International Journal For Technological Research In Engineering
Volume 2, Issue 4, December-2014 *ISSN (Online): 2347 - 4718*

APPROACHES TO FACE RECOGNITION BY VARIOUS TECHNIQUES

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ABSTRACT: Systems that rely on Face Recognition (FR) biometric have gained great importance ever since terrorist threats imposed weakness among the implemented security systems. Other biometrics i.e., fingerprints or iris recognition is not trustworthy in such situations whereas FR is considered as a fine compromise. This survey illustrates different FR practices Efforts on FR in controlled settings have been in the picture for past several years; however identification under uncontrolled conditions like illumination, expression and partial occlusion is quite a matter of concern. By considering some of the approaches for facial recognition .We have just presented a overview of all the approaches in this paper.

I. INTRODUCTION

Three main tasks of face recognition may be named: “document control”, “access control”, and “database retrieval”. The term “document control” means the verification of a human by comparison his/her actual camera image with a document photo. Access control is the most investigated task in the field. Such systems compare the portrait of a tested person with photos of people who have access permissions to joint used object. The last task arises when it is necessary to determine name and other information about a person just based on his/her one casual photo. Because of great difference between the tasks there is not a universal approach or algorithm for face recognition [1-4]. We tested several methods for mentioned above tasks: geometric approach, elastic matching and neuron nets and along with it also considered the methods for solving the illumination problems that usually occurs in facial recognition task.

II. INPUT IMAGE NORMALIZATION

Image normalization is the first stage for all face recognition systems. Firstly face area is detected in the image. We used template matching to localize a face. Then the eye (iris) centers should be detected because the distance between them is used as a normalization factor. We located the eyes in facial images of different size using the luminance component. We required the eyes must be open in input images. The gray-scale image was processed by an edge detector (we used Sobel). Then it was binarized by Otsu method [5]. We calculated the vertical integral projection [6] of the binary image and smoothed the projection profile by averaging of neighboring values. The profile was searched for a large valley with an intervening high peak. The peak indicates to the eye area in the image (see the right part of Fig.1). To locate eyes we applied Hough transform to a small strip of the binary image (the shaded area in Fig.1 using a half circle mask as often the upper part of the iris is covered by eyelid. To speed up the processing, we store several masks corresponding to different radii and then use for Hough Transform. Among several peaks in the Hough space we find two highest scoring candidates. The crosses in Fig.1 show the centers of eyes and some details of their location. The output of this step is the coordinates of the eyes. In the next step we transformed the initial images by rotation, scaling and cropping of the central face part. We tried to remove background and hair, and keep the most invariant (in time) part of a face. The most important facial features are situated around eyes, eyebrows, and nose. We have observed that the nose shape varies a lot as a consequence of head rotation and lighting conditions. Finally mouth is the most variant part of the face.

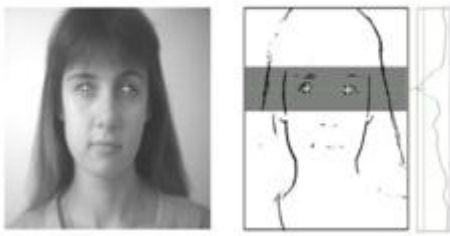

Fig. 1. Original face image and located eye centers.

We can rely on the fact that face expression in document photos is usually minimal, at least discreet, while for a camera control image the test person can be requested to restrain from excessive expressions. Additional features from the original image can be gleaned in the form of a gray-scale edge map using Deriche algorithm. Examples of the input images are given in the top of Fig.2.

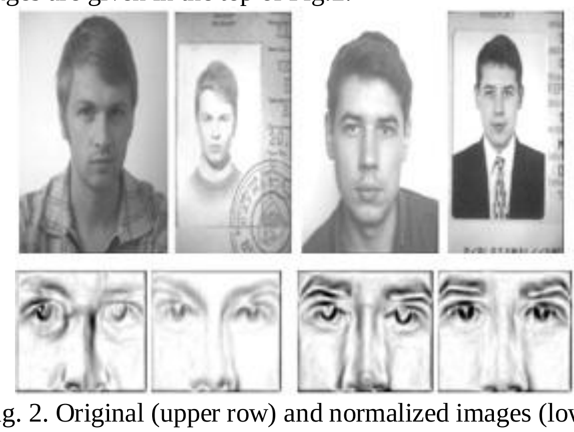

Fig. 2. Original (upper row) and normalized images (lower row), respectively.

Then we apply the ranking transform to the edge map and change the value of every map element by the rank of the edge value corresponding to the element. Histogram of the edge map gives ranking of all edge values. Outcome of the normalization step is the rank map of the cropped original rotated and scaled image (see Fig.2).

III. GEOMETRIC APPROACH TO FACE RECOGNITION

The first historical way to recognize people was based on face geometry. There are a lot of geometric features based on the points. We experimentally selected 37 points (Fig.3). Geometric features may be generated by segments, perimeters and areas of some figures formed by the points. To compare the recognition results we studied the feature set described in detail in [7]. It includes 15 segments between the points and the mean values of 15 symmetrical segment pairs.The approach is robust, but it main problem is automatic point location. Some problems arise if image is of bad quality or several points are covered by hair.

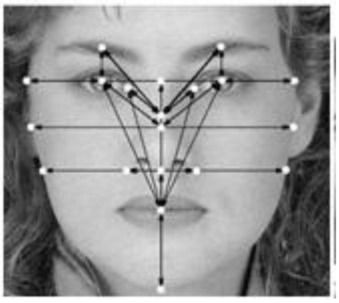

Fig.3. Some facial points and distances between them are used in face recognition.

IV. ELASTIC FACE MATCHING

The previous approach evaluates the point-based features only. Applying some elastic transform we can change geometry and image texture and then compare two images. Given the variability of a face, even under controlled conditions it is futile to try to compare directly original images or even their feature maps. In fact, we have got very low similarity scores with the popular method of mosaic images, and using linear correlation. With the rank transformation differences of luminance and contrast become compensated for. Furthermore to compensate for the local changes due facial expression and pose, we apply a nonlinear warping of one rank map vis-à-vis another map. Among the many algorithms to warp images we used a technique similar to that described in [8]. It turns out that comparison of one warped map with another non-warped one yields much better results than a direct comparison of the maps. However, the computational cost of warping is high, as we must test a large set of randomly generated local deformations. A practical way to maneuver in the warping parameter space consists in checking after every warping the score against the previously achieved level of similarity. We continue to warp the first map if the present score is higher than the previous one; otherwise we start warping with other parameters. Note that the dissimilarity measure we used to compare two maps was the rank correlation coefficient. The smaller this score, the more similar are the two rank maps and, hence, the persons presented in the images. In fact, it equals 0 if the compared maps are identical, equals to 1 if they are very different, and assumes the value 2 if they are reverse images. When the score falls below predefined threshold T, then one can conclude that the two images delineate the same person.

V. NEURAL NETWORKS FOR ACCESS CONTROL

Face Recognition is a widespread technology used for Access Control. The task is stated as follows. There is a group of authorized people, which a recognition system must accept. All the other people are unauthorized or ‘aliens’ and should be rejected. We can train a system to recognize the small group of people that is why application of a Multilayer Perceptron (MLP) Neural Network (NN) was studied for this task. Configuration of our MLP was chosen by experiments. It contains three layers. Input for NN is a grayscale image. Number of input units is equal to the number of pixels in the image. Number of hidden units was 30. Number of output units is equal to the number of persons to be recognized. Every output unit is associated with one person. NN is trained to respond “+1” on output unit, corresponding to recognized person and “-1” on other outputs. We called this perfect output. After training highest output of NN indicates recognized person for test image. Most of these experiments were passed on ORL face database. Any input image was previously normalized by angle, size, position and lightning conditions. We also studied another image representations: a set of discrete cosine transform coefficients and a gradient map. Using DCT first coefficients we reduce the sample size and significantly speedup the training process. DCT representations allows us to process JPEG and MPEG compressed images almost without decompression. A gradient map allows to achieve partial invariance to lightning conditions. In our experiments with NNs we studied several subjects. We explored thresholding rules allowing us to accept or reject decisions of NN. We introduced a thresholding rule, which allow improving recognition performance by considering all outputs of NN. We called this ‘sqr’ rule. It calculates the Euclidean distance between perfect and real output for recognized person. When this distance is greater then the threshold we reject this person. Otherwise we accept this person. The best threshold is chosen experimentally. We have explored ensembles of Neural Networks. There were cases when each NN in an ensemble was trained to recognize assigned to NN person and when each NN was trained to recognize all persons. The best architecture in our experiments was an ensemble of NNs when each NN was trained to recognize all the authorized people. We studied usage of negative examples for improving recognition performance for access control task. A negative example is an image of a person, which is always considered as alien. NN was trained to respond “-1” for negative examples. The performance was better than without negative examples. Then NN was trained to recognize each negative person like an authorized person. If a test person was recognized as one of negative persons, we reject it. It this case performance was best. Equal Error Rate (EER) is the number, when the percent of incorrectly accepted and rejected persons is equal. EER is basic measure for performance of access control systems. Using the above-mentioned improvements we have lowered EER from 20% without improvements to 6% EER in the best case.

VI. SOLVING THE ILLUMINATION PROBLEM

As a fundamental problem in image understanding literature, illumination problem is generally quite difficult and has been receiving consistent attentions. For face recognition, many good approaches have been proposed utilizing the domain knowledge, i.e., all faces belong to one face class. These approaches can be broadly divided into four types [9]: 1) Heuristic methods including discarding the leading principal components, 2) Image Comparison Methods where various Image Representations and Distance Measures are applied, 3) Class-Based methods where multiple images of one face under pose but different lighting conditions are available, and 4) Model-based approaches where 3D models are employed.

A. Heuristic approaches

To handle the illumination problem, researchers have proposed various methods. Within the Eigen-subspace domain, it has been suggested that by discarding the three most significant principal components, variations due to lighting can be reduced. And it has been experimentally verified in [10] that discarding the first few principal components seems to work reasonably well for images under variable lighting. However, in order to maintain system performance for normally lighted images, and improve performance for images acquired under varying illumination, we must assume that the first three principal components capture the variations only due to lighting. In [11], a heuristic method based on face symmetry is proposed to enhance system performance under different lighting conditions.

B. Image comparison approaches

In [12], statistical approaches based on image comparison have been evaluated. The reviewed methods use different image representations and distance measures. The image representations used are: edge maps, derivatives of the gray level, images filtered with 2D Gabor-like functions, and a representation that combines a log function of the intensity with these representations. The different distance measures used are: point-wise distance, regional distance, GL (gray level) distance, local GL distance, and LOG point-wise distance. For more details about these methods and the evaluation database, please refer to [12]. One important conclusion drawn is that these representations are not sufficient by themselves to overcome the image variations. More recently, a new image comparison method proposed by Jacobs et al. [13] uses a measure robust to illumination change. Their method is based on the observation that the difference between two images of the same object is smaller than the difference between images of different objects. However this measure is not strictly illumination-invariant because the measure changes for a pair of images of the same object when the illumination changes.

C. Class-based approaches

With assumptions of Lambertian surfaces, no shadowing and three aligned images faces acquired under different lighting conditions, a 3D linear illumination subspace for a person has been constructed in for a viewpoint. Thus under ideal assumptions, recognition based on the 3D linear illumination subspace is illumination-invariant. More recently, an illumination cone has been proposed as method to handle illumination variations, including shadowing and multiple lighting sources. This method is an extension of the 3D linear subspace method and hence needs three aligned training images acquired under different lightings. One drawback to using this method is that we need more than three aligned images per person. More recently, a new method based on a quotient image has been introduced [14]. The advantage of this approach over existing similar approaches is that it only use a small set of sample images. This method assumes the same shape and different textures for faces of different individuals. An interesting energy function to be minimized is then formulated. Using this formulation, better results are rendered than using connectionist approaches.

D. Model-based approaches

In their paper [15], the authors suggest using Principal Component Analysis (PCA) as a tool for solving the parametric shape-from-shading problem. i.e., obtain the Eigen-head approximation of a real 3D head after training on about 300 laser-scanned range data of real human heads. This assumption does not hold for most real face images and we believe that this is one of the major reasons why most SFS algorithms fail on real face images.

VII. CONCLUSION

We have presented various methods of face recognition approaches, which may be applied in identification systems, document control and access control. The proposed face similarity meter was found to perform satisfactorily in adverse conditions of exposure, illumination and contrast variations, and face pose. We have identified key issue in the face recognition literature: the illumination problem and then examined existing methods of handling illumination problems and how it can be solved.

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