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Face Recognition: Modern Assessment of Features Extraction

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Abstract**—** Face recognition is the capability of identifying and authenticating the dominating and leading features of the face from the dataset images. It's important in Access and Security, Healthcare, Banking, Criminal Identification, Payment, Advertising, and in many other fields. In this paper, we have assessment important basic phases of face recognition like Pre-processing, Face Detection, Feature Extraction, Optimal Feature Selection, and Classification. Feature Extraction, Feature Selection, and Classification play a major role in face recognition. The research area of statistical texture classification is widely investigated in several computer vision and pattern recognition problems. A general framework for face recognition with statistical and geometrical approaches and classification presented in this survey paper.

Keywords**—** Face Recognition, Feature Extraction Approaches, Optimal Feature Reduction, Classification.

I. INTRODUCTION

A face recognition (FR) framework is relied upon to recognize faces images present in dataset. It can work in either or both of two modes: (1) face verification, and (2) face identification. Face verification includes a balanced match that compares a query face image against a template face image whose identity is being guaranteed. Face identification proof includes one-to-numerous matches that thinks about a query face image against all the layout template images in the database to decide the identity of the inquiry face.

FR has number of applications, including biometric validation, observation, human-computer interaction, and multimedia management. FR began during the 1960s. Late years have seen huge improvement here and various face recognition and demonstrating frameworks have been created and deployed. Be that as it may, right and powerful face recognition still offers various difficulties to computer vision and pattern recognition researchers, particularly under unconstrained situations.

The execution of a FR framework to a great extent relies upon an assortment of elements, for example, light, facial posture, demeanor, age, hair, facial wear, and movement.

A face recognition framework by and large comprises of five modules as delineated in Fig. 1: Pre-processing, Face Detection, Feature Extraction, Optimal Feature Selection and Classification. These modules are clarified beneath.

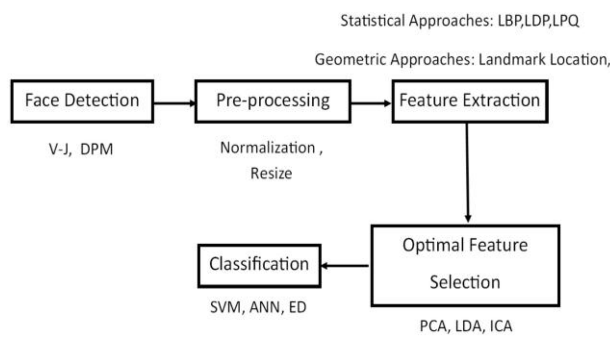

Figure 1*: Block Diagram of Face Recognition*

Face Detection and Face Pre-Processing are rely upon application prerequisite, it might be process first face recognition or pre-preparing or the other way around.

Face Detection segments the face area from the foundation. In the case, the detected faces may need to be tracked across multiple frames using a face tracking component. While face discovery gives a coarse gauge of the area and size of the face, face landmarking limits facial milestones (e.g., eyes, nose, mouth, and facial framework). This might be practiced by a landmarking module or face arrangement module.

Face Pre-Processing is performed to normalize the face geometrically and statistically. This is necessary because state-of-the-art recognition methods are expected to recognize face images with fluctuating posture and enlightenment. The geometrical normalization process changes the face into a standard casing by face cropping. The statistically normalization process normalizes the face dependent on properties, for example, brightening and gray scale.

Feature Extraction is performed on the normalized face to extract salient data that is useful for recognizing faces of various people and is powerful as for the geometric and statistical variations. The extracted face features are used for face matching.

Optimal Feature Selection is to extract a compact set of interpersonal relational features from extracted features and abatement the intricacy.

In *Classification* the extracted features from the input face are coordinated against one or a considerable lot of the enlisted faces in the database.

The organization of the paper as follows; Section I contain basic introduction of face recognition step. A literature review on various research approaches for face recognition is given in section II. It contains description of various methods and techniques used for each step in the recognition process. Finally the is concluded in section III.

II. LITERATURE SURVEY

2.1. Pre- Processing

The pre-processing algorithm is to eliminate the effects of illumination, pose variations, occlusion factor that can impair the performance of an FR system.

Roberto Brunelli and Tomaso Poggio (1993) [1] proposed for computer recognition of human faces. This paper is depends on template matching by means of a normalized cross-correlation coefficient. The extracted features must be somehow normalized in order to be autonomous of position, scale, and turn of the face in the image plane. Wenyi Zhao et al. (1998) [2] performed physically find the eyes and afterward perform geometric normalization with the eye areas fixed and perform intensity normalization, histogram equalization or zero mean unit variance.

Ahonen T. et al. (2004) [3] performed preprocesses the face images. The images are enrolled utilizing eye coordinates and cropped with a curved veil to reject non-face zone from the image. After this, the grey histogram over the non-masked region is adjusted. Xiaoyang Tan and Bill Triggs (2010) [4] propose a straightforward image preprocessing bind that seems to function admirably for a wide range visual capabilities, disposing of a considerable lot of the impacts of changing illumination using Gamma correction, DoG filtering, robust contrast normalization; while as yet protecting the vast majority of the appearance subtleties required for recognition.

Juefei-Xu et al. (2011) [5] apply hearty Walsh-Hadamard transform encoded local binary patterns (WLBP) on preprocessed periocular area (to find the eyes, and after rotation and eye arrange normalization are performed to evenly adjust left and right eyes to fixed eye coordinates for every image. On images with pose correction, since the faces are now all around adjust , simple crop is adequate.). Zhihua Xie et al. (2017) [6] tests are led on infrared face dataset of variable surrounding temperature. That paper performed geometry normalization on infrared face dataset. Xi Yin and Xiaoming Liu (2017) [7] propose a perform multiple tasks Convolutional Neural Network (CNN) for face recognition where identity classification is the main task and Pose, Illumination, and Expression (PIE) estimations. Ayyavoo and Suseela (2018) [8] presented 'Discrete wavelet transform enhanced contrast limited adaptive histogram equalization' (DWT E-CLAHE) which unique image is enhanced using the Gamma intensity correction (GIC); at then point split into low-frequency and high-frequency components utilizing 2D DWT; at last, to the low-frequency segments, the logarithmic transform, GIC and CLAHE are applied in the sequential order.

2.2. Face Detection

Face detection can be performed dependent on a few prompts: skin shading, movement, facial/head shape, facial appearance, or a blend of these parameters. Best face discovery calculations are appearance-based without utilizing different signals. The preparing is done as pursues: An info picture is checked at all conceivable areas and scales by a subwindow. Face detection is acted like ordering the example in the subwindow as either face or nonface.

Osuna et al. (1998) [9] presents a Help Vector Machine application for recognizing vertically situated and unoccluded frontal perspectives on human faces in grey level images. Sung and Poggio, (1998) [10] used face-detection framework in which "canonical" face pattern worked, 19 × 19 mask for eliminating near-boundary pixels of canonical face patterns, and the subsequent "canonical" face pattern in the wake of applying the mask. And after that each scale, the picture is partitioned into numerous perhaps covering windows. Every window design gets delegated either "a face" or "not a face," in light of a lot of neighborhood image estimations.

Yang et al. (2000) [11] used SNoW learning architecture which sparse network of linear functions to detect faces efficiently and vigorously under general conditions. Viola and Jones (2004) [12] portrays a machine learning approach for visual object detection which is fit for handling images extremely rapidly and accomplishing high detection rates. It is presented of a another image representation called the "Integral linage" which permits the features used by detector to be identify object in all respects rapidly.

Weng and Tan (2016) [13], Yang et al. (2018) [14] used face detection techniques for better execution.

2.3. Feature Extraction

Feature extraction is utilized for recognizing and extracting discriminating features from the face images. It is comparability to the entire face organizes are known as global methods, while its in respect to inward facial highlights or areas of intrigue are known as local methods. Here, we present statistical and geometric feature extraction techniques.

Roberto Brunelli and Tomaso Poggio (1993) [1] proposed for computer recognition of human faces. Here, for feature extraction quickly investigate the ramifications of bilateral symmetry and expose some ideas on how anthropometric measures can be utilized to center the hunt of a specific facial utilizing integral projections and horizontal integral projection, which can be very powerful in deciding the situation of features, gave the window on which they act is reasonably situated to abstain from misdirecting obstructions. Ojala et al. (1996) [15] introduced the Local Binary Patterns (LBP), LBP descriptor which offers invariance against monotonic gray level changes. Ojala also proposed Extended LBP (ELBP) way to deal with improve the discriminative capacity of LBP in this equivalent paper.

Ahonen et al. (2004) [3] present a novel way to deal with face recognition which considers both shape and texture data represent in face images. The face area is first divided into small regions from which Local Binary Pattern (LBP) histograms are extracted and concatenated into a single, spatially enhanced feature histogram which productively representing the face image. Viola and Jones (2004) [12] used learning algorithm, based on AdaBoost, which chooses few basic visual features from a larger dataset. Xiaoyang Tan and Bill Triggs (2010) [4] introduce local ternary patterns (LTP), a speculation of the local binary pattern (LBP) local texture descriptor that is more discriminant and less sensitive to noise in uniform districts, and they demonstrate that replacing examinations dependent on local spatial histograms with a distance transform based similarity metric further improves the performance of LBP/LTP based face recognition. Juefei-Xu et al. (2011) [5] present Walsh-Hadamard transform encoded local binary patterns (WLBP) which is the combination of Walsh-Hadamard transform and LBP.

Yimo Guo et al. (2012) [16] proposed a Complete LBP (CLBP), which is quite similar to ELBP. CLBP also includes both the sign and the gray value contrasts between a given focal pixel and its neighbors so as to improve the discriminative intensity of the original LBP. Weng and Tan (2016) [13] introduced manually marked face landmarks and afterward processed the face likeness dependent on local features around landmarks. Zhihua Xie et al. (2017) [6] introduced fusion of textures and edge orientation information is proposed in this paper. The LBP is used to represent texture features of infrared face images. HOG is introduced to attain the complementary edge and orientation features for discriminative ability.

Ayyavoo and Suseela (2018) [8] used the Gabor wavelet-based methods motivate to use the GFC for face recognition. A channel bank of 40 Gabor filters (in five scales 0–4 and eight orientations) is applied to the original image and 40 Gabor filtered images are created. Yang et al. (2018) [14] used SIFT descriptors which was extracted from landmarks and cascaded together for feature extraction and then applied PCA for dimension reduction. Koteswara Rao et al. (2018) [17] utilized standard local quantized patterns (LQP) to gather the spatial relationship as a bigger or more profound texture pattern based on the relative varieties in the gray values of the focal pixel and its neighbors. Feng et al. (2018) [18] used bag-of-visual words (BoW) and color intensity-based local difference patterns (CILDP) are abused to catch local and global features of an image. The proposed combination structure consolidates the positioning aftereffects of BoW and CILDP through graph-based density method. Wang et al. (2018) [19] presents a compelling texture classification techique by combing multi-resolution global and local Gabor features in pyramid space. First, a pyramid space for each image is developed by means of upsampling and downsampling to represent the images with various resolutions. Second, Gabor filtering is applied to each image at various scales and orientations, and then the magnitude and phase components of filtered images are determined. Third, the global and local Gabor features are extracted, where the global Gabor feature is spoken to by the mean and variance of the magnitude component, and the local Gabor feature is spoken to by the joint coding of both size and phase components in a histogram structure.

2.4. Optimal Feature Selection

These techniques include modifying the original feature vector by mapping it into a lower dimensional space while preserving the relevant data. Techniques available for Dimensionality Reduction : Principal Component Analysis(PCA), Modular Eigenfaces, Linear Discriminant Analysis (Fisherfaces), Independent Component Analysis (ICA), Dynamic Link Architecture (DLA), Elastic Bunch-graph Matching (EBGM) etc.

Wenyi Zhao et al. (1998) [2] presented fundamental thought of joining PCA and LDA is to improve the speculation capacity of LDA when just couple of tests per class are accessible. And the hybrid classifier using PCA and LDA gives a valuable structure to other image recognition undertakings too. Xiaoyang Tan and Bill Triggs (2010) [4] improved method robustness by adding Kernel principal component analysis (KPCA) optimal feature extraction. Juefei-Xu et al. (2011) [5] utilized Unsupervised discriminant projection (UDP) to showed adequacy against PCA, LDA LDA and some normal complex systems to discover optimal subspace. Zhihua Xie et al. (2017) [6] used adaptive fusion algorithm based on multiple kernel learning (MKL) is connected to get optimal combination of the two helpful features. Ayyavoo and Suseela (2018) [8] used LDA for face recognition. LDA increases the discrimination among the classes and reduces the dimension.

2.5. *Classification*

After obtaining the optimized feature set, the following stage is to perceive the face and group them into classes. Machine learning strategies accessible, for example, Support Vector Machine (SVM), K-Nearest Neighbor (KNN), Naive Bayes algorithm (NB), Artificial Neural Network (ANN), etc. and Template Based Classifier like Euclidean Distance method, Squared Euclidean Distance method, City-Block Distance method, Canberra Distance, Quadratic Form Distance, Hausdorff Distance, Chi-square.

Roberto Brunelli and Tomaso Poggio (1993) [1] proposed faces recognition performed with a Bayes classifier. Osuna et al. (1998) [9] demonstrated the applicability of SVM by embedding SVM in a face detection system which performs comparably to other state-of-the-art systems. Sung and Poggio, (1998) [10] used euclidean distance and standard normalized Mahalanobis distance to find two value distances between images. Ahonen et al. (2004) [3] performed classification using a closest neighbour classifier in the registered feature space with utilizing Chi square as a divergence measure. Viola and Jones (2004) [12] used cascade method which permits foundation locales of the image to be immediately discarded while spending more calculation on promising object-like regions. Xi Yin and Xiaoming Liu (2017) [7] introduced CNN framework learns entangled features from the data. The weight framework in the completely associated layer of the fundamental undertaking is found out to have near zero qualities for PIE includes so as to avoid Pose, Illumination, and Expression (PIE) variations, which results in PIE-invariant identity features for face recognition.

Ayyavoo and Suseela (2018) [8] used cosine similarity between the test image and training images features compression. Feng et al. (2018) [18] used rank images to improved canberra distance. Wang et al. (2018) [19] used the fusion of global and local Gabor features and the texture classification are implemented in the framework of nearest subspace classifier. Same another literature survey can be seen in table 1.

Table-1 Literature Review Comparison.

NO.	PRE-PROCESSING	FD	FE	FS	L/ G	CLASSIFICATION	DATASET
Fanaee et al. (2018) [20]	Normalization, High pass Filter	Viola Jones	DWT	Y	L/ G	SCN-MSE	ORL
Rao et al. (2018) [17]	Gray Scale	-	LQP, DLEP, LMeQEP	N	L/ G	Euclidean, Canberry, Manhattan	MITvisTex, Corel-1k
Ayyavoo and Suseela (2018) [21]	Grayscale, GIC	-	2DWT, ECLAHE, LT, Gabor wavelet	Y	L/ G	GFC	Yale, AR, CMU PIE, Yale B
F. Yang et al. (2018) [14]	-	Face Landmarks	DMDS, LDMDS	Y	G	MTCNN, SIFT + PCA	FERET, Multi-PIE, SCface
Xie et al. (2017) [6]	Gaussian Filter, normalized	Thermal Infrared	LBP+ HOG	N	G	MKL+ SVM	Farinfrared
Zhou, Yang, andZhang (2017) [22]	-	-	DLBP, LDP, LLBP=JEMD- LBP	N	L	NN,Chi-square	AR, FERET, GT, LFW
Cui et al. (2017) [23]	Gaussian Kernel Function	-	PCA, LDOFH, Histogram	Y	G	NN, Cosine Distance.	AR ,IMM

Weng et al. (2016) [24]	Partial Crop	Geometry and Texture Feature	Scale Invariant LBP (SILBP) + RPSM	Y	L	SiftSurf- SILBP	LFW, PubFig, AR

FD: Face Detection, FE: Feature Extraction, L: Local, G: Global, FS: Feature Selection

GFC: Gabor Fisher classifier, JEMDLBP: joint encoding of multi-direction LBP, LMeQEP : local mesh quantized extrema patterns, DLEP : Directional local extrema patterns.

III. CONCLUSION

In this Survey paper, we are evaluated and analysed all the stages of a Face Recognition process. The process starts with Pre Processing of the image which includes face detection, normalization, crop, resize image. It can be start with face detection based on application or vice versa. Then various feature extraction methods are discussed to representing detail feature information and have managed to overcome numerous challenges affecting to effective FR. Feature Reduction techniques or Feature Selection used for Dimensionality Reduction to achieved optimal feature discrimination. Final step of classification can be performed by either template matching or machine learning to achieved better enhancement on performance.

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