantages over PCA. Multi-class SVM is used for classification purposes. MATLAB is used to perform simulation results. Performance evaluation of the proposed method is carried out in terms of different parameters such as recognition time for different numbers of samples and recognition rate for different dimensions and number of samples. From the comparative analysis, the proposed technique outperformed the existing approaches.

Keywords: Face recognition, Region of interest, LBP, LPQ

I. INTRODUCTION

In today's world, biometrics is an automatic recognition mechanism to identify an individual on the basis of physical and behavioral characteristics [1]. It is classified into different recognition types in physiological areas such as face, fingerprint, palm, iris, and DNA [2]. Taking into account the behavioural pattern, signature, keystrokes, and voice are some parameters that are used for the identification of an individual.

Nowadays the face recognition system is evolving as a widely used authentication system. This type of authentication system can be used n various fields such as surveillance systems. This type of biometric system uses distinctive features for authentication of an individual this is the reason behind its wide level acceptance [3]. It is used for various observation frameworks of security objectives because there is no need for making comparisons in objects. The main benefit of the face recognition system is its uniqueness and ability for accepting as compared to biometric systems. Although the biometric system is assumed to be accurate but detecting face is a quite difficult procedure because face detection faces various changes. The speed with which face is detected and accuracy in face detection are the major issues. Plenty of schemes have been suggested for detection of the face but results obtained using these schemes were not considered as efficient ones [4].

Even though face recognition systems are being used for person authentication and also consider as one of the successful methods but still these system does not have a foolproof method of automatic human recognition. The sensors used in biometric systems and chips are becoming inexpensive, compact as well as fast. Thus, this increasingly fast technology requires a better solution to the issues raising day to day life. Some of the challenges faced by these systems are mentioned as:

- **Recognition Performance:** the method should be effectively represented and recognizable such as how to recognize a person's identity with high accuracy such as 99.999%.

- **System Security:** by this factor, it is mandatory to guarantee that the system is not vulnerable to any kind of damage or interruption.
- **Privacy Issues:** this factor is considered as a vital parameter for any recognition system. Such as how the system can be prevented from intruder and trusted system administrators can access the system.

A significant number of techniques are developed by the researchers to enhance the process of face recognition using various approaches. The techniques such as KNN [5], Principle component analysis (PCA) [6], LDA [7], Independent Component Analysis [8], Gabor Filter [9], and Local Binary Pattern (LBP) [10] are most commonly implemented. Each technique has better performance in its own way but there are some drawbacks to these techniques. A literature survey is also carried out to understand the working of different techniques. To attain effective face recognition techniques, many authors have developed different approaches which are mentioned below:

S. Wang, et al., [11] had used the PCA and 2DPCA feature extraction schemes and compared their results by the experimental setup. The author used the PCA scheme for extracting the features. And for the face recognition part, Euclidean distance was used for computing the projection points of every image of face in face area for making the judgment about the face to be recognized.

W. Zhao, et al., [12] designed a face subspace where they implemented LDA for executing the classification. FERET dataset was used for enhancing the main parts of the face instead of feeding the original image to the LDA classifier. With the help of PCA and LDA, a hybrid classifier was designed. It has shown the effective standard measures which could be used for various image recognition purposes.

A. Ghahari, et al., [13] designed an automatic system that used the facial expression analysis system comprising detection of a face, extraction of components of facial expressions, their representation, and identification of facial expressions. Results of the proposed system verified that the suggested Automatic Facial Expression Analysis system could be implemented for real-time facial expression and emotion classification purposes.

X. Liang, et al., [14] proposed the facial feature extraction scheme depending on the SDFCNN. Shallow features of the face were extracted by applying the parallel multiple conventional layers of various scales. From the results of the facial feature extracted using the SDFCNN, it was found that the SDFCNN gave better representation as compared to the Deep-ID network. On the LFW system, accuracy was 95.72%.

W. Zhao, et al., [15] Author proposed the facial feature extraction technique depending on the local Gabor filter bank and PCA From the experimental results it was shown that local Gabor filter bank was designed using 12 Gabor filter gave a high performance in feature point extraction which resulted in improved efficiency. In [5], [16-22] PCA is utilized by the authors with different techniques to recognize the features of the human face.

This paper presents a novel technique of recognizing the face. The organization of the paper is as follows: Section 1 defines the role of face recognition and also a literature survey is presented. Further, in section 2, the process of face recognition is explained. Section 3 delineates the proposed work followed by the simulation results. Eventually, the paper is concluded.

II. FACE RECOGNITION APPROACH

Face recognition is classified into the following three phases. The flow of these processes is shown in fig. 1.

A. *Face Detection*

The main task of this step is to know (i) if the human face is seen in the image and (ii) location of the face in an image. The expected results of this step are packets having the input image. For making for a robust system and reducing the complexity of the design, alignment of the face is done for scaling and orienting these patches. Instead of working as the pre-processing for the face recognition, it can be used in the ROI detection, retargeting purpose, classification of video and image, etc. [23].

B. *Face Recognition*

After deciding the representation for each face, the next phase is identifying the parameters of these faces. For attaining automatic identification, there is a need for building the database. For every person, multiple images are taken and features of these images are stored in the database after extraction. After that when the input image with the face is taken, face detection and feature extraction are executed and comparison is done with the features of the class in the database.

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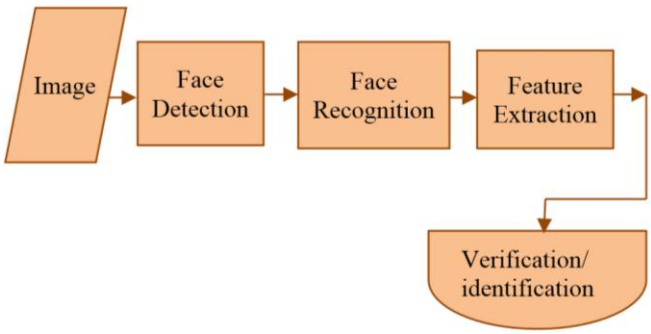

Fig. 1 Configuration of General Face Recognition Structure

C. *Feature Extraction*

After detecting the face, the next step is to extract the human face patches from the image. Direct use of these patches offers some demerits. Each patch posses higher than 1000 pixels which are large for making the robust recognition system. Second is that patches can be taken from the separate alignments of a camera having different expressions for face, illuminations and can face the blood vessel blockage and clutter. For removing these drawbacks, feature extraction is performed for packing the information, reduction of dimensions, extraction of salience and cleaning of noise. After the execution of this step, the face packet is changed in the vector with the fixed dimension or the set of fiducial points with respect to their respective locations.

III. PROPOSED WORK

The traditional research works implements the PCA for feature extraction but it fails to achieve higher efficiency. The drawback was that the standard PCA always finds linear principal components to represent the data in a lower dimension. There is also a need for nonlinear principal component. Therefore, the proposed work implements the LBP and LPQ hybrid approach for feature extraction for effective pattern extraction. This will lead to enhancement of feature extraction even in large data set as PCA is not successful if a dataset is going to increase. Along with this, the proposed work implements the feature extraction from the region of interest which will reduce unwanted information away from the classification process. For the purpose of classification, the Multi-Class SVM will be used instead of clustering-based classification as it is only successful if all data is different enough for classification. The methodology opted by the proposed work is as follows and also a flowchart is presented in fig. 2.

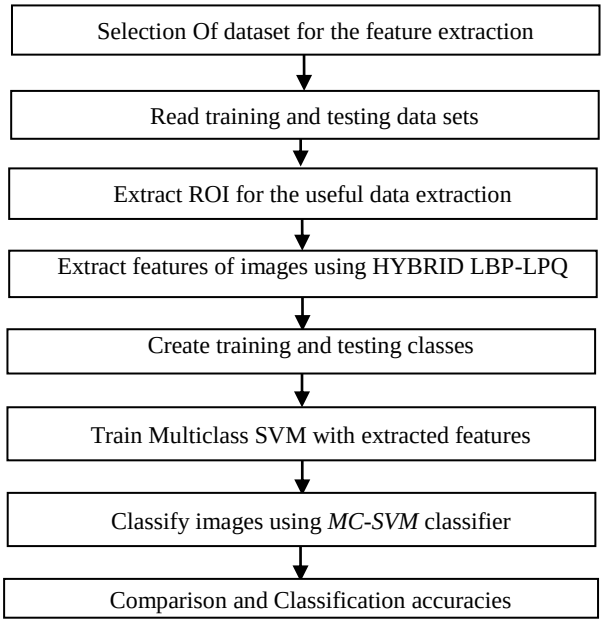

Fig. 2 Flowchart of the proposed model

Step 1. The first step is to select the image data set on which the feature extraction technique will be applied.
Step 2. After the selection of the dataset, the data is sent for training and testing.
Step 3. In the third phase, the region of interest is extracted from the images. In this process, only the useful data is extracted.

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Step 4. The feature extraction technique presented in this paper (HYBRID LBP-LPQ) will be applied to the images.
Step 5. The classes will be then trained and tested.
Step 6. Multi-class SVM will be trained with the extracted features and the images will be classified according to their features.
Step 7. Eventually, the results are obtained in terms of accuracies and performance evaluation will be carried out.

IV. SIMULATION RESULTS

The simulation results carried out to validate the efficiency of the proposed work are presented in the following section. MATLAB environment is used to analyse the results. From the database, six different images are used for their facial recognition.

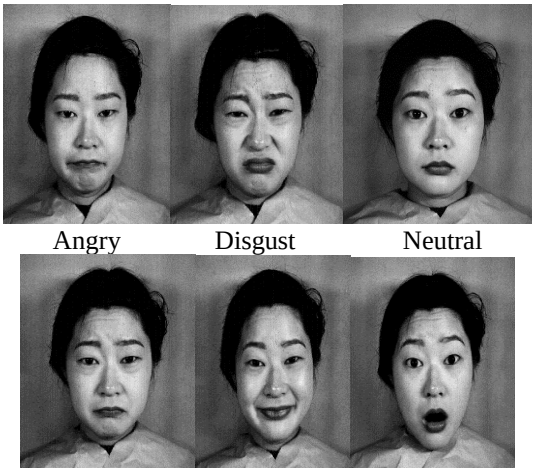

Fig. 3 Different Facial Expression

After applying the proposed scheme, results are determined in terms of recognition rate with respect to dimensions and number of samples, recognition time with respect to the number of samples. As shown in fig. 3, the lady is representing different expressions such as anger, disgust, neutral, sadness, happy and surprise. These pictures are used in order to recognize their facial expressions. These pictures are trained and tested then the feature extraction technique is applied to it. Eventually, the classification technique helps in obtaining accurate results.

A. *Comparison of Recognition time:*

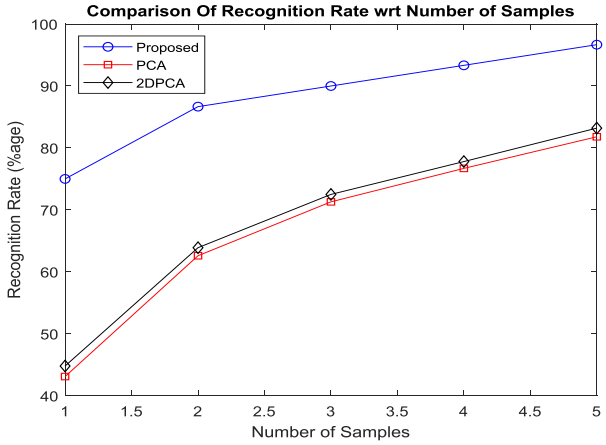

Fig. 4 Comparison of proposed and traditional techniques with respect to the recognition rate in terms of number of samples

In fig. 4, the recognition rate with respect to a number of samples is presented for proposed, PCA and 2D-PCA. The highest rate for proposed work constituted 96.66667%, however, for traditional techniques, it is 81.8% and 83.2%. The proposed technique is capable of recognizing deeply for the same number of samples taken in existing methods (PCA and 2D-PCA). The corresponding values obtained for different numbers of samples for all the techniques are recorded in the tabular chart shown in table I.

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Table I Recognition Rate with Respect to the Number of Samples

Samples	Proposed	PCA	2DPCA
1	75	43.1	44.8
2	86.66667	62.6	63.9
3	90	71.3	72.5
4	93.33333	76.7	77.8
5	96.66667	81.8	83.2

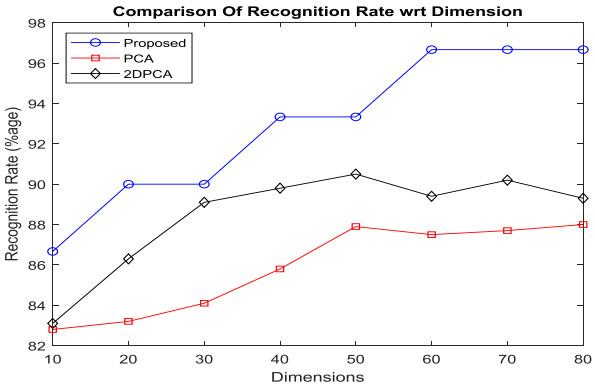

Fig. 5: Comparison of proposed and traditional techniques with respect to the recognition rate in terms of dimension

The comparison analysis of the recognition rate with dimensions is delineated in fig. 5. PCA is a conventional technique and presents the least effectiveness in recognizing facial expression. Overall, it can be said that a novel approach can recognize more accurately with respect to the dimensions. In the case of 30 dimensions, the recognition rate for the proposed method is 90% and for other approaches is 84.1% and 89.1. The highest rate for the three approaches accounted for 96.66667%, 89.3%, and 88% for Proposed, 2DPCA and PCA that demonstrates a high efficacy of the novel approach. The corresponding values for recognition techniques acquired for different values of dimension are recorded in Table II.

Table III Recognition Rate with Respect to Dimension

Dimensions	Proposed	PCA	2DPCA
10	86.66667	82.8	83.1
20	90	83.2	86.3
30	90	84.1	89.1
40	93.33333	85.8	89.8
50	93.33333	87.9	90.5
60	96.66667	87.5	89.4
70	96.66667	87.7	90.2
80	96.66667	88	89.3

B. *Comparison of Average recognition time:*

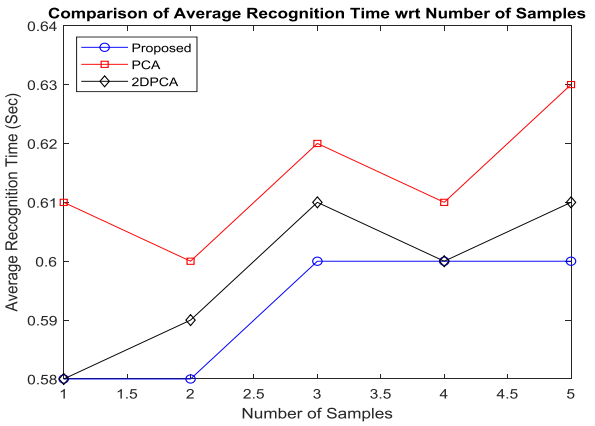

Fig. 6: Comparison in terms of average recognition time with respect to the number of samples

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All three approaches are evaluated for average time with respect to the different number of samples. The analysis is performed from the graphical representation of the results shown in fig. 6. The proposed technique takes less time than other techniques. For the proposed method, time attained for 1 and 2 samples and from 3 to 5 samples is constant which constituted 0.58 seconds and 0.6 seconds respectively. Moreover, for every different number of samples, average time changes for the existing technique. Respective values of average time are recorded in Table III to analyze more deeply.

Table III Average Recognition Time with Respect to the Number of Samples

Samples	Proposed	PCA	2DPCA
1	0.58	0.61	0.58
2	0.58	0.6	0.59
3	0.6	0.62	0.61
4	0.6	0.61	0.6
5	0.6	0.63	0.61

From the results obtained for the proposed system and their comparison with the existing techniques, it is observed that hybrid LBP-LPQ based proposed method is more efficient as it can recognize the facial expression more accurately in less time than other traditional approaches (PCA and 2DPCA).

V. CONCLUSION

Feature extraction is one of the important mechanisms in identifying the human face. A literature survey is carried out to deeply analyze the works done in this field. PCA, LBP, LDA, LPQ are commonly used techniques to extract features from the input image. Due to some pitfalls in the exiting technique, a novel approach introduced a region of interest (ROI) to the input image. Secondly, the novel method amalgamates LBP and LPQ to enhance the performance of the existing system. Classification utilizes multi-level SVM to accurately classify the features. Simulation results are obtained in MATLAB Environment. The results attained from the comparative analysis showed the supremacy of the proposed work as the recognition rate for both factors is higher than the existing techniques.

In the future, there is a scope of enhancing this technique by considering the lighting effects on the images and the reliability of the approach should be taken into consideration while designing for real-time scenarios.

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