Journal of King Saud University – Computer and Information Sciences (2016) xxx, xxx–xxx

King Saud University

Journal of King Saud University – Computer and Information Sciences

www.ksu.edu.sa
www.sciencedirect.com

Face recognition using Angular Radial Transform

Bensenane Hamdan *, **Keche Mokhtar**

Laboratoire Signals and Images, Dept. of Electronique, Université des Sciences et de la Technologie d'Oran Mohamed Boudiaf, USTO-MB, BP 1505, 3100 Oran, Algeria

Received 8 May 2016; revised 24 October 2016; accepted 27 October 2016

KEYWORDS

Angular Radial Transform (ART);
Legendre moment invariants (LMI);
Zernike moments (ZM);
Pseudo-Zernike moments (PZM);
Euclidean distance (ED);
Nearest Neighbor Classifier (NNC);
Support Vector Machines (SVM);
Essex Faces94 database;
Essex Faces96 database;
ORL face database;
Yale face database

Abstract Moment-based Angular Radial Transform, Legendre moment invariants and Zernike moments are a family of orthogonal functions which allow the generation of non-redundant descriptors by the projection of an image onto an orthogonal basis. These descriptors can be used for classification, such as in face recognition. Zernike moments and Legendre moments have already been used for this purpose.

This paper proposes to use moment-based Angular Radial Transform for extracting the face characteristics that feed a Support Vector Machine or a Nearest Neighbor Classifier for face recognition. Facial images from the ORL database, Essex Faces94 database, Essex Faces96 database, and Yale database were used for testing the proposed approach. The experimental results obtained show that the proposed method is more efficient, in terms of recognition rate, than the methods based on Zernike and Legendre moments. It is also found that its performance is comparable to that of the best state-of-the-arts methods.

Contents

* Corresponding author.
E-mail addresses: hamdan.bensenane@univ-usto.dz (B. Hamdan), m_keche@yahoo.com (K. Mokhtar).

Peer review under responsibility of King Saud University.

Production and hosting by Elsevier

http://dx.doi.org/10.1016/j.jksuci.2016.10.006

1. Introduction

In recent years, security has become an international concern. Today, it is required to use appropriate data processing techniques to ensure global security. Security is to be ensured in several areas like access control to work or public places, access control to computers, e-commerce, banking system based on identification, means of transportation, etc. Nowadays, biometrics occupies a particular place as a means for ensuring security. It consists of identifying a person from one or more of his physiological characteristics (fingerprints, face, iris, hand's contour, DNA, etc.), or from his behavior (signature, gait, etc.).

Over the last decade, a great deal of research work has been done to improve the reliability of biometric systems. The choice of using facial recognition as a biometric modality is motivated by the fact that this kind of modality is contactless, natural, well accepted and requires only a very cheap sensor (webcam) which is available on a great number of electronic devices. However, it requires a little cooperation from the user during the facial image acquisition phase. Automatic face recognition is performed in two essential steps, namely extraction of facial features and classification.

Several research works have been carried out for the extraction of facial features. This research has led to the development of a multitude of methods, which can be classified into three categories, i.e. global, local, and hybrid.

The global methods for facial feature extraction use the whole image as input to the recognition system. The advantage of this representation is that it implicitly preserves the texture information and shape, which are required for face recognition. In addition, compared to local representations, this one allows a better appearance capture of the face (O'Toole et al., 1993). However, its major drawback is the very large storage space that it requires (Jain and Chandrasekaran, 1982). In practice, it is not necessary to have a large amount of data to develop an accurate model for the facial features of a person. Dimension reduction techniques, such as Eigenfaces (PCA) Turk and Pentland, 1991, Fisherfaces (LDA) Duda et al., 2001, are commonly used. In order not to lose information during the conversion process from 2D images to 1D image vectors, a 2D image-based PCA (2DPCA) method was proposed by Yang et al. (2004). Using similar 2D projections onto a subspace, Yang et al. proposed the 2DLDA method (Yang et al., 2005), whereas Niu et al. suggested the 2DLPP method (Niu et al., 2008). To improve the performance of the 2D projection method, Li et al. (2016) suggested a sequential three-way decision approach for cost-sensitive face recognition. The proposed method is based on a formal description of granular computing.

Local or geometric methods are based on the extraction of the relative position of the elements that make up the face (such as the nose, mouth and eyes). In the early 1990s, Brunelli and Poggio (1993)) described a facial recognition system that automatically extracts 35 geometric characteristics of the face. The similarity was calculated using Bayes classifiers. Manjunath et al. (1992) proposed the Elastic Bunch Graph Matching (EBGM), a local characteristics method for face recognition, based on Gabor Wavelet Transform (Lee, 1996). Zhang et al. (2015) presented a simple but efficient feature extraction method based on facial landmarks and multi-scale fusion features (FLWLD). They first extracted the local features using Weber Local Descriptors (WLD) Chang and Lin, 2001 and multi-scale patches centered at predefined facial landmarks, and then constructed fusion features by randomly selecting parts of the local features. However, the geometric characteristics are usually difficult to extract, especially in complex situations, such as variable illumination, and occlusions. The geometric characteristics alone are not sufficient to represent a face. Hybrid methods may be used in a modular manner for different facial areas. A global model may then be obtained from the combination of different local models. Consequently, the different facial regions are not affected in the same way by the various sources of variability. For example, wearing sunglasses considerably changes the appearance of the eyes, and a smile affects more the area around the mouth. The modular Eigenspace approach, introduced by Pentland et al. (1994), belongs to the above mentioned category. Another efficient feature extraction algorithm, called Discriminant Sparse Local Spline Embedding (D-SLSE), which can be considered as a hybrid approach for face recognition was proposed by Lei et al. (2015).

During the second phase of recognition, namely the classification phase, the system must decide whether the person belongs to the database and if so, to what class he belongs; in other words: who is the person? Of course, the answer of the system may be wrong. The approaches proposed in the literature, to solve such a problem, belong to the field of automatic data classification, a research field that has been widely explored in the recent decades, in many domains. The methods that can be applied in this step depend mainly on the technique used in the signature extraction step. These methods, include

Please cite this article in press as: Hamdan, B., Mokhtar, K. Face recognition using Angular Radial Transform. Journal of King Saud University – Computer and Information Sciences (2016), http://dx.doi.org/10.1016/j.jksuci.2016.10.006