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EFFICIENT FACE RECOGNITION METHOD FOR PERSON AUTHENTICATION

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Abstract

In this paper, we propose efficient methods for face recognition which provides better performance for given images which might be taken in presence of different lighting conditions and slight pose variations. Face detection is performed through segmentation and face region coordinate computation. In face recognition process for each training sample the distance metric is learned to find the similarities between images. In order to raise the efficiency of face recognition, a method based on distance metric learning and hybrid neural network (back-propagation (BP) neural network and probabilistic neural network (PNN) integration) was introduced. This method based on FFT in feature extraction, distance metric data is propagated into the HNN and outputs the classification and recognition results by relative voting method. The performance analysis comparison proves the superiority of the proposed method.

Key words: Face detection, face recognition, distance learnng,hybrid neural network.

I. INTRODUCTION

Face recognition can be categorized into two classes: face verification and face identification. The first aims to verify whether a given pair of face images/video is from the same person or not, and the second aims to recognize the given face image from a gallery set and find the most matched one. In this work, we focus on face detection and identification, which aims to determine whether a given pair of face images captured in unconstrained environments is from the same person or not. Images containing faces are essential to intelligent vision-based human computer interaction, person identification and verification.

Research efforts in face processing include face recognition, face tracking, pose estimation, and expression recognition. However, many reported methods assume that the faces in an image or an image sequence have been identified and localized. To build fully automated systems that analyze the information contained in face images, robust and efficient face detection algorithms are required. The purpose of face authentication is to verify the claim of the identity of an individual in an input image, while face tracking methods continuously estimate the location and possibly the orientation of a face in an image sequence in real time [7], [3].Facial expression recognition concerns identifying the affective states (happy, sad, disgusted, etc.) of humans. Evidently, face detection is the first step in any automated system which solves the above problems. We focus on face detection and recognition methods rather than tracking methods.

II. FACE RECOGNITION TECHNOLOGY

Perfecting face recognition technology is dependent on being able to analyze multiple variables, including lighting, image resolution, uncontrolled illumination environments, scale, orientation, pose (out-of-plane rotation).

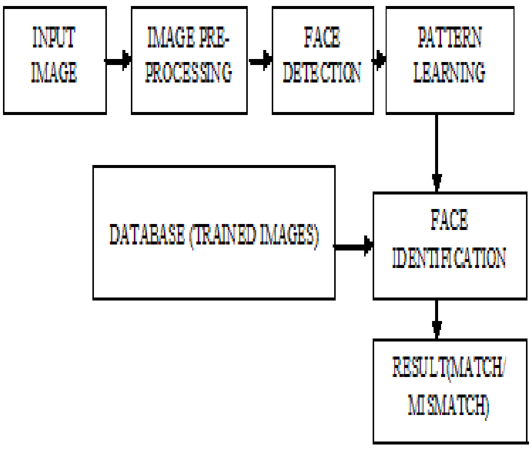

Fig. 1. Block diagram for face recognition process

Face detection should be performed before recognition system. This is done to extract relevant information for face and facial expression analysis. A face is represented as an array of pixel intensity values suitably pre-processed in appearance based approaches (texture). This array is then compared with a face template using a suitable metric [4]. Face identification generates the final output of complete face- recognition system: the identity of the given face image. Based on normalized face image and facial feature locations derived from previous stages, a feature vector is generated from given face and compared with a database of known faces. If a close match is found, the algorithm returns the associated identity.

A. Applications

Person authentication can be performed based on face image recognition technology in the server database or user login. Face-detection programs in digital photo-management software are used to tag photos and organize photo collections. Most digital cameras today have built-in face detectors that improve auto-focusing and auto-exposure. There are also prototypes of applications that use the built-in camera in the mobile phone. After taking a snapshot of the crowd, for example, the application searches all available social networks to identify faces. If matches are located, that profile information can then be displayed almost in real time while you're walking down the street.

B. Challenges associated with face recognition

The images of a face vary due to the pose(relative camera- face pose some facial features such as an eye or the nose may become partially or wholly occluded),presence or absence of structural components, facial expression, occlusion(faces may be partially occluded by other objects),image orientation(face images directly vary for different rotations about the camera's optical axis),imaging conditions When the image is formed, factors such as lighting and camera characteristics (sensor response, lenses) affect the appearance of a face. There are many closely related problems of face detection. Face localization aims to determine the image position of a single face; this is a simplified detection problem with the assumption that an input image contains only one face . The goal of facial feature detection is to detect the presence and location of features, such as eyes, nose, nostrils, eyebrow, mouth, lips, ears, etc., with the assumption that there is only one face in an image [2].

III. THE PROPOSED WORK

A. Pre-processing steps for an image

The placement of the light sources can make a considerable difference in the type of message that is being presented. Multiple light sources can wash out any wrinkles in a person's face, for instance, and give a more youthful appearance. The goal of illumination correction is to remove uneven illumination of the image caused by sensor defaults non uniform illumination of the scene, or orientation of the object- surface.

Illumination correction is based on background subtraction This type of correction assumes the scene is composed of an homogeneous background and relatively small objects brighter or darker than the background. There are two major types of background subtraction techniques depending on whether the illumination model of the images can be given as additional images or not. In image processing, to smooth a data set is to create an approximating function that attempts to capture important patterns in the data, while leaving out noise or other fine-scale structures/rapid phenomena. The probability maps are obtained, the decision rule is applied to each pixel of the image to classify it either as a skin or non-skin pixel. In order to speed up the process, the original image is subsampled by a factor of 4 before the skin segmentation routine is applied. After skin segmentation, the image mask is up-sampled back to the original image size for further processing.

Fig. 2. Illumination controlled and smoothed images

In smoothing, the data points of a signal are modified so individual points (presumably because of noise) are reduced, and points that are lower than the adjacent points are increased leading to a smoother signal. Smoothing may be used in two important ways that can aid in data analysis by being able to extract more information from the data as long as the assumption of smoothing is reasonable and by being able to provide analyses that are both flexible and robust.

B. Face detection

Face detection takes images as input and locates face areas within these images. This is done by separating face areas from non-face background regions. Facial feature extraction locates important feature positions within a detected face this is achieved by distance metric learning using fast fourier transform(FFT). Feature extraction simplifies face region normalization where detected face aligned to coordinate framework to reduce the large variances introduced by different face scales and poses. The accurate locations of feature points sampling the shape of facial features provide input parameters for the face identification. When a raw or filtered image is considered as input to a pattern classifier (HNN). The classes of face and non-face images are decidedly characterized by multimodal distribution functions and effective decision boundaries are likely to be nonlinear in the image space.

Fig. 3. Proposed face detection process (segmentation, noise eroded, region fill, detected region, face detected images)

Original image and its size are read, skin segmentation is performed, suspected face regions set to 1 and non-face regions set to 0,image is Converted into the BW format, noise eroded, holes are filled to get fully connected face regions, each connected region in the BW image are Labeled ,face regions are filtered out, the coordinates of each face region are computed, each detected face is highlighted by a box around face region.

C. Feature Extraction

Feature transform (FFT) in used to detect and describe local features in images. The key points of objects are first extracted from a set of reference images and stored in a database. An object is recognized in a new image by individually comparing each feature from the new image to this database and finding candidate matching features based on distance[1], of their feature vectors. From the full set of matches, subsets of key points that agree on the object and its location, scale, and orientation in the new image are identified to filter out good matches. In Dense SIFT , SIFT descriptors are densely sampled on each 16 × 16 patch without overlapping and. In LBP, each image divided into 8×15 non- overlapping blocks, where the size of each block is 10×10,SparseSIFT includes localization of nine fixed landmarks in each image and extracted SIFT features over three scales at these landmarks by following . Then, we concatenate these SIFT descriptors to form one feature vector. For these three features, FFT is performed to project each feature into a feature subspace.

D. Hybrid Neural Network

The first stage consists of two parallel sub networks in which the inputs are intensity values from an original image and intensity values from filtered image. The inputs to the second stage network consist of the outputs from the sub networks and extracted feature values such as the standard deviation of the pixel values in the input pattern, a ratio of the number of white pixels to the total number of binarized pixels in a window, and geometric moments.

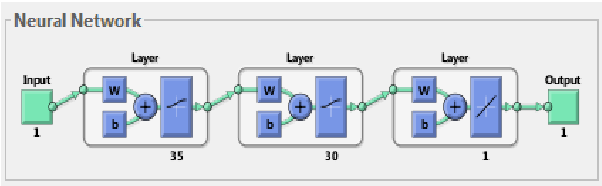

Fig. 4. Layer diagram of proposed neural network

An output value at the second stage indicates the presence of a face in the input region. Neural network is used to find a discriminate function to classify face and non-face patterns using distance measures. There are two major components: multiple neural networks (to detect face patterns) and a decision making module (to render the final decision from multiple detection results). Given a test pattern, the output of the trained neural network indicates the evidence for a non- face(close to 0) or face pattern (close to 1). To detect faces anywhere in an image, the neural network is applied at all image locations.

In HNN When an input is present, the first layer computes the distance from the input vector to the training input vectors.This produces a vector where its elements indicate how close the input is to the training input. The second layer sums the contribution for each class of inputs and produces its net output as a vector of probabilities. Finally, a compete transfer function on the output of the second layer picks the maximum of these probabilities, and produces a 1 (positive) for that class and a 0 (negative identification) for non-targeted classes. Training set contains face images collected from various face databases. Each image is divided into small sub images and then each one is tested separately using a HNN. The network is trained with multilayer back propagation neural networks (BPNN). FFT feature values of faces that represent the data set of face candidates obtained ,are fed into PNN to classify whether original image included in the DB. The PNN input is feature vector based on FFT.

IV RESULTS AND DISCUSSION

The proposed method for human face recognition is implemented by using MATLAB software in programming level. MATLAB is a data analysis and visualization tool which has been designed with powerful support for matrices and matrix operations. As well as this, MATLAB has excellent graphics capabilities, and its own powerful programming language. The test/input image is preprocessed face region is detected, image pattern generated and then compared with the database (consists of trained images whose pattern are formed) of images to identify whether the input image belong to the database images. Finally image match or mismatch status is declared through a message/dialogue box in the text or voice format.

The detected face is highlighted by a box around face region. Face identification generates the final output of complete face-recognition system: the identity of the given face image. Based on normalized face image and facial feature locations derived from previous stages, a feature vector is generated from given face and compared with a database of known faces. If a close match is found, the algorithm returns the associated identity.

The HNN is used to represent function using arbitrary decision surfaces by utilizing nonlinear activation functions. Their experiments showed that the methods show closer performances for the classification in face and non-face space, and the method has achieved high detection rates and an acceptable number of false negatives and false positives face detection. The advantage of using neural networks for face detection is the feasibility of training a system to capture the complex class conditional density of face patterns. The usage of HNN increases accuracy compared to the other type of neural networks. The HNN classification implementation improves accuracy and almost 87% accuracy is obtained in the face recognition process. This proposed method can be used for both face identification and face verification, incase of face verification the preloaded image and query images are concerned, but for face identification database images and query image are of concern.

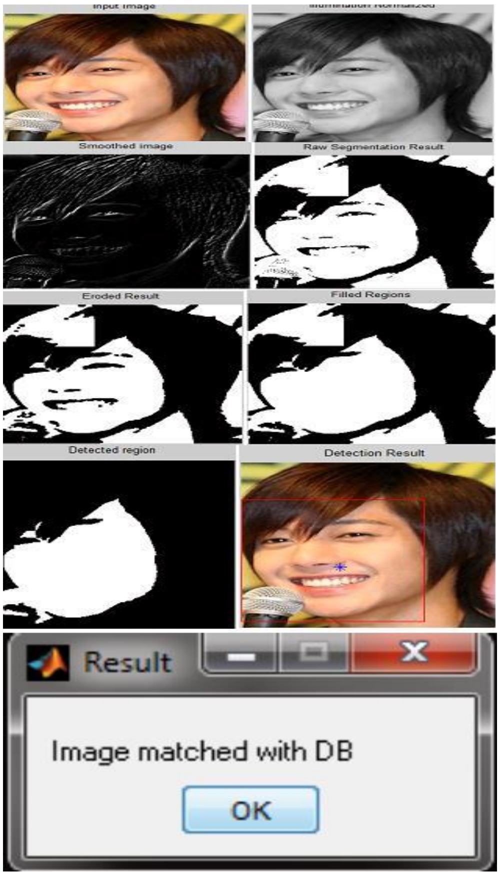

Fig. 5. Proposed Face detection & identification stages

V. CONCLUSION

We proposed the methods for face recognition which could perform efficiently for images that are captured with different lighting conditions, pose variations(provided 75% of visible face view), with the presence or absence of structural components, occlusion. The face detection and face recognition process is performed on the test/input image with the help of proposed methods(distance metric learning, HNN) to improve the accuracy of the face recognition process so that it can be used in security based applications such as person authentication in the organizations, user login through face authentication. This method effectively solves the interferences of illumination, facial pose variation, and as a result improves the classification of the human face recognition ability. The performance analysis result shows the efficacy(87% accuracy) of the proposed methods compared to the other methods.

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