Face Recognition System using Discrete Cosine Transform Combined with MLP and RBF Neural Networks

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ABSTRACT

Proposed is an efficient face recognition algorithm using the discrete cosine transform DCT Technique for reducing dimensionality and image parameterization. These DCT coefficients are examined by a MLP (Multi-Layer Perceptron) and radial basis function RBF neural networks. Their purpose is to present a face recognition system that is a combination of discrete cosine transform (DCT) algorithm with a MLP and RBF neural networks. Neural networks have been widely applied in pattern recognition for the reason that neural-networks-based classifiers can incorporate both statistical and structural information and achieve better performance than the simple minimum distance classifiers. The authors demonstrate experimentally that when DCT coefficients are fed into a back propagation neural network for classification, a high recognition rate can be achieved by using a very small proportion of transform coefficients. Comparison with other statistical methods like Principal component Analysis (PCA) and Linear Discriminant Analysis (LDA) is presented. Their face recognition system is tested on the computer vision science research projects and the ORL database.

Keywords: Discrete Cosine Transform (DCT), Feature Extraction, Linear Discriminant Analysis (LDA), Multi-Layer Perceptron (MLP), Principal Component Analysis (PCA), Radial Basis Function (RBF), Recognition

INTRODUCTION

Face recognition is one of the most challenging tasks in the pattern recognition field. It has many applications such as person identification; human computer interaction; security systems and video surveillance.

Face recognition from a biological point of view has been a topic widely studied by neuroscientists. Physiological researches have indicated that in the human brain we possess some concrete face detector cells for face recognition, specifically placed in the inferotemporal cortex.

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and also spread over the frontal right hemisphere (Ferrer, 2005).

Engineers have found many of the psychophysics and neurophysiologic disclosures relevant when trying to implement an automatic face detection/recognition system. Some of those disclosures, directly extracted from the study carried out by Zhang, Samaras, and Goldstein (2005) are exposed next:

- Human recognition system uses a broad spectrum of stimuli, especially those that come from the visual, auditory and olfactory senses.
- Face perception is a mixture of both holistic and feature analysis. For adults, the brain tries first a holistic approach with a posterior refinement carried out taking on account the individual facial features. On the other hand, children pay attention mainly to isolated features.
- Spatial frequency analysis plays an important role in face detection (Ferrer, 2005).

HUMAN face recognition has become a very active research area in recent years mainly due to increasing security demands and its potential commercial and law enforcement applications. Numerous approaches have been proposed for face recognition and considerable successes have been reported (Chellappa, Wilson, & Sirohey, 1995). However, it is still a difficult task for a machine to recognize human faces accurately in real-time, especially under variable circumstances such as variations in illumination, pose, facial expression, makeup, etc. The similarity of human faces and the unpredictable variations are the greatest obstacles in face recognition (Er, Chen, & Wu, 2005).

During the past thirty years, many face recognition techniques have been proposed, motivated by the increased number of real-world applications requiring the recognition of human faces (Lu et al., 2007).

Generally speaking, face recognition approaches can be divided into feature-based, template-based, the appearance-based methods like statistics-based and neural network-based categories (Chang et al., 2008). Feature-based approaches are based on the geometrical relationships of invariant salient features of the face, such as eyes, eyebrows, mouth; nose (Chang et al., 2008). The recognition rate of the feature based techniques is highly depended on the correctness of the detected invariant salient features (Chang et al., 2008). Unfortunately, the variations of illumination and facial expression will affect the detection of invariant salient features (Chang et al., 2008). Template-based approaches are based on similarity measurement of two feature sets, which can be calculated without the pairing of the invariant salient features. The drawback of the template-based method is the recognition results are highly depended on the variation of scale, pose and shape (Chang et al., 2008).

The appearance-based methods aim to learn the models from a set of training images. Neural networks, Hidden Markov model, and support vector machines are frequently adopted as the learning machines (Er et al., 2005).

Holistic face recognition (appearance based methods) has attracted more attention since the well-known statistical method; the principal component analysis (PCA), also known as Karhunen-Loeve transform (KLT), was applied in face recognition (Er et al., 2005; Chellappa et al., 1995). Another well-known approach is the Fisherfaces in which the Fisher’s linear discriminant (FLD) is employed after the PCA is used for dimensionality reduction (Wang et al., 2008). Compared with the Eigenface (PCA) approach, the Fisherface approach is more insensitive to large variations in lighting direction and facial expression. More recently, some variants of FLD (LDA) have been developed for face recognition such as F-LDA (Tan et al., 2005), D-LDA (Chang et al., 2008), FD-LDA (Zhang, 2006), and KDDA (Sing et al., 2007) etc. However, the computational requirements of these approaches are greatly related to the dimensionality of the original data and the number of training samples. When the face database becomes larger, the time for training and the memory requirement will significantly increase.
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