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Robust Face Recognition and Tagging in Visual Surveillance System

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Abstract:
Face recognition is one of the most successful applications in the field of image processing. Most robust face methods are difficult to improve their performance under certain environments. The paper proposes a method for robust face recognition and implementing a tagging process in video surveillance. It provides an interface for communicating with camera or webcam capturing images storing and sending them along with relevant information. Video based face recognition is much efficient in many real world applications. Motion detection is the first step before the face detection. The face image is divided in to several regions and finding the weight for each region. Face is one of the most suitable biometrics for surveillance applications. It is client server architecture. A user interface is provided at the client and the user interacts with the Web cam view and captures the image. The user sends the relevant data to server for verification. The authentication is based on face matching. After motion detection the face is extracted from the image and calculates the corresponding eigen vectors of each face region. If the face matches with the image in the database the server provides a tagging mechanism. Face is calculated with PCA, LCA, LDA and local binary pattern. There is additional facility provided at the server side to views and generates reports which provide visitor’s information. The main advantage of this system is that the security in-charge need not be positioned at the secured area.
Keywords—Video based image capturing, Face detection, pose and illumination changes, security authentication, Tagging.

I. INTRODUCTION

As a biometric technology, automated face recognition has a number of desirable properties that are driving research into practical techniques [15]. The problem of face recognition can be stated as ‘identifying an individual from images of the face’ and encompasses a number of variations other than the most familiar application of mug shot identification. One notable aspect of face recognition is the broad interdisciplinary nature of the interest in it: within computer recognition and pattern recognition; biometrics and security; multimedia processing; psychology and neuroscience. It is a field of research notable for the necessity and the richness of interaction between computer scientists and psychologists. Machine recognition of faces is emerging as an active research area spanning several disciplines such as image processing, pattern recognition, computer vision and neural networks. Face recognition technology has numerous commercial and law enforcement applications. These applications range from static matching of controlled format photographs such as passports, credit cards, photo

ID’s, driver’s licenses, and mug shots to real time matching of surveillance video images[13].Vision is the most advanced of our senses, so it is not surprising that images play the single most important role in human perception. However, unlike humans, who are limited to the visual band of the electromagnetic (EM) spectrum, imaging machines cover almost the entire EM spectrum, ranging from gamma to radio waves. They can operate also on images generated by sources that humans do not customarily associate with images. Based on the existing video surveillance monitoring system, the new system uses introduces a facial recognition technology that adopts “client server architecture”. First, the system analyzes facial data capturing from the camera, then sends these real-time results to the server. Motion detection is an effective method used here. After that the system management application compares the real-time data with data in the database. If the results match with each other, the alarm will be triggered and the image will be tagged [4]. Some of the most popular and well-established algorithms for face recognition (PCA, LDA, ICA, and SVMs) to assess the feasibility of real world face recognition in uncontrolled setting [2]. Illumination and pose variations are two factors that may and actually do hinder correct recognition. The main objective is to improve the performance accuracy of the face image under various pose and illumination changes. Particularly, compared with existing face recognition techniques the proposed system are able to provide excellent recognition rates for face images taken under severe variation in illumination, as well as for small- (low-) resolution face images. Images are captured in uncontrolled environment using video surveillance cameras of various quality and resolution. For better accuracy image is compared against PCA, LDA, and ICA [2]. For feature extraction local binary pattern algorithm is used and it captures the local structure of the image area. In the existing methods of face recognition it is difficult to extract features from a face which contains shadow regions. More efficient algorithms are performed here to identify the images which are in uncontrolled pose and illuminations. When it is possible to request a new sample, this is done; otherwise, such as it is the case for tagging, the system follows a different protocol, where answers are ordered according to their reliability and user feedback is sought. In the existing methods of face recognition it is difficult to extract features from a face which contains shadow regions. Although previous works in robust face recognition have successfully demonstrated the detection of a face in unlimited pose and illumination effect but it is limited in motion detection. The proposed systems implements a real world application in face recognition problem and tagging in visual surveillance system and improve accuracy of the images. The main advantage of this system is that the security in-charge need not be positioned at the secured area.

The paper is further organized as follows: Section II proposes face detection. Section III Face matching and tagging, while the experimental result is shown in section IV and conclusion is defined in section V.

II. FACE DETECTION

This section starts with face and landmark detection. It then describes the image capturing and authentication process. Sample pose and Sample illumination are two factors which estimate the distortions of some face image in pose and illumination.

A. Video based image capturing

Face can be captured by a video. Face images are typically captured over multiple frames in uncontrolled conditions, where head pose, illumination, shadowing, motion and focus change over the sequence. Video-based identity inference in surveillance conditions is challenging due to a variety of factors, including the subjects' motion, the uncontrolled nature of the subjects, variable lighting, and poor quality CCTV video recordings [13]. Here the motion of the image is also captured. The distance between two videos is the minimum distance between two frames across two videos. A state space model with tracking state vector and recognizing identity variable was used to characterize the identity by integrating motion and identity information over time. One approaches utilize spatial information by considering frames from videos as still image sets without considering their temporal information. Person-specific models are trained from video sequences to form many individual eigen spaces in. Angles between subspaces are considered as the similarity between videos.

B. User authentication

Each user has an account and a corresponding ID in the Face Database. On a user logging in the system, Face authentication will use face recognition technologies to analyze and determine his ID as well as his permissions on the system.

C. Face detection

Face detection segments the face areas from the background. In the case of video, the detected faces may need to be tracked using a face tracking component. Face alignment is aimed at achieving more accurate localization and at normalizing faces, whereas face detection provides coarse estimates of the location and scale of each face [3]. Facial components and facial outline are located; based on the location points, The input face image is normalized in respect to geometrical properties, such as size and pose, using geometrical transforms or morphing, The face is further normalized with respect to photometrical properties such as illumination and gray scale [4]. After a face is normalized, feature extraction is performed to provide effective information that is useful for distinguishing between faces of different persons and stable with respect to the geometrical and photometrical variations. For face matching, the extracted feature vector of the input face is matched against those of enrolled faces in the database; it outputs the identity of the face when a match is found with sufficient confidence or indicates an unknown face otherwise, Motion detection is one of the features used here. It detects the direction of the face. It identifies all the common features in all faces in the database. Consequently, frontal face images form a very dense cluster in image space which makes it virtually impossible for traditional pattern recognition techniques to accurately discriminate among them with a high degree of success [5].

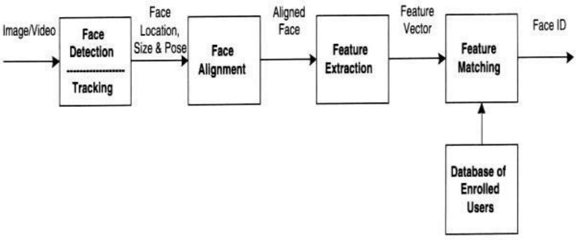

Fig 1:Face detection process

III. FACE MATCHING AND TAGGING

Given quality indices SP and SI, for pose and illumination distortions, respectively, and normalization process that corrects estimated pose and illumination changes, it proceed to the second module of FACE, dealing with identification and decision making. It describes the matching algorithm and the reliability ("confidence") for the matching scores. The latter relies on the gallery composition, namely, the relations holding among all of the measured distances from the probe image.

A Matching algorithm description

- Acquire an initial set of face images (the training set)
- Calculate the faces 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 faces can be updated or recalculated
- Calculate the corresponding distribution for each known individual, by projecting their face images onto the "face space."
- Calculate a set of weights based on the input image and the M eigenfaces by projecting the input image onto each of the faces.
- Determine if the image is a face at all by checking to see if the image is sufficiently close to "face space."
- If it is a face, classify the weight pattern as either a known person or as unknown.
- Update the faces and/or weight patterns.

B. Measuring pose and illumination

A way to measure the quality of a FACE probe is to consider the amount of "effort" that would be needed to correct for corrections yielding lower quality ("distortion") indices. pose and illumination distortions in the image, with larger corrections yielding lower quality ("distortion") indices[9].

Roll is approximated as the angle θ between the line passing through the centre of the eyes and the *x* axis.

$$roll = \min\left(\left|\frac{2\cdot\theta}{\pi}\right|, 1\right). \quad (1)$$

Measure the left distance d_l and right distance d_r between the external corner of each eye and the nose tip:

$$yaw = \frac{\max(d_l, d_r) - \min(d_l, d_r)}{\max(d_l, d_r)}. \quad (2)$$

The distances of concern are *eu* and *ed*, which are, respectively, the distances to the root of the nose and of the chin from the nose tip:

$$pitch = \frac{\max(e_u, e_d) - \min(e_u, e_d)}{\max(e_u, e_d)}. \quad (3)$$

The SP index is defined as a weighted linear combination of values computed from them as follows:

$$SP = \alpha\cdot(1 - roll) + \beta\cdot(1 - yaw) + \gamma\cdot(1 - pitch) \quad (4)$$

with $\alpha + \beta + \gamma = 1$. When a face is illuminated in an optimal (uniform) way, neither shadows nor saturated areas appear on it due to the light reflected by the skin. Under such optimal conditions, empirical experience shows that some specific face regions, namely, the more smoothed ones, tend to present a uniform distribution of gray levels, i.e., they present quite similar gray level histograms. Note that sun glasses as well as the beard (except if it is grizzled), are still uniform regions, if correctly illuminated.

For each such reference point, here select the corresponding region *w* of the image, whose size is proportional to the square containing the whole face. For each region *w*, here compute the histogram *h* and its centre of mass, using the formula:

$$mc(w) = \left(\sum_{i=0}^{255} i\cdot h_w(i)\right) \Big/ \sum_{i=0}^{255} h_w(i). \quad (5)$$

The sample illumination quality index SI is defined as a scalar in the interval [0,1] (the higher, the better), computed as:

$$SI = 1 - F\left(std(mc)\right). \qquad (6)$$

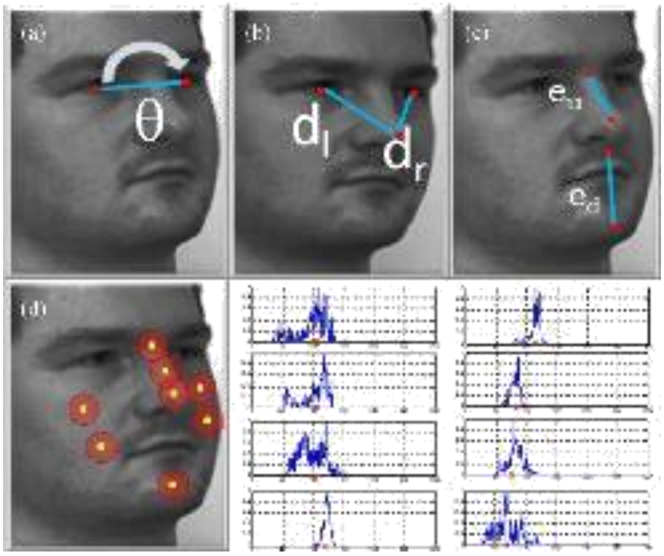

Fig. 2. Feature points used to compute (a)–(c) pose and (d) illumination distortion measures, and histograms of gray levels in face regions identified by points in (d).

C.Tagging

The system analyses facial data capturing from the camera, then sends these real-time results to the server. After that the system management application compares the real-time data with data in the database. If the results match with each other, he alarm will be triggered and the image will be tagged.. Facial recognition is the use of the unique configuration of a person's facial features to accurately identify them, usually from surveillance video [4].The server checks whether the image is matched with the image in the database. If it is an authenticated person the face can be detected and photo can be tagged. If it is not an authenticated person the registration will occur. A common goal in many vision applications is to identify objects with distinctive visual features or tags.

IV. EXPERIMENTAL RESULT

In this section, it present different sets of experiments aimed at assessing different aspects of FACE. First of all, here describe the set of different databases of face images that are used as a test-bed, as well as the set of techniques that are compared. The performances achieved by our local correlation matching technique with the other methods. In this set of experiments, the proposed normalization procedure is not yet exploited. The experiments reported the contribution of the proposed normalization procedure, which does not only affect the accuracy of local correlation matching but also that of the other methods. The experiments on SCface databases assess first the precision of interest point location found on a given face. As expected, the precision decreases as the image distortion increases (pose and illumination). Some images in SCface come with a file containing information about the image (file name, acquisition date, etc.) and coordinates of some face landmarks (left eye centre, right eye centre, noise tip, and mouth centre)[18].

The SCface database contains static images of human faces. Images are captured in uncontrolled indoor environment using several video surveillance cameras of various quality and resolution. The database consists of 4160 face images (in visible and infrared spectrum) of 130 subjects. Images are divided in a significant number of subsets, according to interesting conditions such as type of camera and distance from the camera. An example of normalization in cases of correct/incorrect location is shown in Fig. 3, where the first row shows faces from SCfaces sets Frontal (first image) and R1 (second and third image).

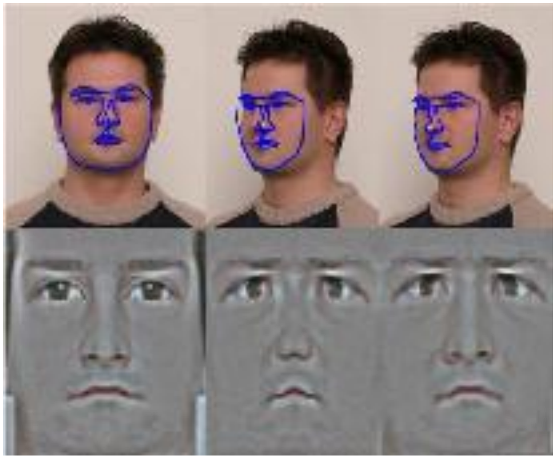

Fig:3 Example faces from SCface normalized by FACE based on interest points: frontal face with correct location (leftmost), rotated face with incorrect location (middle), and rotated face with correct location based on file annotations (rightmost).

SCface contains, among the others, subsets of face images rotated left (Left1, L1 for short) and right (Right1, R1 for short) [13]. It also contains further subsets, namely, L2, L3, and L4, andR2, R3, and R4, which differ from L1 and R1, respectively, for the increasing amount of rotation.Additional experiments using SCface aimed at assessing two critical aspects affecting the overall authentication process: 1) the location of interest points and 2) the effects of a bad point location regarding system recognition performances. In this paper, the training was further refined with a subset of images from LWF (not used in the experiments).

To evaluate performances when combining quality/reliability indices, it is first necessary to set suitable thresholds for their values, according to which here it accept/discard samples (SP and/or SI) and/or responses (SRR I and/or SRR II). To do this, here the aforementioned values are analysed when applying single indices. It separately considered SP and SI, and for each of them, it looked for a balance between the obtained RR value and the reduction of the rate of adequate images (RAI) [9]. Figs. 4 and 5 shows that performance is about 75% accuracy, with 100% responses marked as adequate, when no index is considered. On the contrary, with a relatively high threshold of 0.81 for SP, it reaches an RR of about 80%, with a rate of adequate responses of 60%. Analogously, with very high thresholds for SI, the number of adequate responses decreases to 65%, while accuracy reaches 79%.

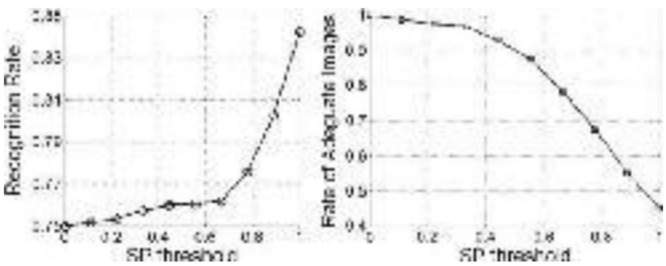

Fig. 4. Accuracy variations and RAI versus variations of the threshold for SP index.

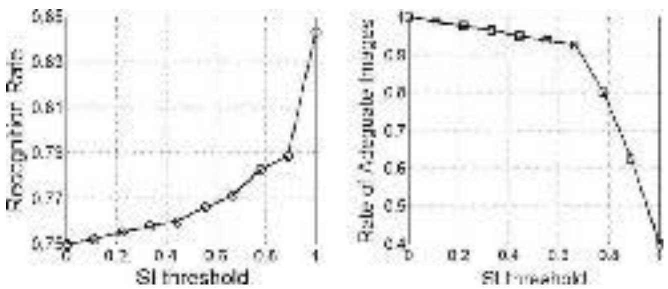

Fig. 5. Accuracy variations and RAI versus variations of the threshold for SI indices.

V. CONCLUSION

In summary it has been concluded that this paper has described a new framework for face analysis and tagging in visual surveillance system. It improves accuracy performance for uncontrolled pose and illumination settings. It deals about real time applications and provides high performance when the images acquisition conditions are not optimal. Due to several characteristics, FACE can be considered as a good candidate to support tagging. The main advantage of this system is that the security in-charge need not be positioned at the secured area. The database consists of several collection of photographs of interesting subjects in different contexts and automatically detect the features according to the subject's identity. The paper describes a model of client server architecture. Experimental results show that FACE outperforms competing methods, with a significant increment in accuracy versus the next ranked methods. The improvement depends on the complexity of the data set at hand but is always worth of consideration. A number of research issues are still open. One of them regards scaling, i.e., the efficient use of our reliability measures with galleries consisting of millions of images, where such procedures can be very expensive. At present, many mass screening applications of face recognition require to process a large amount of data (even thousands of images at a time) despite uncontrolled settings. An example of such application is the automatic clustering of real-world images for *tagging* purposes [4]. More specifically, one may consider the organization of databases, which collects photographs of interesting subjects (actors and public personalities) in different contexts, poses, and environmental conditions, and automatically cluster them according to the subjects' identity.

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