

Review of Advances in Face Recognition Approaches

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Abstract— As of late decade facial recognition has drawn much attention and its studies have briskly heightened by not alone engineers but additionally neuroscientists , simply because it has countless possibilities applications in computer vision communication and automated access control system . Particularly , face identification is a natural part of face recognition as the starting point of robotic face recognition . Nevertheless , facial detection is not quick since it carries a great deal of shifts of figure look , for example pose variation (front , non-front) , image orientation, occlusion, lightning conditions and facial expressions. This paper is a Survey of recent advances and works carried out by the researchers in this field.

Index Terms—Human Computer Interface, Biometrics, Face Recognition, Eigen Faces

I. INTRODUCTION

With the quick rise of computational states and potential of present detecting, analysis and rendering supplies and technologies, computers are becoming extra and extra intelligent. Countless analysis undertakings and business produce have clarified the skill for a computer to interact alongside human in a usual method by looking at people across cameras, listening to people across microphones, understanding these inputs, and reacting to people in a approachable manner.

In present years, face credit has enticed far attention and its analysis has quickly increased by not merely builders but additionally neuroscientists, as it has countless possible requests in computer vision contact and automatic admission manipulation system. Especially, face detection is an vital portion of face credit as the early pace of automatic face recognition. Though, face detection is not frank because it has lots of variations of picture emergence, such as pose variation (front, non-front), occlusion, picture orientation, illuminating condition and facial expression.

Many novel methods have been counseled to ascertain every single variation tabulated above. For example, the template-matching methods are utilized for face localization and detection by computing the correlation of an input picture to a average face pattern. The feature invariant ways are utilized for feature detection of eyes, mouth, ears, nose, etc. The appearance-based methods are utilized for face detection

alongside Eigne Face neural web and data hypothetical approach. Nevertheless, requesting the methods totally is yet a outstanding challenge. Fortunately, the pictures utilized in this undertaking have a little degree of uniformity therefore the detection algorithm can be simpler: early, the all the faces are vertical and have frontal view; subsequent, they are below nearly the alike illuminate condition. This undertaking presents a face detection method generally established on the color segmentation, picture segmentation and template matching methods.

One of the frank methods that enable such usual human-computer Interface (HCI) [1] is face detection. Face detection is the pace stone to all facial analysis algorithms, encompassing face alignment, face modeling, face relighting, face credit, face verification/authentication, head pose pursuing, facial expression tracking/recognition, gender/age credit, and countless more. Merely after computers can comprehend face well will they onset to honestly comprehend people’s thoughts and intentions.

There have been hundreds of described ways to face detection. Main Works had been agreeably surveyed in. For instance, many authors gathered the assorted methods into four categories:

1. **knowledge-based methods,**
2. **feature invariant ways,**
3. **template matching methods, and**
4. **appearance-based methods**



Fig 1: ORL Database For Face Recognition Procedure [2]

Knowledge-based methods [3] use pre-defined laws to ascertain a face established on human knowledge; feature

invariant ways target to find face construction features that are robust to pose and lighting variations; template matching methods use pre-stored face templates to judge if a picture is a face; appearance-based methods discover face models from a set of representative training face pictures to present detection. In finish, appearance-based methods had been displaying superior presentation to the others, cheers to the quick producing computation manipulation and data storage.

The earth of face detection has made momentous progress in the past decade. In particular, the seminal work by Viola and Jones has made face detection usefully feasible in real globe requests such as digital cameras and photo association software. In this report, we present a brief survey on the latest progress in face detection methods as the publication of. Extra attention will be given to boosting-based face detection schemes, that have evolved as the de-facto average of face detection in real-world requests since.

II. APPLICATION OF FACE RECOGNITION

Application of Face Recognition: Safeguard Admission to Entrances, Protected Property: Currently, the most accepted way of admission are key admission, magnetic/smart card, and/or pin number authentication. The provider of way of admission trusts that merely the authorised person holds those way of access.

Surveillance Statistics/Audit: Currently, a surveillance arrangement plainly records snapshots from the surveillance camera at fixed intervals. This arrangement does not furnish each statistical data, and is usefully unusable unless one spends a outstanding deal of period looking at the video. Requesting face credit knowledge to merely those snapshots should unveil a finished scope of statistical data and give a possible audit trail.

Authenticating Users of Computer Networks: The most usually utilized method of authenticating a computer user is via username and password. Countless firms have discovered that passwords can be estimated, stolen or forgotten. They can frequently be cracked employing instruments freely obtainable on the internet. Several passwords each user is not feasible, as this is inconvenient for the user, tough to recall, and period consuming for administrators.

Time and Attendance: Countless firms impose a punch card strategy on employees. This needs the operative to insert a card into a period stamping contraption (the established method). The target is to record the period of becoming into work, departing work, and the attendance of this particular employee. This method is bulky and sluggishly losing its popularity. A prosperous face credit provides the identical functionality

lacking the hassle of a punch-card, and the recorded date and period can be fed into the workers association arrangement directly.

III. FACE RECOGNITION SYSTEMS

In finish, automatic face credit arrangements are encompassed of three steps. A General flowchart is given in Figure 2. Amid it, detection could contain face frontier detection, segmentation and localization, namely obtaining a pre-processed intensity face picture from an input scene, whichever easy or unkempt, discovering its locale and segmenting the picture out of the background. Feature extraction could denote the acquirement of the picture features from the picture such as discernible features, statistical pixel features, change coefficient features, and algebraic features, alongside emphasis on the algebraic features, that embody the intrinsic qualities of an image. Face credit could embody to present the association to the above picture features in words of a precise criterion. Segmentation amid three steps is believed to be trivial, facile and easy for countless requests such as mug shots, drivers licenses, confidential ID card, and passport pictures. Therefore this setback did not accord far attention. Scholars have given extra attention on addressing supplementary problems. Though, presently extra power is devoted to the segmentation setback alongside the advancement of face credit arrangements below convoluted background.



Figure 1 The basic flowchart of a face recognition

In face credit arrangements, it is clear that the evaluation and benchmarking of the algorithms is crucial. Preceding work on the evaluations provides visions into how the evaluation of credit algorithms and arrangements can be gave efficiently. The most vital facts learned in preceding evaluations are as follows:

- (1) colossal sets of examination pictures are vital for adequate evaluation;
- (2) The example ought to be statistically as comparable as probable to the pictures that arise in the request being considered;
- (3) Scoring ought to be completed in a method that reflects the prices or supplementary arrangement necessity adjustments that consequence from errors in recognition; Arrangement reject-error deeds ought to be learned, not just compelled recognition;

- (4) The most functional form of evaluation is that established as closely as probable on a specific application;
- (5) The accuracy, examples, speed and hardware, and human interface are tremendously needed for the face recognition.

IV. FEATURE-BASED APPROACH

The progress of the feature-based way can be more tear into three areas. Given a normal face detection setback in discovering a face in a unkempt scene, low-level analysis early deals alongside the segmentation of discernible features employing pixel properties such as gray-scale and color. Because of the low-level nature, features generated from this analysis are ambiguous. In feature analysis, discernible features are coordinated into a extra globe believed of face and facial features employing data of face geometry. Across feature analysis, feature ambiguities are decreased and locations of the face and facial features are determined. The subsequent cluster involves the use of alert form models. These models fluctuating from snakes, to the extra present point distributed models (PDM) [4] have been industrialized for the intention of convoluted and nonrigid feature extraction such as eye acolyte and lip tracking.

1.4.1 Feature searching

Feature searching methods onset alongside the determination of prominent facial features. The detection of the prominent features next permits for the attendance of supplementary less prominent features to be hypothesized employing anthropometric measurements of face geometry. For instance, a tiny span on top of a larger span in a head and shoulder sequence implies a “face on top of shoulder” scenario, and a pair of dark spans discovered in the face span rise the assurance of a face existence. Amid the works survey, a pair of eyes is the most usually requested reference feature due to its different side-by-side appearance. Supplementary features contain a main face axis, chart (top of the head) and body (below the head).

The facial feature extraction algorithm [5] is a good example of feature searching. The algorithm starts by theorizing the top of a head and next a searching algorithm scans downward to find an eye-plane that appears to have a unexpected rise in frontier densities (measured by the ratio of black to white alongside the horizontal planes). The length amid the top and the eye-plane is next utilized as a reference length. Employing this reference length, a flexible facial template obscuring features such as the eyes and the mouth is initialized on the input image.

V. RELATED WORK

Yaniv Taigman et al., 2014 [6] In this paper in present face credit, the standard pipeline consists of their stages: detect) align) represent) classify. They revisit both the alignment pace and the representation pace by retaining explicit 3D face modeling in order to apply a piecewise affine makeover, and derive a face representation from a nine-layer deep neural network. This deep web involves extra than 120 million parameters employing countless innately related layers lacking heaviness allocating, rather than the average convolutional layers. Therefore they trained it on the biggest facial dataset to-date, an individuality labeled dataset of four million facial pictures fitting in to extra than 4,000 identities. The learned representations coupling the precise model-based alignment alongside the colossal facial database generalize remarkably well to faces in unconstrained settings, even alongside a easy classifier. Their method reaches an accuracy of 97.35% on the Labeled Faces in the Feral (LFW) dataset, cutting the error of the present state of the fine art by extra than 27%, closely approaching human-level performance.

Hyunjong Cho et al., 2014 [7] In this paper alongside the quick progress of computers and the rising, mass use of high-tech mobile mechanisms, vision-based face credit has elevated significantly. Though, it is hard to finish that the presentation of computers surpasses that of humans, as humans have usually exhibited larger presentation in challenging situations including occlusion or variations. Motivated by the credit method of humans who use both holistic and innate features, they present a computationally effectual hybrid face credit method that employs dual-stage holistic and innate feature-based credit algorithms. In the early crude credit period, the counseled algorithm utilizes Main Constituent Analysis (PCA) to recognize a examination image. The credit ends at this period if the assurance level of the consequence turns out to be reliable. Otherwise, the algorithm uses this consequence for filtering out top candidate pictures alongside a elevated degree of similarity, and passes them to the subsequent fine credit period whereas Gabor filters are employed. As is well recognized, knowing a face picture alongside Gabor filters is a computationally heavy task. The contribution of their work is in counseling a flexible dual-stage algorithm that enables fast, hybrid face recognition. Experimental examinations were gave alongside the Spread Yale Face Database B to confirm the effectiveness and validity of the analysis, and they obtained larger credit aftermath below illumination variations not merely in words of computation period but additionally in words of the credit rate in analogy to PCA- and Gabor wavelet-based credit algorithms.

Luo Zhong et al., 2014 [8] In this paper alongside the quick progress of city assembly, the number of city tunnels is rising and the data they produce come to be extra and extra complex. It aftermath in the fact that the established clustering algorithm cannot grasp the mass data of the tunnel. To resolve this setback, an enhanced parallel clustering algorithm established on k-means has been proposed. It is a clustering algorithm employing the Chart Cut inside cloud computing that deals alongside data. It not merely has the supremacy of being utilized to deal alongside mass data but additionally is extra efficient. Moreover, it is able to compute the average dissimilarity degree of every single cluster in order to clean the atypical data.

Jin Dai et al., 2014 [9] In this paper the similarity amid objects is the core analysis span of data mining. In order to cut the interference of the uncertainty of nature speech, a similarity measurement amid normal cloud models is adopted to text association research. On this basis, a novel text classifier established on cloud believed hopping up (CCJU-TC) is proposed. It can effectually finish conversion amid qualitative believed and quantitative data. Across the conversion from text set to text data table established on VSM ideal, the text qualitative believed, that is extraction from the alike group, is hopping up as a finished group concept. According to the cloud similarity amid the examination text and every single group believed, the examination text is allocated to the most comparable category. By the analogy amid disparate text classifiers in disparate feature selection set, it fully proves that not merely does CCJU-TC have a forceful skill to change to the disparate text features, but additionally the association presentation is additionally larger than the established classifiers.

Pengfei Dou et al., 2014 [10] In this paper 3D-Model-Aided 2D face credit (MaFR) has enticed a lot of attention in present years. By registering a 3D ideal, facial textures of the gallery and the probe can be lifted and aligned in a public space, therefore alleviating the trial of pose variations. One obstacle stopping precise registration is the 3D-2D pose estimation, that is facilely altered by landmarks. In this work, they present the presentation that state-of-the fine art pose estimation algorithms might grasp employing state-of-the fine art automatic attraction localization methods. They generated an application-specific dataset alongside extra than 59,000 synthetic face pictures and earth truth camera pose and attractions, obscuring 45 poses and six illumination conditions.

Their examinations contrasted four presently counseled pose estimation algorithms employing 2D attractions noticed by two automatic methods. Their aftermath highlight one near-real-time attraction detection method and a exceedingly precise pose estimation algorithm, that should potentially boost the 3D-Model-Aided 2D face credit performance.

Wu, Fengxiang et al., 2014 [11] In this paper alongside the progress of data knowledge, face credit knowledge has been unceasingly developed. This knowledge has enticed the attention of countless researchers, encompassing institutions and creation enterprises. Face credit knowledge has come to be a moderately autonomous request knowledge span in assorted communal services. This paper presents a face credit algorithm established on wavelet change and local directional weighted innate binary pattern. Early of all, this algorithm puts onward a new basis for face credit, namely the level of methodical constituents of face pictures encompassing valid facial sense features, and the credit rate is larger than that of the vertical constituent data and diagonal constituent information. This is shouted Horizontal Constituent Prior Principle (HCPP). According to HCPP, the early picture is decomposed alongside wavelet transformation. The algorithm extracts the scale and level of methodical components. To enhance the early LBP operator, it presents the local directional weighted innate binary outline (RDW-LBP). Employing the RDW-LBP, it can compute the histogram of scale constituents and methodical constituents decomposed by wavelet. The histogram feature vector of face picture can be became alongside the disparate weighted sub-regions. The feature vector can be matched alongside Chi-Square distance. This way more enhances the skill to remove face association data effectively.

Issam Dagher et al., 2014 [12] In this paper, face credit employing the most representative SIFT pictures is presented. It is established on obtaining the SIFT (SCALE INVARIANT FEATURE TRANSFORM) features in disparate spans of every single training image. Those spans were obtained employing the K-means clustering algorithm requested on the key-points obtained from the SIFT algorithm. Instituted on these features, an algorithm that will become the most representative pictures of every single face is presented. In the examination period, an unfamiliar face picture is understood according to those representative images. In order to display its effectiveness this algorithm is contrasted to supplementary SIFT algorithms and to the LDP algorithm for disparate databases.

Rahib H. Abiyev et al., 2014 [13] In this paper face credit is one of the biometric methods utilized for identification of

humans. The design of the face credit arrangement includes two frank steps. The early pace is the extraction of the image's features and the subsequent one is the association of patterns. Feature removing is a extremely vital pace in face recognition. The credit rate of the arrangement depends on the meaningful data removed from the face image. If the features fit in to the disparate classes and the distance amid these classes are bigger next these features are vital for credit of the images. In this discover, the design of face credit arrangement employing three disparate feature extraction techniques- Main Constituent Analysis (PCA), Fisher Linear Discriminant Analysis (FLD) and Fast Pixel Instituted Matching (FPBM) is presented. The comparative analysis of the simulation aftermath of these methods is presented.

Bo He, Dongxun et al., 2014 [14] In this paper most face credit ways industrialized so distant stare the sparse coding as one of the vital way, as the sparse coding models have been hindered by the tremendously luxurious computational price in the implementation. In this paper, a novel scheme for the fast face credit is gave via great discovering contraption (ELM) and sparse coding. The public feature hypothesis is early gave to remove the basis purpose from the innate universal pictures, and next the solitary hidden layer feed onward web (SLFN) is instituted to simulate the sparse coding procedure for the face pictures by ELM algorithm. A little events have been completed to uphold the effectual inherent data embedding in the ELM learning. The emerging innate sparse coding coefficient will next be gathered into the globe representation and more fed into the ELM ensemble that is composed of a number of SLFNs for face recognition. The simulation aftermath have shown the good presentation in the counseled way that might be comparable to the state-of-the-art methods at a far higher speed.

Yujian Zhou et al., 2014 [15] In this paper tensor subspace analysis (TSA) and discriminant TSA (DTSA) are two competent two-sided protrusion methods for dimensionality reduction and feature extraction of face picture matrices. Though, they have two weighty drawbacks. Firstly, TSA and DTSA iteratively compute the left and right protrusion matrices. At every single iteration, two generalized eigenvalue setbacks are needed to resolve, that makes them inapplicable for elevated dimensional picture data. Secondly, the metric construction of the facial picture space cannot be upheld as the left and right protrusion matrices are not normally orthonormal. In this paper, they counsel the orthogonal TSA (OTSA) and orthogonal DTSA (ODTSA). In difference to TSA and DTSA, two draw ratio optimization setbacks are needed to be resolved

at every single iteration. Thus, OTSA and ODTSA have far less computational price than their nonorthogonal counterparts as the draw ratio optimization setback can be resolved by the inexpensive Newton-Lanczos method. Experimental aftermath display that the counseled methods accomplish far higher credit accuracy and have far lower training cost.

Augusto Salazar et al., 2014 [16] In this paper they ponder the setback of computing precise point-to-point correspondences amid a set of human face scans alongside fluctuating expressions. Their fully automatic way does not need each manually allocated markers on the scan. Instead, the way learns the locations of a set of attractions present in a database and uses this vision to automatically forecast the locations of these attractions on a presently obtainable scan. The forecasted attractions are next utilized to compute point-to-point correspondences amid a template ideal and the presently obtainable scan. To precisely fit the expression of the template to the expression of the scan, they use as template a blend form model. Their algorithm was tested on a database of human faces of disparate cultural clusters alongside powerfully fluctuating expressions. Experimental aftermath display that the obtained point-to-point correspondence is both exceedingly precise and consistent for most of the tested 3D face models.

Zhenhua Chai et al., 2014 [17] In this paper outstanding progress has been attained in face credit in the last three decades. Though, it is yet challenging to describe the individuality connected features in face images. This paper proposes a novel facial feature extraction method shouted Gabor Ordinal Measures (GOM), that integrates the distinctiveness of Gabor features and the robustness of ordinal measures as a enthusing resolution to jointly grasp inter-person similarity and intra-person variations in face images. In the proposition, disparate kinds of ordinal measures are derived from magnitude, period, real and imaginary constituents of Gabor pictures, suitably, and next are jointly encoded as discernible primitives in innate regions. The statistical allocations of these discernible primitives in face picture blocks are concatenated into a feature vector and linear discriminant analysis is more utilized to attain a compact and discriminative feature representation. Finally, a two-stage cascade discovering method and a voracious block selection method are utilized to train a forceful classifier for face recognition. Comprehensive examinations on openly obtainable face picture databases such as FERET, AR and colossal scale FRGC v2.0 clarify state-of-the-art face credit presentation of GOM.

Kailash Jagannath Karande et al., 2014 [18] In this paper they address the setback of face credit employing frontier data

as autonomous components. The frontier data is obtained by employing Laplacian of Gaussian (LoG) and Canny frontier detection methods next preprocessing is completed by employing Principle Constituent analysis (PCA) beforehand requesting the Autonomous Constituent Analysis (ICA) algorithm for training of images. The autonomous constituents obtained by ICA algorithm are utilized as feature vectors for classification. The Euclidean distance and Mahalanobis distance classifiers are utilized for assessing of images. The algorithm is tested on two disparate databases of face pictures for variation in illumination and facial poses up to 180° rotation angle.

Xi Peng et al., 2014 [19] In this paper The ideal of low-dimensional manifold and sparse representation are two well-known concise models that counsel every single data can be delineated by a insufficient characteristics. Manifold discovering is normally investigated for dimension reduction by maintaining a little anticipated innate geometric constructions from the early space to a low-dimensional one. The constructions are usually ambitious by employing pair astute distance, e.g., Euclidean distance. Alternatively, sparse representation denotes a data point as a linear combination of the points from the alike subspace. In useful requests, though, the adjacent points in words of pair astute distance could not fit in to the alike subspace, and vice versa. Consequently, it is interesting and vital to discover how to become a larger representation by incorporating these two models together. To this conclude, this paper proposes a novel coding algorithm, shouted Locality-Constrained Cooperative Representation (LCCR), that enhances the robustness and discrimination of data representation by familiarizing a kind of innate consistency. The locality word derives from a biologic observation that the comparable inputs have comparable code. The goal purpose of LCCR has an analytical resolution, and it does not involve innate minima. The empirical studies established on four area facial databases, ORL, AR, Spread Yale B, and Several PIE; display that LCCR is enthusing in knowing human faces from frontal sights alongside fluctuating expression and illumination, as well as assorted corruptions and occlusions.

George Toderici et al., 2014 [20] In this paper Presentation boosts in face credit have been enabled by the formation of facial databases, alongside collection protocols customized to address trials such as light variability, expressions, pose, sensor/modality contrasts, and, extra presently, uncontrolled buy conditions. In this paper, they present database UHDB11,

to enable 3D-2D face credit evaluations, whereas the gallery has been acquired employing 3D sensors (3D mesh and texture) and the probes employing 2D sensors (images). The database consists of examples from 23 people, in the form of 2D high-resolution pictures spanning six illumination conditions and 12 head-pose variations, and 3D facial mesh and texture. It addresses limitations considering resolution, variability and kind of 3D/2D data and has clarified to be statistically extra challenging, varied and data affluent than continuing cohorts of 10 periods larger number of subjects. They counsel a set of 3D-2D experimental configurations, alongside frontal 3D galleries and pose illumination fluctuating probes and furnish baseline presentation for identification and verification.

VI. CONCLUSION AND FUTURE SCOPE

In the Works Several features methods use countless joined facial features to find or notice faces. First, find the face by employing features like skin color, size and form and next confirm these candidates employing methodical features such as eye brows, nose, and hair. These way is incapable to work below disparate imaging conditions because the picture construction varies too far to be robustly detected. Moreover, if the algorithm fails to notice one of the critical facial features, it will be incapable to find symmetrical connection amid the features and hence fails to notice a face. On the supplementary hand Feature hunting methods onset alongside the determination of prominent facial features. The detection of the prominent features next permits for the attendance of supplementary less prominent features to be hypothesized employing anthropometric measurements of face geometry. In our upcoming works we will propose on a robust Facial Feature Extraction centered face recognition system, that can extract and facial features more accurately.

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