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FACE ANNOTATION WITH EFFICIENT GENDER AND FACIAL EXPRESSION RECOGNITION

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ABSTRACT

A large portion of photos shared by users on the internet are human face images. Some of these face images are assigned with names, but many of them are not assigned properly. As an alternative of training unambiguous classification models by the regular model-based face annotation technique, the search based face annotation (SBFA) paradigm aims to tackle the automated face annotation task by exploiting content-based image retrieval (CBIR) techniques in mining massive weakly labeled facial images on the web. The most important purpose of SBFA is to assign correct name labels to a given query facial image. Emotional information is an important way of information transmission in interpersonal communication. The computer can infer a person's mental state according to the facial expression. In this paper, focus on the problem of automatic gender classification that separates his faces from her faces. Gender classification could be of important value in human-computer interaction, such as personal interaction. Extract the facial feature such as stretch eyebrows, frowned, giggle, half smile, frown, smiling and common human facial expressions in much rich expression. Facial expression recognition is an active direction in the field of human-computer interaction. Face annotation is the extension of face recognition to resolve research challenge in computer vision and image understanding and provides various techniques or methods that are used to annotating facial images.

Keywords: Face annotation, web facial images, weak label, Gender identification, Facial expression recognition and Search based facial annotation.

I. INTRODUCTION

Classical face annotation approaches are often treated as an extended face recognition problem. Day by day the digital media devices are increasing so the different social media tools used for sharing photos. The large number of human facial images shared over the different social real world application some of this images are tagged properly but many of images are not tagged properly so the facial annotation are came.

The main objective of search based annotation is to assign name label to facial image. To enhance the label quality of facial images automatically.Facial annotation also applied in video domain to identify the person who appeared in video. The model base annotation has more restrictions i.e. it is more time consuming and more costly to collect large amount of human labelled training facial image. It is more difficult to simplify the models when new persons are added, in which retraining process is required and last the annotation performance is become poor when the number of persons is very more. To address the challenges "Auto face annotation" is important technique which automatically gives name of related person. This method is more beneficial to different real world application for (e.g. facebook) which annotates photos uploaded by the users for managing online album and searches the photos.The search-based face annotation paradigm aims to tackle the automated face annotation task by exploiting content-based image retrieval (CBIR) techniques in mining number of weakly labeled facial images on the web. The main objective of search-based face annotation is to assign correct name labels to a given query facial image. One challenge faced by such SBFA paradigm is how to effectively exploit the most similar facial images and their weak labels for the face name annotation task.

The first group of related work is on the topics of face recognition and verification [5]. The classical research that has been extensively studied [6]. The limitations are (i) high-quality labeled face images collected in well-controlled environments and (ii) add a new person or new training data is nontrivial. The second group is about the studies of generic image annotation [7].Train face classification models by adapting the existing face recognition techniques. Suffer the same limitations above. The third group is about face annotation on personal/family/social photos. In auto image annotation object recognition it is hard to collect human labeled training images. The Limitations of this method is semantic gap, and (ii) suffer from noisy web data. The fourth group is about the studies of face annotation in mining weakly labeled facial images on the web [9][10]. Some studies consider a human name as the input query, and mainly intend to process the text based search results by exploiting visual consistency of facial images. The web facial image with the names extracted from its caption. Unsupervised Face Annotation: searching facial images for a given name, purify, and re-rank text-based search results. These works are not based on the search-based annotation paradigm. An automatic system that will tag persons in personal and group photos using face recognition techniques [11].In Automatic image tagging technique it extract the key word using text mining technique. It only concentrates on text not on visual features [13]. Gender Classification based on Principle Component Analysis, Linear Component Analysis and Independent Component Analysis, it is observed that ICA and PCA produce less accuracy in recognizing the gender [15].

Search Based Face Annotation:

An effective unsupervised label refinement for refining the web facial images [2]. For improving the performance they also propose optimization algorithm to solve large-scale learning effectively i.e. clustering based approximation system improves the performance of search based face annotation method. The effort are dissimilar form all preceding work by two things. To solve general content based face annotation problem using search based where face image as query image. They unsupervised label refinement algorithm which enhanced new label matrix. This effort is also related recent work of the WRLCC method [3] it is a unified learning scheme [4].

II. RELATED WORK

Face Detection:

Face detection is an easy visual task for human vision, however; this task is not easy and is considered to be a challenge for any human computer interaction approach based on computer vision because it has a high degrees of variability in its appearance. How can computers detect multiple human faces present in an image or a video with complex background? That is the problem. Face detection determines the location and size of human face in digital image. Face detection is defined as the process of extracting faces from scenes. This procedure has many applications like face tracking, pose estimation or compression. Face detection must deal with several well known challenges. These challenges can be attributed to some factors:

Pose variation: The ideal scenario for face detection would be one in which only frontal images were involved. Moreover, the performance of face detection algorithms drops severely when there are large pose variations

Feature occlusion: The presence of elements like beards, glasses introduces high variability. Faces can also be moderately covered by objects or other faces.

Facial expression: Facial features also fluctuate to a great extent because of different facial gestures and also the ambiental conditions can affect the quality of an image, affecting the appearance of a face.

There are some problems closely related to face detection besides feature extraction and face classification. Face detection is, therefore, a two class problem where we have to decide if there is a face or not in given query image.

The face region is directly detected by the powerful method, namely Viola and Jones' face detection algorithm from an image. The Viola–Jones framework is the first object detection framework to provide competitive object detection. The cascade object detector uses the Viola-Jones algorithm to detect people's faces, noses, eyes, mouth, or upper body. Vision.CascadeObjectDetector creates a system object, detector that used to detects objects using the Viola-Jones algorithm.

Feature Extraction:

Feature extraction creates new features from functions of the original features. When the input data to is too large to be processed and it is suspected to be notoriously redundant then the input data will be formed into a reduced representation. Changing the input data into the set of feature called feature extraction.

The Edge, Gabor, LTP features are generated for the facial image. From the experimental result it is clear to observe that LTP is much or at least slightly better than other common features. Appearance features describe the change in face texture when particular action is performed. A prosperous descriptor for local texture feature extraction is called **Local Ternary Patterns (LTP)** .whereas texture is a tactile or visual characteristic of a surface. Local Ternary Pattern is extended version of LBP. Unlike LBP it does not threshold the pixels onto 0 and 1,rather it uses a threshold constant to threshold constant ,c as the value of the centre pixel , a neighbouring pixel p, the result of threshold is

$$\begin{cases} 1, \text{ if } p > c + k \\ 0, \text{ if } p > c - k \text{ and } p < c + k \\ -1, \text{ if } p < c - k \end{cases} \quad (1)$$

In this way each threshold pixel has one of the three vales neighbouring pixels are combined after thresholding into a ternary pattern. Calculate a histogram of these ternary values will result in a huge range, so this ternary pattern is split into two binary patterns. The 3x3 making window is placed over the input image .In the resulting 3x3 sub image a boundary is computed whose Upper Limit is +t and Lower Limit is –t. If the neighbouring pixel has a value greater than the upper limit, then neighbouring pixel value is replaced by 1. If the neighbouring pixel has a value lower than the upper limit, then neighbouring pixel value is replaced by -1. If the neighbouring pixel has a value lies between the upper limit and the lower limit, then neighbouring pixel value is replaced by 0. In this way all the neighbouring pixel will be replaced by 0, 1, or -1. This subimage is segmented into two subimage one by replacing all 1 by 0 and other by replacing all -1 by 0. Thus we get two subimages. Now compute the binary to decimal conversion and replace the centre pixel as in LBP. Hence here for each centre pixel two LTP are obtained. This procedures will repeated for all pixels and the resulting two output images are the LTP of the original image.

Face Recognition:

Face Identification is one-to-many matching, i.e. given an image of an unfamiliar person, determining that person's identity by comparing possibly after encoding that image with a database of (possibly encoded) images of known individuals. Face is identified by histogram based face recognition method.

For training, grayscale images with 256 gray levels are used. Initially, frequency of every gray-level is computed and stored in vectors for further processing. Then, mean of consecutive nine frequencies from the stored vectors is calculated and are stored in another vectors for later use in testing phase.

This mean vector is used for calculating the absolute differences among the mean of trained images and the test image. At last the minimum difference found identifies the matched class with test image.

III. PROPOSED WORK

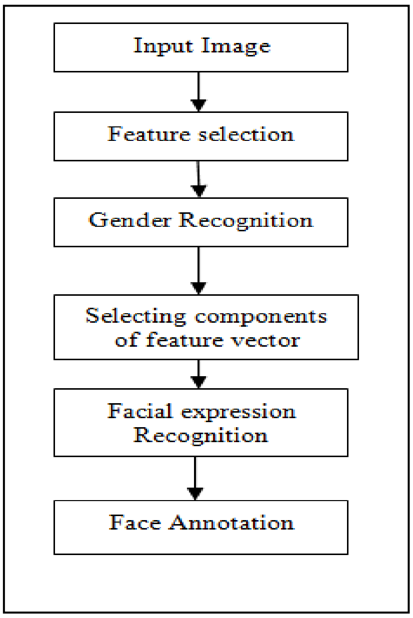

Figure 2: Flow chart

A. Gender Recognition

Illumination compensation and normalization play a crucial role in face recognition. The **Oriented Local Histogram Equalization (OLHE)** that captures not only the edges, but also captures their orientations of the given query image. The main innovation of this work is to encode the edge orientation in the face representation. OLHE is similar to histogram equalization (LHE), but it captures the orientation of edges while LHE does not. Histogram equalization (HE) is sometimes useful for illumination compensation. However, it works well only when the image is intensified or darkened globally. LDA was applied to the data, and the most discriminant template was extracted. Thus the feature of male and female is classified for the given query image.

PCA & LDA features are extracted from training images (dataset).In recognition test image PCA & LDA features are extracted and matched to the train image features then it returns the recognized gender for the given query image.

PCA: Principal component analysis is a statistical tool used to analyze data sets. The mathematics behind principle component analysis is statistics and is hinged in the rear, eigenvalues and eigenvectors, standard deviation (SD).

Feature Extraction Using PCA: Principal Components Analysis is a very well known approach for reducing the dimensionality of data. For applying PCA to images, the image is first represented as a column of vectors. Matrix is created by concatenating the column of training set images. Let this matrix be **X,** and **X**=[x1 x2.... xn], where xi is the $_i$th column vector representing the $_i$th training image. Then the mean is subtracted from each column and the covariance matrix is computed.

Let the mean image be,

$$\bar{x} = \frac{1}{n}\sum_{i-1}^{n} x_i \qquad (2)$$

- And Y= [$x_1 - \bar{x}$ .... $x_n - \bar{x}$]
- The covariance matrix Q=cov(Y) =YY^T

Finally, eigenvalue decomposition is performed to find the highest ranking (based on eigenvalue) eigenvectors. These vectors, known as principal components span the low dimensional subspace. Out of these eigenvectors *m* most significant vectors are chosen, let these vectors be s1, s2...sm. The accusation of *m* is chosen by regarding the cumulative sum of the eigenvalue. The features of an image *x* is then calculated by projecting it onto the space spanned by the eigenvectors as g = [s1 s2 ...sm]^T ($x - \bar{x}$), where g is an *m* dimensional vector of features. This feature vector *g* is used during training and classification.

LDA: The standard LDA can be seriously degraded if there are only a limited number of observations N Compared to the dimension of the feature space n .To avoid this it is recommended that the linear discriminant analysis be preceded by a principle component analysis. In PCA, the shape and location of the original data sets changes when transformed to a different space whereas LDA doesn't change the location but only tries to provide more class separability and draw a decision region between the given classes.

Feature Extraction using LDA: Linear Discriminant Analysis (LDA) finds the vectors in the underlying space that best discriminate among classes. All classes the between-class scatter matrix SB and the within-class scatter matrix SW are defined by

$$S_{B=}\sum_{i=1}^{c} M_i (x_i - \mu)(x_i - \mu)^T \qquad (3)$$

$$S_{W=}\sum_{i=1}^{c} \sum x_k \in x_i (x_k - \mu)(x_k - \mu)^T \qquad (4)$$

Where M_i is the number of training samples in class i, c is the number of distinct classes, is the mean vector of samples belonging to class i and Xi represents the set of samples belonging to class i with x_k being the k-th image of that class. S_w denotes the scatter of features around the mean of each face class and S_B denotes the scatter of features around the overall mean for all face classes. The goal is to maximize $S_B$while minimizing S_w.This ratio is exploit when the column vectors of the projection matrix (W_{LDA}) are the eigenvectors of $S_w^{-1} S_B$. In order to prevent to S_w become singular, PCA is used as a pre-processing step and the final transformation is $W^T_{opt} = W^T_{LDA} W^T_{PCA}$.

B. Facial Expression Recognition

Face is the primary focus of attention in social interaction, playing a major role in conveying personality and sensation. Even though the ability to understand intellect or personality from facial appearance is suspect, the human ability to recognize face is extraordinary. This expertise is relatively forceful, in spite of large changes in the visual incentive due to viewing conditions, expression, aging and disruptions such as glasses or changes in hair style or facial hair.

Implementation of Expression Recognition Annotation Using PCA:

The entire sequence of training and testing is sequential and can be broadly classified as consisting of following two steps:

1. Training
2. Testing

The steps are shown below

Eigenfacecore

- Calculating the mean image.
- Computing the average face image.
- Calculating the deviation of each image from mean image.
- Computing the difference image for each image in the training set
- Merging all centered images.
- Facial Expression Recognition Using PCA:
- Face Space and Its Dimensionality: The pixels may encode color or only intensity. After proper normalization and resizing to a fixed m-by-n size, the pixel array can be represented as a point (i.e. vector) in an mn-dimensional image space by simply writing its pixel values in a fixed order. A critical issue in the analysis of such multi-dimensional data is the dimensionality, the number of coordinate necessary to specify a data point.

Facial Expression Recognition Using PCA:

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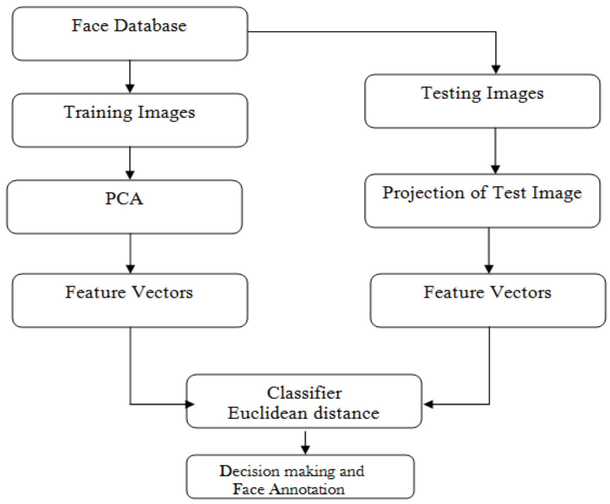

Figure 1: Implementation of Facial expression annotation using PCA

Image Space Vs Face Space: In order to specify an arbitrary image in the image space, one needs to specify every pixel value. Therefore, per-pixel sampling is in fact unnecessarily dense. The value of a pixel is typically highly correlated with the values of the surrounding pixels. Moreover, the appearance of faces is highly constrained, for example, any frontal view of a face is roughly symmetrical, has eyes on the sides, nose in the middle, etc. A vast proportion of the points in the image space do not represent physically possible faces. Thus the natural constraints dictate that the face images will in fact be confined to a subspace, which is referred to as the face.

Principal Component Analysis:

Principal Component Analysis is a standard technique used in statistical pattern recognition for data reduction and Feature extraction. Principal Component Analysis (PCA) is a dimensionality reduction technique based on extracting the desired number of principal components of the multi-dimensional data. The purpose of PCA is to reduce the large dimensionality of the data space (observed variables) to the smaller intrinsic dimensionality of feature space (independent variables), which are needed to describe the data economically. This is the case when there is a strong correlation between observed variables. The first principal component is the linear combination of the original dimensions that has the maximum variance the n-th principal component is the linear combination with the highest variance, subject to being orthogonal to the n -1 first principal component.

Eigenfacecore:

- Calculating the mean image.
- Computing the average face image.
- Calculating the deviation of each image from mean image.
- Computing the difference image for each image in the training set
- Merging all centered images.

This approach of expression detection involves the following initialization operations:

- Acquire the initial set of face images (the training set).
- Calculate the eigenfaces from the training set, keeping only the M images that correspond to the highest eigenvalues. These M images define the face space. As new faces are experienced; the eigenfaces can be up-dated or recalculated.
- Calculate the corresponding distribution in M-dimensional weight space for each known individual, by projecting his or her face images onto the "face space".

C. Face annotation:

Face Annotation is the combined problem of face detection and face recognition. The classical image annotation approaches usually apply some existing object recognition techniques to train classification models from human training images and annotate with keywords to enhance the label quality of the image. The name of recognized expression is automatically annotated as a text on the image.

Applications:

Face annotation discovers its application in the field of

- Face annotation at micro and macro scale.
- Wild landmark face annotation.
- Online photo album management Acknowledgment.

D. Gentleboost Method:

Boosting is method of combing collection of weak classifier (weak learner) to form a strong classifier. Gentleboost is the algorithm that boosts the sequence of classifier, in that weights are updated dynamically according to the errors in previous learning. Gentleboost belong to the class of large margin classifier. GentleBoost Classifier with two different weak-learners. With Gentleboost and SVM a multiclass system can be built from two class classifiers. There are two main schemes used for this purpose, one is the one- against-all strategy to classify each class against all the remaining classes; the other scheme is one-against-one strategy that classify between each pair. Multi-class problem is performed with the one-vs-all strategy.

IV. EXPERIMENTAL RESULTS

The ORL Database of Facial Images is used for performing the experiments. The database consists of 400 facial images of 40 individuals with 10 images of each. For performing the experiments we have taken 100 images of 10 individuals with 10 images of each. And the JAFFE database

The image database we use in our experiment is the JAFFE (Japanese female facial expressions) database. This dataset is used as the benchmark database for researchers. The database contains ten Japanese females' images. There are seven different facial expressions, such as neutral, happy, angry, disgust, fear, sad and surprise. Each female has two examples for each expression. Totally, there are 213 grayscale facial expression images in this database. Each image is of size 256×256.

V. CONCLUSION

Face Annotation is the combined problem of face detection and face recognition so a novel face detection algorithm using combination of face detector methods is presented to improve face detection that automatically detects face in complex background. The proposed algorithm starts by finding region of interest using Viola - Jones. A rich descriptor for local texture called LTP is used to extract texture and face is identified by Histogram Processed Face Recognition Method. Thus this paper concludes with the fact that the integrated approach to the detection, feature extraction and face recognition along with gender recognition using PCA and LDA and face annotated by the facial expression is efficiently classified using PCA better than Gentleboost is success.

for excellence.

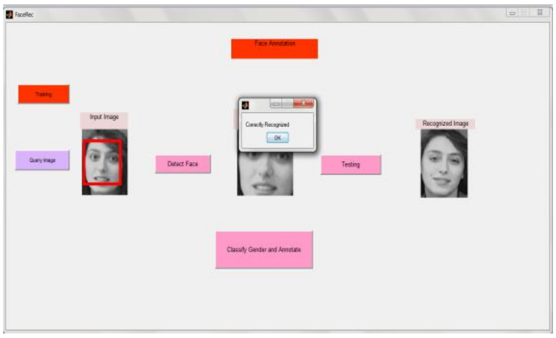

Figure 4: Face Detected Correctly Recognized

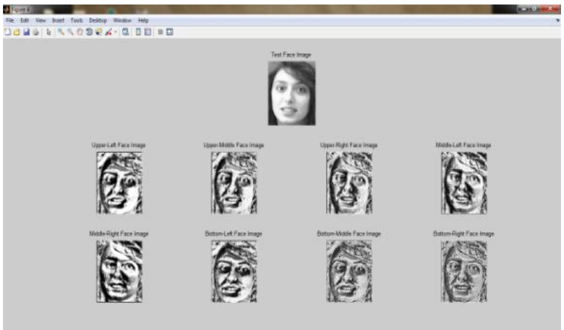

Figure 5: Oriented Local Histogram Equalization

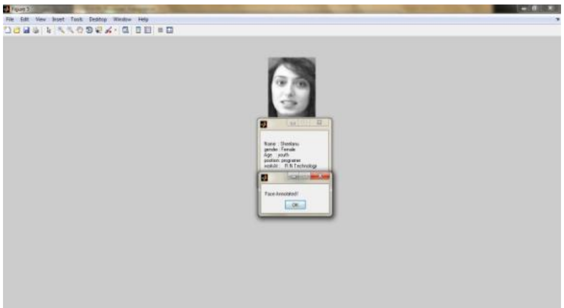

Figure 6: Classified gender as female and annotated with name and gender

Figure 7: Facial Expression Is Recognized As Happy And Annotated using PCA

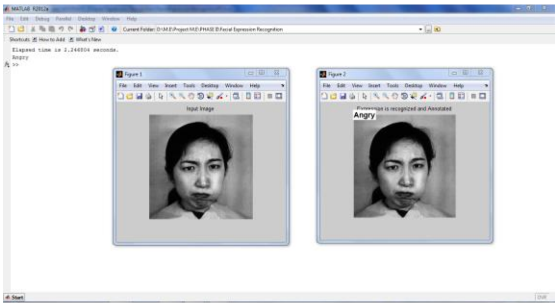

Figure 6: Facial Expression Is Recognized As Anger And Annotated using PCA

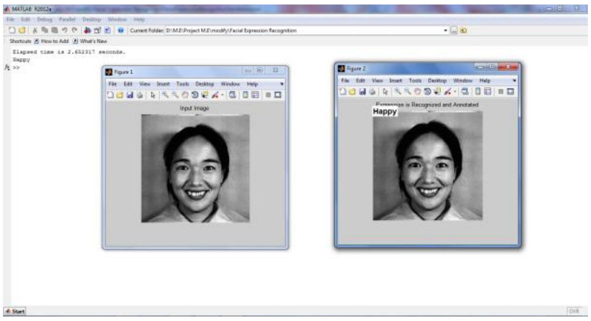

Figure 8: Facial Expression Is Recognized As Happy And Annotated using Gentleboost

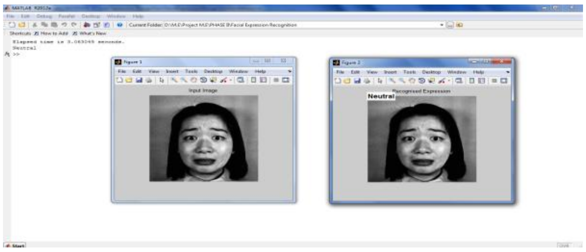

Figure 9: Facial Expression Fear is Recognized as Neutral And Annotated using Gentleboost

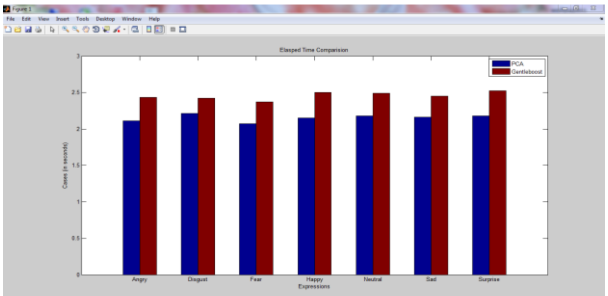

Figure 10: Elapsed Time Variation

VI. FUTURE WORK

To improve the efficiency of face annotation in future work, the proposed approach can be applied to detect face, facial expression or other objects recognition for 3D objects using integral imaging technique.

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