CHALLENGES IN FACE RECOGNITION TECHNIQUES

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Abstract: - Over the last couple of years, face recognition researchers have been developing new techniques. These developments are being fueled by advances in computer vision techniques, computer design, sensor design, and interest in fielding face recognition systems. Such advances hold the promise of reducing the error rate in face recognition systems by an order of magnitude over Face Recognition Vendor Test (FRVT) 2002 results. The Face Recognition Grand Challenge (FRGC) is designed to achieve this performance goal by presenting to researchers a six-experiment challenge Problem along with data corpus of 50,000 images. The data consists of 3D scans and high resolution still imagery taken under controlled and uncontrolled conditions. This paper describes the challenge problem, data corpus, and presents baseline performance and preliminary results on natural statistics of facial imagery.

***Keywords:* face reorganization, personal identification, biometrics**

1. INTRODUCTION

There are two major challenges faced during the testing are:

- The illumination problem
- The pose variation problem

Both these problems are serious and cause the degradation of the existing system. These problems can be formulated and a common approach could be followed by sequencing the following:

- Face detection
- Face normalization
- Inquire database

1.1 The Illumination Problem

Same image may appear differently due to illumination condition .If the illumination induced is larger than the difference between the individuals, system may not be able to recognize the input image. It has been suggested that one can reduce variation by discarding the most important eigenface. And it is verified in [1] that discarding the first few eigenfaces seems to work reasonably well. Many of the methods were suggested by researchers which ultimately led to the result that the methods were illumination-invariant and the measure of the same object changes when illumination changes. An illumination subspace can be constructed but one drawback of this method is that many of the faces of one person are needed to construct the subspace. Methods have been developed to solve the illumination problem the approaches have been divided into four categories:

- Heuristic methods including discarding the leading principal components
- Image comparison methods where various image representations and distance measures are applied
- Class-based methods where multiple images of one face under a fixed pose but different lighting conditions are available
- Model-based approaches where 3D models are employed.

1.1.1 Heuristic approach

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 [1] 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 [1], a heuristic method based on face symmetry is proposed to enhance system performance under different lighting.

1.1.2 Image comparison approaches

In [2], 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, affine GL (gray level) distance, local affine-GL distance, and LOG point-wise distance. 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. [3] 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.

1.1.3 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 [2, 3, 4] for a fixed 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 an effective method to handle illumination variations, including shadowing and multiple lighting sources [2, 4] .This method is an extension of the 3D linear subspace method [3,4] 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. 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.

1.1.4 Model-based approaches

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. Though the ill-posed SFS problem is transformed into a parametric problem, they still assume constant albedo .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.

1.2 Solving the Pose Problem

Researchers have proposed various methods to handle the rotation problem .Basically they can be divided into three classes:

- Multiple images based methods: when multiple images per person are available,
- Hybrid methods: when multiple training images are available during training but only one database image per person is available during recognition , and
- Single image/shape based methods when no training is carried out.

1.2.1 Multi-image based approaches

Among the first class of approaches one of the earliest is by Beymer [5] in which a template based correlation matching scheme is proposed .In this work, pose estimation and face recognition are coupled in an iterative loop. For each hypothesized pose, the input image is aligned to database images corresponding to a selected pose. The alignment is first carried out via a 2D affine transformation based on three key. Feature points (eyes and nose), and then optical flow is used to refine the alignment of each template. After this step, the correlation scores of all pairs of matching templates are used to perform recognition.
The main restrictions of this method are:

- Many images of different views per person are needed in the database, and
- No lighting variations (pure texture mapping) or facial expressions are allowed, and finally
- The computational cost is high since it is an iterative searching approach.

More recently an illumination based image synthesis method [6] has been proposed as a potential method for robust face recognition handling both pose and illumination problems. This method is based on the well-known approach of an illumination cone [2] and can handle illumination variation quite well. To handle variations due to rotation, it needs to completely resolve the GBR (generalized-bas-relief) ambiguity when reconstructing the 3D shape.

1.2.2 Hybrid approaches

Numerous algorithms of the second type have been proposed and are by far the most popular ones. Possible reasons for this are:

- It is probably the most successful and practical method up to now,
- It utilizes prior class information

We review three representative methods here: the first one is the linear class based method [7], the second one is the graph matching based method [8], and the third is the view base Eigen face approach [9]. The image synthesis method in [7] is based on the assumption of linear 3D object classes and the extension of linearity to images which are 2D projections of the 3D objects. It extends the linear shape model from a representation based on feature points to full images of objects. To implement their method, a correspondence between images of the input object and a reference object is established using optical flow. Also

correspondences between the reference image and other example images having the same pose are computed. Finally, the correspondence field for the input image is linearly decomposed into the correspondence fields for the examples Compared to the parallel deformation scheme in [10], this method reduces the need to compute the correspondence between images of different poses .This method is extended in [11] to carry an additive error term for better synthesis. In [8] a robust face recognition scheme based on Elastic Bunch Graphic Matching (EBGM) is proposed. The authors basically assume a planar surface patch in each key feature point (landmark), and learn the transformation of 'jets' under face rotation They demonstrate substantial improvements in face recognition under rotation. Also, their method is fully automatic, including face localization, landmark detection, and finally a flexible graph matching scheme. The drawback of this method is the requirement of accurate landmark localization which is not an easy task especially when illuminations variations are present the popular eigenface approach to face recognition has been extended to view based eigenface method in order to achieve pose invariant recognition [9].
This method explicitly codes the pose information by constructing an individual eigenface for each pose. Despite their popularity, these methods have some common drawbacks: 1). they need many example images to cover all possible views, and 2). the illumination problem is separated from the pose problem.

1.2.3 Single image/shape based approaches

Finally, there is the third class of approaches which include low level feature based Methods, invariant feature based methods, and the 3D model based method. In [12] a Gabor wavelet based feature extraction method is proposed for face recognition and is robust to small angle rotation. There are many papers on invariant features in the computer vision literature. To our knowledge, serious application of this technology to face recognition has not yet been explored. However, it is worthwhile to point out that some recent work on invariant methods based on images may shed some light in this direction. For synthesizing face images under different appearances /lightings/expressions 3D facial models have been explored in the computer graphics, computer vision and model based coding communities In these methods, face shape is usually represented either by a polygonal model or a mesh model which simulates tissue However due to its complexity and computational cost, any serious attempt to apply this technology to face recognition has not yet been made.

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