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Feature Extraction and Classification-Based Face Recognition Using Deep Learning Architectures

Dilipkumar Jang Bahadur Saini
Computer Science & Communication Engineering
Swami Rama Himalayan University
ORCHID ID-0000-0002-7608-8788
dilipsaini@gmail.com

Dr. Imran Qureshi
Computer Science & Communication Engineering
University of Technology and Applied Science Al Musanna
ORCHID ID-219772735
imranqureshi1210@gmail.com

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Abstract

Computer vision research is currently focused on face identification. One of the biometric systems with the quickest recent growth is this one.This paper proposed technique in face recognition using deep learning based technique in feature extraction and classification. Initially data has been processed for noise removal and image resize, then to segment the image for smoothening. Then to extract the features using Scale Invariant Feature Transforms and classified using deep belief networks. Deep learning is a way for performing facial recognition, and given its great accuracy, it appears to be a suitable technique. The proposed facial recognition system's accuracy is shown through experimental findings. The classified output shows face features and parametric analysis has been carried out in terms of accuracy, precision, recall and F-1 score for face dataset.

Keywords: Face recognition, deep learning, feature extraction, classification, face features.

1. Introduction:

Due to rising security concerns and the quick development of mobile devices, face recognition has recently become a hot study area. Offices, computers, phones, and ATMs are all subject to access control [1]. Face recognition technology may be able to reduce the danger and ultimately stop future attacks, particularly in locations like airports as well as border crossings [2]. Last but not least, facial recognition technology has appeared in social media applications on websites like Facebook that encourage users to tag friends. In general, there are three processes to accomplishing this: face identification, feature extraction, and model training [3].

2. Related works:

There is a vast body of literature that focuses on facial recognition. The focus of the paper's next portion is a review of earlier studies on face recognition [4]. A face detection technique based on the Gabor wavelet transform and ANN was proposed by the author in [5]. Another intriguing article using ANN and the Gabor wavelet was published in [6]. From the input photos, wavelet features were taken out and used as ANN inputs. A approach that combines the wavelet transform and ANN is described in [7]. A face recognition method with BP neural network was suggested by the author in [8]. The suggested method starts with various preprocessing steps including image resizing and normalisation, and then uses the normalised image as feature vectors for BP neural network training [9,10].

3. Proposed method:

This section discuss proposed technique feature extraction and classification of face features. The overall proposed architecture is given in figure-1. Initially face dataset has been pre-processed for noise removal and image resize. Then the segmentation of the image has been carried out for edge smoothening and normalization. This segmented image has been extracted based on their features utilizing SIFT in which the spatial transform based features of the image has been extracted. From this extracted features, the classification has been carried out using DBN.

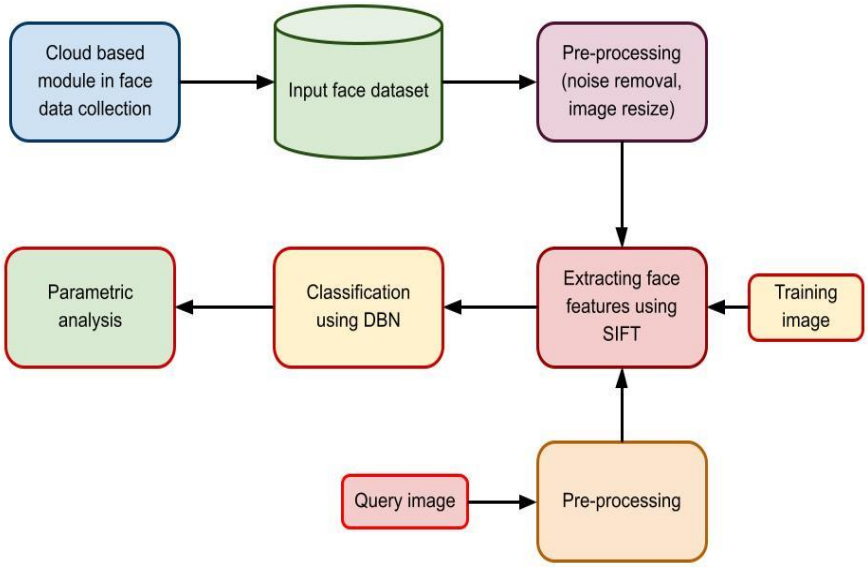

Figure-1 Overall Proposed architecture

3.1 Feature extraction using SIFT:

By using the SIFT method, features are retrieved that are partially invariant to the illumination and viewpoint of a 3D camera as well as invariant to picture transition, rotation, and scaling. It is divided into two parts, such as the key point detection module and the descriptor generating module. To improve algorithm performance, a different method is applied in the descriptor generating model.

3.1.1 Scale-Space Extrema Detection:

This level of filtering seeks to categorise all positions and sizes that is distinguished from different perspectives of same object. This is accomplished quickly by utilizing a "scale-space" function. Additionally, it has been demonstrated that, under logical assumptions, it is based on the Gaussian equation. It's described as eq. (1), (2)

$$L(x, y, \sigma) = G(x, y, \sigma) * L(x, y) \quad (1)$$

$$D(x, y, \sigma) = L(x, y, k\sigma) - L(x, y, \sigma) \quad (2)$$

To get the local maximum and minimum of D(x, y,), each point is compared to its eight neighbours on same scale and its nine neighbours up and down on the same scale. Any of these points are minimal or bound by this value at this point, which is a critical point.

3.1.2 Key point Localization:

More points are removed from the keypoints list thanks to this approach. This is accomplished by measuring the Laplacian value for each significant step 1 point. What determines the extremum's z position is given by eq. (3):

$$z = -\frac{\partial D^{-1}}{\delta x^2}\frac{\partial D}{\delta x} \quad (3)$$

By the following steps, orientation can be determined by eq. (4):

- Gaussian smoothed image L is selected by utilizingkeypoint scale.
- Evaluate gradient magnitude *m*,

$$m(x,y) = \sqrt{L(x+1,y) - L(x-1,y)^2 + L(x,y+1) - L(x,y-1)^2} \quad (4)$$

- Calculate orientation θ given by eq. (5),

$$\theta(x,y) = \tan\left(\frac{L(x,y+1)-L(x,y-1)}{L(x+1,y)-L(x-1,y)}\right) \quad (5)$$

- An orientation histogram is produced from sample points with gradient orientation.
- The apex of the histogram is here. This peak or any other peak with an 80% angle is utilised to construct an orientation keypoint.
- Some points are given multiple orientations.
- Fit a parabola to three histogram values that are near to each peak value in order to interpolate the position of the peaks.

Algorithm of SIFT:

Input: Query Image.

Approximate keypoint location by eq. (6):

$$D(x,y,\sigma) =$$
$$L(x,y,k\sigma) - L(x,y,\sigma)$$
$$L(x,y,\sigma) = G(x,y,\sigma) * I(x,y). \quad (6)$$

Descriptors for each keypoint given by eq. (7):

$$\nabla^2 g = \frac{\partial^2 g}{\partial x^2} + \frac{\partial^2 g}{\partial y^2}$$
$$E(v,h) = -a^T v - b^T h - v^T W h \quad (7)$$

Here, the letters a and b stand for the corresponding bias weights for visible and concealed units. The probability distribution P is given by eq. [8] with v and h in terms of E:

$$P(v,h) = \frac{1}{Z}e^{-E(v,h)} \quad (8)$$

Here, eq.[9]-[11] provides the normalising constant Z:

$$Z = \sum_{v',h'} e^{-E(v',h')} \quad (9)$$

$$P(v) = \frac{1}{Z}\sum_h e^{-E(v,h)} \quad (10)$$

$$P(v_i = 1 \mid v) = \sigma\left(a_i + \sum_j W_{ij}h_j\right) \quad (11)$$

Although the unbiased sampling with v i,h j> is typically not simple, it is appropriate for reconstructing the initial sampling of v from h, and Gibbs sampling is then utilised for several iterations. The weight update rule in back propagation on CONV layer may be explained as follows, using the same procedures as those used to derive the training procedure for FC layer by eq. (12):

$$\mathcal{F}(i,j,w,h) \leftarrow \mathcal{F}(i,j,w,h) - \epsilon\sum_{x=0}^{w_2}\sum_{y=0}^{h_2}\mathcal{X}(i,x-w,y-h) \quad (12)$$

$\times \frac{\partial J}{\partial \mathcal{Y}(i,x,y)}$, for any

$\mathcal{F}(i,j,w,h) \neq 0$,

$$\frac{\partial J}{\partial \mathcal{X}(i,j,x)} = \sum_{g=0}^{c_0/p-1}\sum_{w=0}^{w_1-1}\sum_{h=0}^{h_1-1}\mathcal{F}(i,j,w,h)\frac{\partial J}{\partial \mathcal{Y}(i,x+w,y+h)}$$

4. Performance analysis:

The necessary individuals for the system to recognise are stored in a database. Data pre-processing is a process that clarifies unprocessed data. This method is carried out using the Python language. The model works well and can identify faces in still photographs, video, side views, dark faces, and paintings. The outcome is seen below for various photos.

Table 1: Comparative analysis of Proposed and existing technique

Parameters	MLP	CNN	LBPH	FR_DBF_SIFT
Accuracy	86	87	88	95
Precision	71.6	73.2	75.1	76.5
Recall	73	75	81	86
F1_Score	65	71	75	79

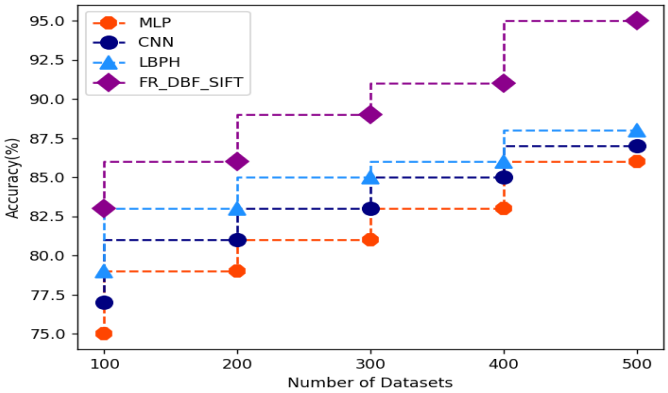

Figure-3 Comparison of Accuracy

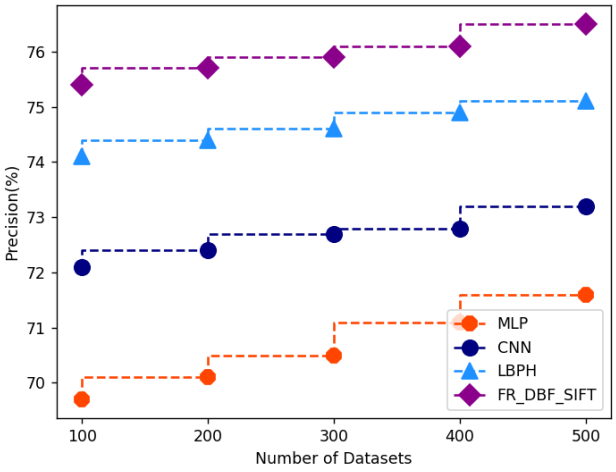

Figure-4 Comparison of Precision

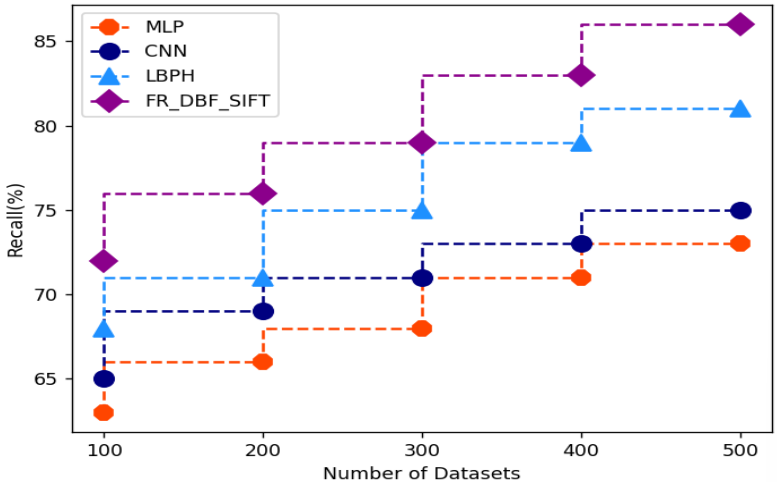

Figure-5 Comparison of Recall

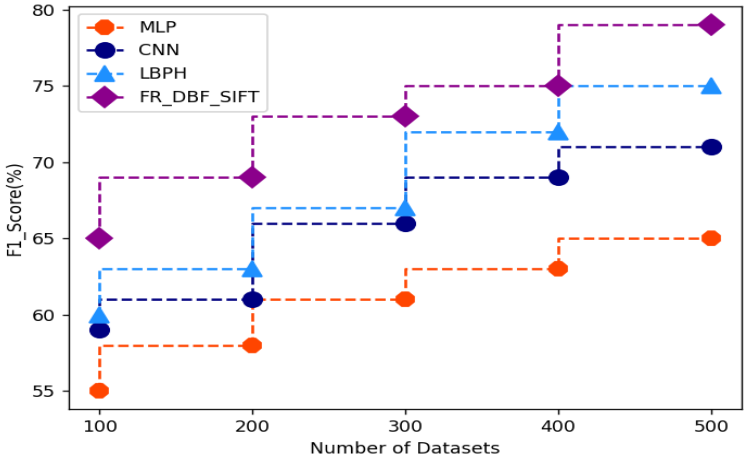

Figure-6 Comparison of F-1 Score

Above table-1 and figure 3-6 shows the comparative analysis of face image classification and feature extraction using proposed FR_DBF_SIFT. Here the comparison has been carried out in terms of accuracy, precision, recall, F-1 score. The existing technique compared are MLP, CNN and LBH among which proposed technique obtained optimal results in extracting features of the input and classification of the extractedfeature.

5. Conclusion:

This paper proposed novel method in face recognition utilizing DL based classification and feature extraction. Then feature extraction has been carried out utilizing Scale Invariant Feature Transforms and this feature has been classified using deep belief networks.The classified output shows face features and parametric analysis has been carried out in terms of accuracy, precision, recall and F-1 score for face dataset.We think the system shown here can learn more pertinent aspects in order to deliver better generalisation when compared to the current method. By design, the system is only partially susceptible to modifications to the local picture samples, scaling, translation, and deformation.

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