Halmstad University Post-Print

Guest Editorial: Special Issue on Human Detection and Recognition

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Guest Editorial
Special Issue on Human Detection and Recognition

WITH A very security-conscious society, biometrics-based authentication and identification have become one of the key technologies for many important applications. It is generally believed that biometrics can provide the necessary accuracy and reliability for applications, such as access control. Biometrics research and technology continue to mature rapidly, driven by pressing industrial and government needs. As the number and types of biometrics architectures and sensors increase, the need to disseminate research results increases as well. This special issue is intended to be positioned at the frontier of biometrics research and showcase the excellent advanced work underway at academic and private research organizations as well as government laboratories.

A biometrics system may involve a variety of techniques from signal processing, image processing, image analysis, pattern recognition, human vision, and machine learning. As many of the applications require a higher level of performance that is not feasible with a single biometrics, it is believed that fusing multiple biometrics or an ensemble of algorithms will provide a wider coverage of the population who may not be able to provide a single biometrics at all times. This will also improve the security of the biometric systems against spoof attacks.

Research issues in biometrics deal with sensing (intensity, color, depth, thermal, pressure, time series); the nature of an individual or multibiometrics systems (face, finger, ear, eye, iris, retina, vein pattern, palm, gait, foot, handwriting); biometric template computation, storage, and its readiness over time; feature extraction, feature selection, classification, indexing, and matching and identification techniques; score level, decision-level and feature-level integration; architectures for integration and evidence accumulation; attacks on biometric systems and the determination of liveness; normalization techniques involved in fusion techniques; signal-processing and machine-learning techniques in biometrics fusion; application-dependence personalization of multibiometrics systems; theoretical studies showing models for integration; performance modeling, prediction and evaluation of multibiometrics systems; and security improvement assessment for multibiometrics systems.

The evolution of standards, protocols, competition, and organized challenges, availability of large publicly available databases and score files, performance baselines in single and multibiometric systems, and a balance between the needs of security and privacy with a wide variety of real-world applications are important issues in single or multibiometrics systems.

This special issue addresses some aspects of the above research issues dealing with different sensing modalities with the goal of improving performance of biometrics over existing techniques. In the following, we present a synopsis of the papers selected for this special issue on human detection and recognition using a range of biometrics and their associated techniques.

PAPERS IN THIS ISSUE

The goals of this special issue are to provide the reader with an overview of the state of the art in this field and to collect significant research results. All of the papers were reviewed in accordance with the transactions policy. The special issue consists of 15 papers: 12 regular papers and three correspondences. These papers represent gait, face (3-D, 2-D, video), iris, palmprint, cardiac sounds, and vulnerability of biometrics and protection against the spoof attacks.

Regular Papers

The first two papers deal with spoof attacks for gait and the protection of biometric templates for face recognition. In the first paper on spoof attacks on the gait authentication system, Gafurov *et al.* address the problem of vulnerability of gait biometrics to two kinds of attacks: minimal-effort impersonation attack and the closest person attack. It is found that minimal effort impersonation attacks are not serious but the attackers with knowledge of their closest person in the database can be a serious threat to the gait authentication system. The second paper by Sutcu *et al.* on protecting biometric templates with sketch: theory and practice deals with the issue of enhancing privacy and security of biometrics template with a focus on face recognition. It is shown that the theoretical bounds have their limitations in practical schemes, and the security of the system often needs careful investigation.

The next three papers address representation and recognition algorithms for 3-D face recognition. In the third paper on 3-D face recognition based on warped examples, Zou *et al.* present a 3-D face recognition system that uses carefully selected examples and a generic face. The results are shown on a database of 600 range images. The fourth paper on multiscale representation for 3-D face recognition by Cook *et al.* suggests multiscale techniques based on Gabor filters to partition the information contained in the frequency domain prior to dimensionality reduction by techniques based on eigenfaces and Fisherfaces. The FRGC dataset of 3-D face images is used to examine the performance of face recognition. The fifth paper on 3-D face recognition with the geodesic polar representation by Mpiperis *et al.* proposes a new representation that can handle the surface deformation caused by expressions. The authors view the face surface as a 2-D manifold embedded in the 3-D Euclidean space, characterized by a Riemannian metric and described by intrinsic properties, namely geodesics.

An important first step in face recognition is the detection of faces. Face detection can reduce the computational burden by selecting regions of images possibly containing faces. The next two papers deal with face detection in images. The sixth paper on real-time face detection and motion analysis with application in liveness assessment by Kollreider *et al.* introduces a robust face detection technique that can process video frames in real time. The proposed method is also used to assess the liveness and to achieve lip reading of digits. The seventh paper on components and their topology for robust face detection in the presence of partial occlusions by Goldmann *et al.* discusses robust detection of faces by combining techniques from statistical and structural pattern recognition domain in conjunction with face component detection.

The eighth paper by Goudelis *et al.* proposes nonlinear subspace methods for face verification, modeled as a two-class problem. The methods proposed in this paper exploit the individuality of the human face and find a nonlinear subspace representation with enhanced discriminant power. The ninth paper on a discriminant non-negative matrix factorization algorithm with applications to facial image characterization problems by Kotsia *et al.* explore an algebraic theory to solve problems in face biometrics and facial expression recognition. The convergence stability of the limit during factorization iterations pays particular attention to obtain meaningful solutions.

Any biometric trait has circumstances in which it cannot be utilized or its performance is poor. Accordingly, novel biometric signal modalities expand the application fields of the identification technologies. The tenth paper on biometric identification based on frequency analysis of cardiac sounds by Beritelli and Serrano is a contribution in this direction. It studies the biometric characteristics of PhonoCardioGram (PCG) signals from cardiac auscultation and discusses their usefulness. An important aspect of biometric recognition is the storage and transmission of biometric images and/or associated templates. In the eleventh paper on an evaluation of image sampling and compression for human iris recognition, Rakshit and Monro investigate the robustness of the performance of three human iris image-matching algorithms to subsampling and compression. Correlating two patterns to match them belong to fundamentals in machine recognition. The technique requires a prototype per class to reach a decision. The last paper on palmprint classification using multiple advanced correlation filters and palm-specific segmentation by Hennings *et al.* improves the correlation paradigm by devising multiple prototypes or filters per class and shows its usefulness for palmprint classification.

Correspondences

The first correspondence on gait recognition using compact feature extraction transforms and depth information by Ioannidis *et al.* presents a gait identification and authentication method based on the use of 2-D and 3-D features of the image silhouette sequence. In the second correspondence on 3-D face recognition using local appearance-based models, Ekenel *et al.* present a local appearance-based approach for face recognition. The last correspondence on face verification using template matching by Sao and Yegnanarayana proposes a template-matching approach using an edge-based representation of the face image. The authors use reference face images (at different poses or different lighting conditions) separately for template matching.

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