Introduction to the Special Section on Biometric Systems and Applications

NOWADAYS, biometrics is an important technological area receiving continuously growing interest from academia, industry, government, and the general public, due to the criticality and the social impact of its applications. Biometric systems are in fact rapidly being adopted in a wide variety of applications such as security, ambient intelligence, electronic and physical access control, digital rights management, background checking and defense, medical diagnosis as well as for adaptive environments.

To create a biometric system various issues need to be studied in an integrated way: from sensing to measurement procedures, from signal analysis and interpretation to quality assessment, from feature extraction to classification and analysis, from knowledge creation to extraction, from algorithms to data structure, from large data base management to interoperability, from computational complexity to system performance, from system engineering to software engineering, from privacy to social implications, and much more. Interdisciplinarity and integration of various technological areas are a key aspect of biometrics systems and applications.

This special section addresses the use of biometric technologies for creating advanced application systems. Out of 24 papers submitted for consideration in this special section, only seven papers have been accepted by taking into account the technical quality, the originality, and the innovation of the proposed ideas, solutions, and systems.

Recently, the hypothesis that individuals can be distinguished by means of the attributes of their motion behaviors is receiving increasing attention from the scientific community. The paper "User Identification for Home Entertainment Based on Free-Air Hand Motion Signatures" presents a user identification system based on free-air hand signature-gestures acquired with a 3-D camera. The proposed system performs user identification by comparing the distances of a sample to other signatures, adopting an neighborhood component analysis (NCA) based metric. The authors conducted several validation tests to assess the performances of the proposed system that demonstrated its robustness when all users use a single predefined signature-gesture and higher average accuracies if each user adopts a personal signature-gesture.

Performing effective tracking is one of the most critical challenges for real-time applications such as automated video surveillance, traffic monitoring, motion based recognition, video indexing, human–computer interaction, and vehicle navigation. The main goal of a tracking process is to estimate the trajectory of an object as it moves around a scene from a sequence of images acquired by a set of video sensors. The paper "An improvement of Kernel-based Object Tracking based on Human Perception" provides a new method representing the target through features related to its visual appearance and using a variant of the KbOT algorithm as a metric that exploits the human visual perception (HVP) framework. In order to demonstrate the stability and the robustness of the proposed technique, several experiments are reported also including a set of partial or complete target occlusion in a limited number of subsequent frames.

In the human-pose estimation using a stationary depth sensor, one of the most challenging open problems concerns the reduction of the feature ambiguity and the modeling of human poses in high dimensional human-pose space. The paper "A 3D-Point-Cloud System for Human-Pose Estimation" proposes 3-D point-cloud features, namely viewpoint and shape feature histogram (VISH), capable of trapping some human geometric properties such as orientation and shape, and arranging them into a tree structure that preserves the global and local properties of the 3-D points. As the human poses are based on an action-mixture model (AMM) in a discrete space, a kinematic model is added to model the spatial relationship of body parts in continuous space. Experimental results used a benchmark dataset and showed that the overall error and standard deviation of the proposed 3-D point-cloud system were reduced compared with some existing approaches without action classification.

In last few years electrocardiogram (ECG) as a biometric modality received an increasing interest from the scientific community. The paper "ECG Biometric with Abnormal Cardiac Conditions in Remote Monitoring System" presents an ECG based identification system operating on signals with abnormal cardiac conditions in network environments. The system adopts a normalize-convolute-normalize (NCN) technique and extraction method consisting of QRS sample normalization and convolution methods. In order to assess the performances of the proposed framework, the authors selected three different databases containing various irregular heart states obtaining high accuracy results. The authors also considered improving the classification performance by using ECG recordings with low sampling frequency, but increasing at the same time the number of ECG samples.

Hand shape recognition based on hand geometry characteristics has been intensively investigated, demonstrating some advantages if compared with other biometric traits. In "Pose Invariant Hand Shape Recognition Based on Finger Geometry," the authors present a pose invariant hand shape recognition technique exploiting the CAF-Fourier descriptors

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for the geometry of the fingers. A novel OTSU threshold method and component-based finger segmentation are also employed to remove the sharp corners. Experimental results demonstrated both the soundness of the proposed method and its use for real-world applications.

Multimodal based solutions are known to be able to improve the security and the performance of biometrics systems. The paper "Decision Fusion for Multimodal Biometrics using Social Network Analysis" presents an approach to multimodal biometric system using a social network analysis (SNA) based decision fusion. Final classification result combines two levels of decision fusion methods, where Social Network Classifier improves the confidence level of any classifier. The employ of SNA strategy guarantees the reduction of the false acceptance rare for both single traits and multimodal biometrics. The effectiveness of the proposed system is validated using a virtual database that includes data form several sample unimodal biometric databases of face, ear, and signature.

Advances in the field of RGB-D cameras, as the Kinect sensor, open new scenarios for 3-D data applications including face recognition. The paper "KinectFaceDB: a Kinect Database for Face Recognition" presents and describes a publicly-available face database, namely KinectFaceDB, that is composed of a complete multimodal face database based on the Kinect sensor. The authors describe the method used to obtain the well aligned and processed 2-D, 2.5-D, and 3-D video face data and suggest potential applications of the proposed KinectFaceDB. Several standard face recognition techniques, such as PCA, LBP, SIFT, LGBP, ICP, and TPS, have been intensively tested and compared on different data modalities, providing also quantitative comparison between the KinectFaceDB and the state-of-the-art FRGC database. The experimental results also suggest the deployment of existing algorithms and the development of new face recognition methods toward more practical systems.

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