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Face Recognition: A Realistic Far-Fetched Technology

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Abstract: Science and technology have always astonished us in every field and pattern recognition is one such aspect. There has been constant endeavor in fields of Image processing which makes pattern recognition possible. One such application of pattern recognition is observed in the fields of Security and Biometric analysis in the form of Facial Recognition. Facial Recognition is a very challenging problem and up to date, there is no technique that provides a robust solution to all situations and different applications that face recognition may encounter. There are various algorithms that deal with Facial Recognition and image reconstruction (E.g. – Viola Jones Algorithm), but do not have a higher success rate. In a general context, it is believe that facial recognition in complex scenarios will remain unsolved for the next years. However there might be hope for specific contexts and applications if some techniques are further studied, developed and combined. This paper will address the difficulties that arise in face recognition, how it is done and also the question: Is there any hope for face recognition.

Keywords – Facial Recognition, Biometric analysis, Algorithm, Image Processing.

1. Introduction

Almost in any face recognition application, a face detection stage is needed. Although face detection poses also a very challenging problem, many techniques have been proposed with enough success to consider face detection a very mature field of research. However, although it is clear that face detection is far from being solved, it requires continuous work and development. Face recognition is one of the few biometric methods that possess the merits of both high accuracy and low intrusiveness. It has the accuracy of a physiological approach without being intrusive. For this reason, since the early 70's (Kelly, 1970), face recognition has drawn the attention of researchers in fields from security, psychology, and image processing, to computer vision. Numerous algorithms have been proposed for face recognition [1]. Face recognition can be divided into two basic applications: identification and verification. In the identification problem, the face to be recognized is unknown and is matched against faces of a data base containing known individuals. In the verification problem the system confirms or rejects the claimed identity of the input face.

Although differences may exist, this position paper will address the general problem of face recognition and no particular distinction will be made among the two problems as the challenges and the used techniques are basically the same.

2. Face Recognition Approaches

Face recognition approaches on still images can be broadly grouped into geometric and template matching techniques. In the first case, geometric characteristics of faces to be matched, such as distances between different facial features, are compared. This technique provides limited results although it has been used extensively in the past. In the second case, face images represented as a two-dimensional array of pixel intensity values are compared to a single or several templates representing the whole face. More successful template matching approaches use Principal Components Analysis (PCA) [9] or Linear Discriminant Analysis (LDA) [2]to perform dimensionality reduction achieving good performance at a reasonable computational complexity/time. Other template matching methods use neural network classification and deformable templates, such as Elastic Graph Matching (EGM).
Recently, a set of approaches that use different techniques to correct perspective distortion are being proposed. These techniques are sometimes referred to as view-tolerant.

3. How Does It Work

We have seen the use of facial recognition technology in many movies. A photo of the person to be identified will be obtained from some hidden camera. It will then be run in through the police database so as to find a match with their existing records. At last a match will be found and the criminal will be caught red handed. Though this may seem fascinating in movies, it may not be the same in real world.
The facial recognition system was equipped in cameras and was placed in some streets so as to cut down the number of crimes in the area. But, the technology failed to provide results as the people around the streets wore masks, prohibiting the

cameras from getting a clear enough shot to identify anyone. The facial recognition software's have been upgraded well enough to provide 99% accuracy at present. In this post, we will discuss about the origin of this technology and also their enhancing capabilities for both governmental and personal use.
From the phrase facial recognition, it is understood that the software used for this purpose mainly recognizes a number of distinguished features of the face. All the features added together make almost 80 nodal points. The software used for facial recognition recognizes and distinguishes the face from its background by some of the common nodal points given below [4].

- Distance between the eyes
- Nose width
- Depth of the eye sockets
- Cheekbone shape
- Length of jaw-line

The above nodal points are measured altogether to provide a common numerical code known as the face print.

Figure 1 How Face Recognition Works [10]

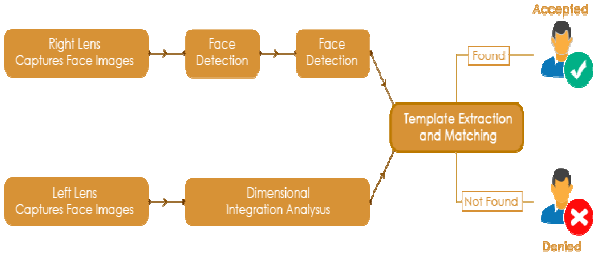

Figure 2 How matching Takes Place (flowchart) [10]

5. Face Recognition Algorithms

In the previous section we have shown that the task of facerecognition encounters complex variations. In order to cope with such complication and find out the true invariant for recognition, researchers have developed various recognition algorithms. In this section, we will describe two representative ones. The eigenfaceapproach applies the Karhonen-Loeve (KL) transform for feature extraction. It greatly reduces the Facial feature dimension and yet maintains reasonable discriminating power. The neural networkapproach, though some variants of the algorithm work on feature extraction as well, mainly provides sophisticated modeling scheme for estimating likelihood densities in the pattern recognition phase.

Eigenface [6]

As mentioned, one of the goals that the feature extraction routine wishes to achieve is to increase the efficiency. One simple way to achieve this goal is using alternative orthonormal bases other than the natural bases. One such basis is the Karhonen-Loeve (KL). KL bases are formed by the eigenvectors of the covariance matrix of the face vector X. In the high dimensional "face" space, only the first few eigenvalues have large values. In other words, energy mainly locates in the subspace constituted by the first few eigenvectors. Therefore, a great compression can be achieved by letting those eigenvectors with large eigenvalues to represent the face vectors
The eigenface representation is well known in statistics literature as the principal component analysis. Pentland's Photobook is one implementation of the eigenface algorithm. It compresses a facial image with 128x128 pixels (16,384 pixels) into a vector with only 40 eigenfaces (80 bytes). It recognizes 95% of the 200 faces chosen from a large database with 7562 facial images (3000 different persons) [13]

Neural Network

In principle, the popular back-propagation neural networkmay be trained to recognize face images directly. For even an image with moderate size, however, the network can be very complex and therefore difficult to train. For example, if the image is 128x128 pixels, the number of inputs of the network would be 16,384. To reduce complexity,

neural network is often applied to the pattern recognition phase rather than to the feature extraction phase. One example of the neural classifier is the Probabilistic Decision-based Neural Network (PDNN). [11]

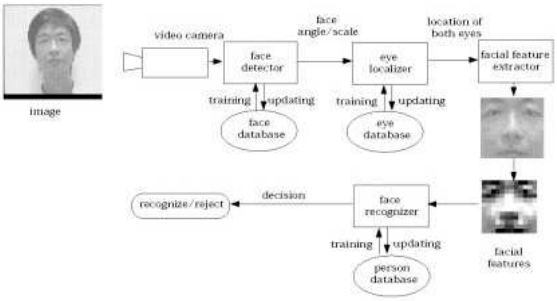

Figure 3 Using a Recognizer [12]

There are many other face recognition algorithms that are not discussed in this paper, such as elastic matching, HMM [9] and convolutional neural network. [1]

4. Fundamental Issues in Face Recognition

Robust face recognition requires the ability to recognize identity despite many variations in appearance that the face can have in a scene. The faceis a 3D object which is illuminated from a variety of light sources and surrounded by arbitrary background data (including other faces). Therefore, the appearance a face has when projected onto a 2D image can vary tremendously. If we wish to develop a system capable of performing non-contrived recognition, we need to find and recognize faces despite these variations. In fact, 3D pose, illumination and foreground-background segmentation [7] have been pertinent issues in the field of computer vision as a whole.

Additionally, our detection and recognition scheme must also be capable of tolerating variations in the faces themselves. The human face is not a unique rigid object. There are billions of different faces and each of them can assume a variety of deformations. Inter-personal variations can be due to race, identity, or genetics while intra-personal variations can be due to deformations, expression, aging, facial hair, cosmetics and facial paraphernalia.

Furthermore, the output of the detection and recognition system has to be accurate. A recognition system has to associate an identity or name for each face it comes across by matching it to a large database of individuals. Simultaneously, the system must be robust to typical image-acquisition problems such as noise, video-camera distortion and image resolution.

Thus, we are dealing with a multi-dimensional detection and recognition problem. One final constraint is the need to maintain the usability of the system on contemporary computational devices (≈100 MIPS) [5]. In other words, the processing involved should be efficient with respect to run-time and storage space.

Broadly speaking, the approaches proposed in the last years have been able to *solve* specific still face images recognition applications. Examples of scenarios where face recognition achieves very good results are given in Figure 4 and Figure 5. Although many details are being skipped (quality and size of the data base, scaling, feature extraction, face detection, etc.,) it can be considered that in such scenarios the face recognition problem is very well focused and almostsolved.

Figure 4

Figure 5

When the scenario departs from the *easy* scenario, then face recognition approaches experience severe problems. Among the special challenges let us mention: pose variation, illumination conditions, scale variability, images taken years apart, glasses, moustaches, beards, low quality image acquisition, partially occluded faces etc. Figures 6 and 7 show different images which present some of the problems encountered in face recognition. An additional important problem, on top of the images to be recognized, is how different face recognition systems are compared


Figure 6Figure 7

5. Conclusion

Face recognition is a both challenging and important recognitiontechnique. Among all the biometric techniques, face recognition approach possesses one great advantage, which is its user-friendliness (or non-intrusiveness). It has been and will continue to be a very challenging and difficult problem. In spite of the great work done in the last 30 years, we can be sure that the face recognition research community will have work to do during, at least, the next 30 years to completely *solve* the problem and hence strong and coordinated effort between the computer vision, signal processing and psychophysics and neurosciences communities is needed. In this paper, we have given an introductory survey for the face recognition technology. We have covered issues such as the generic framework for face recognition, factors that may affect the performance of the recognizer, and several state-of-the-art face recognition algorithms. Hence we can infer that Facial Recognition has a wide scope and field of application and will prove to be a vital technology for pre-determining intrusion threats. We hope this paper can provide the readers a better understanding about face recognition, and we encourage the readers who are interested in this topic to go to the references for more detailed study.

REFERENCES

[1]Chellappa (1995) and Zhang (1997).

[2] Ming-Hsuan Yang, D. Kriegman and N. Ahuja, "Detecting Faces in Images: A Survey", IEEE Transactions on Pattern Analysis and Machine Intelligence, Vol. 24, No. 1, pp. 34-58, January 2002.

[3] W. Zhao, R. Chellappa, A. Rosenfeld and P.J. Phillips. Face Recognition: A literature survey. Technical Report CART-TR-948. University of Maryland, Aug. 2002.

[4] R. Chellappa, C. L. Wilson, S. Sirohey, "Human and Machine Recognition of Faces: a Survey", Proceedings of the IEEE, Volume 83, No. 5, pp. 705 -740, May 1995.

[5] L. Torres, J. Vilà, "Automatic Face Recognition for Video Indexing Applications", Pattern Recognition, Vol35/3, pp. 615-625, December 2001.

[6] T. Choudhury, B. Clarkson, T. Jebara and A. Pentland. "Multimodal Person Recognition Using Unconstrained Audio and Video", International Conference an Audioand Video-based Biometric Authentication, pp, 176-181, Washington D.C., 1999.

[7] A. Albiol, L. Torres, E Delp, "The Indexing of Persons in News Sequences using Audio-visual Data", International Conference on Acoustics, Speech and Signal Processing, Hong-Kong, China, April 6-10, 2003.

[8] I. Biederman, P. Kalocsai, "Neural and Psycophysical Analysis of Object and Face Recognition"

[9] "*FaceRecogntion, from Theory and Applications*", Berlin, Springer-Verlag, pp. 3-25, 1998.

[10]https://www.abine.com/blog/2011/facial-recognition-faqs/

[11] Lin, 1997

[12]http://www.makeuseof.com/tag/3-fascinating-search-engines-search-faces/

[13] What the Face Reveals: Basic and Applied Studies of Spontaneous Expressionby Paul Ekman, Erika L. Rosenberg