Editorial

Recent Advances in Biometric Systems: A Signal Processing Perspective

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We were pleased to receive a total of thirty-nine submissions to the special issue on "Recent advances in biometric systems: a signal processing perspective." The Guest Editors divided up the responsibility for the submissions, and each submission was reviewed by a minimum of two experts in the relevant area of biometrics. Following the first round of reviews, some of the submissions were revised by the authors and then underwent a second round of review. The final result of the process is the set of fifteen papers that appear in this special issue.

The first six papers all deal with face recognition in some respect. Then we have one paper dealing with iris biometrics and one dealing with recognition by gait. The topic of the next two papers is fingerprint image analysis and the following paper addresses the related topic of palmprint analysis. The next two papers cover issues in signature verification. Lastly, there is one paper on retinal verification and one on using electrocardiogram signals as a biometric. The broad variety of topics in this special issue represents the dynamism and breadth of biometrics.

In "Recognition of faces in unconstrained environments: a comparative study," Ruiz-del-Solar, Verschae and Correa present the results of a comparative study of existing face recognition methods in the context of unconstrained environments. The recognition approaches considered include two local-matching methods, histograms of LBP features and Gabor Jet descriptors, one holistic method, generalized PCA, and two novel image-matching methods, SIFT-based and ERCF-based. The FERET, LFW, UCHFaceHRI, and FRGC face databases are used in the evaluation. Two conclusions are that there is a large dependence of the methods on the amount of face and background information in the image, and that outdoor illumination results in a large decrease in the performance of all of the methods.

In "Facial expression biometrics using statistical shape models," Shark et al. perform face recognition by combining 3D range images and expression. The authors' method is based on a shape space vector derived from a statistical shape model for 3D range data. Experimental results are reported on the SUNY Binghamton BU-3DFE dataset of the 3D face images. Results are reported for both recognition and expression classification.

In "Evolutionary discriminant feature extraction with application to face recognition," Lu et al. present a technique that searches for subspaces to represent faces. The search technique is based on evolutionary computing and is designed to be efficient. One reason the algorithm is efficient is because the search space is confined to discriminatory subspaces.

In "Comparison of spectral-only and spectral/spatial face recognition for personal identity verification," Pan et al. compare the performance of single-band, multiband, and combined spectral/spatial approaches to face recognition. They use the eigenface algorithm from the CSU Face Identification Evaluation System for the basic recognition engine. Multiband eigenface methods in which the multiple bands are processed independently are shown to improve face recognition performance relative to single-band results.

The new spectral-face approach is proposed to preserve both spectral and spatial properties and shown to provide even better performance.

In "Talking-face identity verification, audiovisual forgery and robustness issues," Karam et al. develop an interesting multimodal approach involving face appearance and speaker recognition. They emphasize the aspect of robustness to imposter attacks. Using audio conversion and an MPEG-4 compliant face animation system, they also demonstrate the production of audio-visual forgeries that substantially increase the equal-error rate of an identify verification system.

Protecting the privacy of biometric samples has become an active area of research in biometrics. In "Sorted index numbers for privacy preserving face recognition," Wang and Hatzinakos introduce the concept of sorted index numbers to protect privacy. The sorted index numbers technique converts a feature vector into an ordered set of indices. The authors show the effectiveness of this technique for protecting the privacy of biometric samples.

In "A new user-dependent iris recognition system based on an area preserving pointwise level set segmentation approach", Barzegar and Moin compare their new approach to iris recognition with other methods. A level set approach is used in finding the papillary and limbic boundaries. The approach is claimed to have advantages in cases where the iris is partly occluded. Results of the comparison to five other approaches using three different iris image datasets indicate an improvement in accuracy and speed of processing.

In "Gait recognition using wearable motion recording sensors," Gafurov and Snekkenes investigate the use of wearable motion recording sensors for gait-based person recognition. Such wearable sensors record motion of the body parts during walking. This paper analyzes acceleration signals from the foot, hip, pocket, and arm. The authors also analyze the robustness of the proposed recognition method under three distinct security attacks including a minimal effort-mimicry, knowing the closest person in the database in terms of gait similarity, and knowing the gender of the user in the database.

In fingerprint recognition, there has been debate about the existence of biometric "goats." A biometric goat is a person who consistently has an unusually high false nonmatch rate. In "Inter-subject differences in false non-match rates for a fingerprint-based authentication system," Kelkboom et al. look for the existence of goats. In their study of fingerprint performance, the authors find that 10% of the subjects account for a large portion of the false nonmatches and are classified as biometric goats.

Many applications would benefit from the implementation of biometric authentication with smart cards. In "Integrating the fingerprint verification into the smart card-based healthcare information system" by Pan et al. a typical fingerprint verification algorithm is integrated in a smart card and smart card reader where various designs are compared in terms of real-time execution and security and privacy tradeoffs.

In "Development of a new cryptographic construct using palmprint based fuzzy vault" by Amioy Kumar and Ajay Kumar, this research focuses on a combination of biometrics and cryptography to create a "fuzzy vault" for secure authentication. Asymmetric approaches typically have high security but require high computation. This paper uses the combination of symmetric and asymmetric cryptography in a palmprint authentication system to alleviate the drawbacks of a symmetric-only system.

This special issue presents two novel methods for recognition of individuals based on sample signatures. In "A novel criterion for writer enrolment based on a time-normalized signature sample entropy measure," Garcia-Salicetti et al. promote time-normalized sample entropy as a novel criterion for writer enrollment. They also propose a novel criterion for writer enrollment targeting enhanced signature verification. In "On-line signature verification using fourier descriptors," Yanikoglu and Khomatov involve Fourier descriptors in the process of feature extraction and template formation. The application of Fast Fourier Transform results in a compact representation with a fixed number of coefficients. The main challenge that the authors address in their paper is the design of matching algorithms. The improved performance is achieved through a fusion of the proposed system with a state-of-the-art Dynamic Time Warping (DTW) system.

In their work "Retinal verification using a feature points based biometric pattern," Rouco et al. present a novel approach to the selection of landmark points in the retinal vessel tree. The approach is based on extracting a set of landmarks (bifurcations and crossovers of retinal vessel tree). However, the use of reference structures is avoided, which allows the system to cope with a wider range of images and users. Together with new set of features a new similarity metric is introduced, and a careful analysis of the proposed method is performed using a large and diverse database of retinal images.

In "A sequential procedure for individual identity verification using ECG," Irvine and Israel tackle an intriguing biometrics modality that has received relatively little attention to date. They are interested in identity verification that uses the minimum number of heartbeats of electrocardiogram data for verification. Initial experiments on datasets representing twenty-nine and seventy-five persons indicate that fifteen or fewer heartbeats of data are sufficient in nearly all instances.

We hope that you enjoy reading this selection of papers that samples the variety of modalities and themes in current biometrics research.

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