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The design of a composite wavelet matched filter for face recognition using breeder genetic algorithm

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Abstract

We describe a method using the breeder genetic algorithm to design a composite wavelet matched filter for face recognition. The designed filter can be used in an optical correlator to separate two classes of input face images. Mexican hat and Morlet wavelets have been used for the design of the filter. The performance of the filter has also been evaluated in the presence of additive white Gaussian noise.

Keywords: Face recognition; Wavelets; Matched filter; Composite wavelet matched filter; Breeder genetic algorithm; Morlet wavelet; Mexican hat wavelet; Gaussian noise

1. Introduction

There is an ever-growing need to identify and authenticate individuals in today's interconnected information society. The traditional approaches of using a proxy for personal identification, such as passwords and keys hardly meet the requirement of identifying a person. As a result, the process of automatically identifying persons, as

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opposed to tokens, in information transaction continues to pose great challenges. Some of the limitations of the traditional automatic personal identification technologies can be overcome by using biometric-based authentication and identification systems [1]. These systems use biological features inherent in an individual. A biometric-based system deals with physiological or behavioral characteristics, such as fingerprints, signature, palm-print, iris, hand, voice or face. These can be used to authenticate a person's claim to identity or can be used to establish an identity from a database. There is a growing need for technology based on biometrics because of properties such as universality, uniqueness, reliability, performance, and acceptability. It is a challenging task to design an automated biometric-based identification system to handle a large population size, assuring accuracy and reliability of the pattern acquisition and recognition components.

Systems for identification based on facial images are preferred over other biometric techniques because these are not direct contact methods and the durability of the database lasts longer [2–7]. There are, however, inherent problems associated with face images. These are associated with the two-dimensional representation of a three-dimensional (3D) face, out-of-plane and in-plane facial distortions such as rotation and scale variations and other general factors such as change in the background as well as variations in illumination [8–10].

A system based on gradually adapting photorefractive holograms has been described by Li et al. [2]. In this system, a photorefractive hologram-based optical neural network is described in which the weights are stored holographically and the network is trained to recognize faces at standard video frame rates. Javidi et al. [3] have proposed a real-time face recognition system based on a non-linear joint—transform correlator and a two-layer neural network. Kodate et al. [4] have developed a human face recognition system based on a binary zone plate and a parallel joint transform correlator. Ganotra et al. [5] have proposed a single layer optical neural network based on the joint-transform correlator architecture for face recognition. They [6] have also proposed a face recognition system based on the back propagation neural networks. This uses the data from the diffraction pattern, which has been sampled with a digital ring-wedge detector. A face recognition system based on a fringe pattern correlator has also been proposed [7]. This uses the facial 3D structure. Face recognition systems based on the fringe-adjusted joint-transform correlator [8–10] have been proposed by Alsamman et al. Various techniques like the projection-slice synthetic discriminant functions [8], neural networks [9] and pose estimations [10] in conjunction with the fringe-adjusted joint—transform correlator have been used to design the face recognition system.

In this paper, we describe a method to design a composite wavelet matched filter (CWMF) [11,12] using the breeder genetic algorithm (BGA) [13]. The designed filter can be used in an optical correlator to separate two classes of face images exhibiting a variety of facial expressions. Mexican hat and Morlet wavelets [14] have been used for the design of the filter. The performance of the filter has also been evaluated in the presence of additive white Gaussian noise.