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Chapter VIII

Discriminant DCT Feature Extraction

ABSTRACT

This chapter provides a feature extraction approach that combines the discrete cosine transform (DCT) with LDA. The DCT-based frequency-domain analysis technique is introduced first. Then, we describe the presented discriminant DCT approach and analyze its theoretical properties. Finally, we offer detailed experimental results and a chapter summary.

INTRODUCTION

Frequency-domain analysis is a commonly used image processing and recognition technique. During the past years, some work has been done to extract the frequency-domain features for image recognition. Li, Zhang, and Xu (2002) extract Fourier range and angle features to identify the palmprint image. Lai, Yuen, and Feng (2001) use holistic Fourier invariant features to recognize the facial image. Another spectral feature generated from SVD is used by some researchers (Chellappa, 1995). However, Tian, Tan, Wang and Fang (2003) indicate that this feature does not contain adequate information for face recognition. In Hafed and Levine (2001), they extract DCT feature for face recognition. They point out that DCT obtains the near-optimal performance of K-L transform in facial information compression. And the performance of DCT is superior to those of discrete Fourier transform (FT) and other conventional transforms. By manually selecting the frequency bands of DCT, their recognition method achieves similar recognition effect as the eigenface method (Turk & Pentland, 1991) which is based on K-L transform. Nevertheless, their method cannot provide a rational band selection rule or stategy. And it cannot outperform the classical eigenface method.

To enhance the image classification information and improve the recognition effect, we propose a new image recognition approach in this section (Jing & Zhang, 2004), which combines DCT with the linear discrimination technique. It first uses a 2D separability judgment that can facilitate the selection of useful DCT frequency bands for image recognition, because not all the bands are useful in classification. It will then extract the linear discriminative features by an improved fisherface method and perform the classification by the nearest-neighbor classifier. We will perform the detailed analysis of the theoretical advantages of our approach. The rest of this section is organized as follows: First, we provide the description of our approach. Then, we show its theoretical analysis. Next, the experimental results on different image data and some conclusions are given.

APPROACH DEFINITION AND DESCRIPTION

In this section, we present a 2D separability judgment and introduce the whole recognition procedure of our approach.

Select DCT Frequency Bands by Using a 2D Separability Judgment

Suppose that image training and test sample sets are X_1 and X_2, respectively; each gray image matrix is sized $M \times N$ and expressed by $f(x,y)$, where $1 \le x \le M$, $1 \le y \le N$ and $M \ge N$. Assume there are c known pattern classes ($w_1, w_2, \ldots, w_c$) in X, where P_i ($i = 1, 2, \ldots, c$) denotes the a priori probability of class w_i. Perform a 2DDCT on each image (Hafed & Leveine, 2001) by:

$$F(u,v) = \frac{1}{\sqrt{MN}} \alpha(u)\alpha(v) \sum_{x=1}^{M} \sum_{y=1}^{N} f(x,y) \cos\left[\frac{(2x+1)u\pi}{2M}\right] \cos\left[\frac{(2y+1)v\pi}{2N}\right] \qquad (8.1)$$

where $F(u,v)$ is sized $M \times N$, and $\alpha(\bullet)$ is defined as follows:

$$\alpha(w) = \begin{cases} \frac{1}{\sqrt{2}}, & w = 1 \\ 1, & otherwise \end{cases} \qquad (8.2)$$

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