

## Guest editorial: Recent advances in representation learning for robust biometric recognition systems

Over the past few decades, biometric security is increasingly becoming an important tool to enhance security and brings greater convenience. Nowadays, biometric systems are widely used by government agencies and private industries. Though a growing effort has been devoted in order to develop robust biometric recognition systems that can operate in various conditions, many problems still remain to be solved, including the design of techniques to handle varying illumination sources, occlusions and low quality images resulting from uncontrolled acquisition conditions.

The performance of any biometric recognition system heavily depends on finding a good and suitable feature representation space satisfying, smoothness, cluster, manifold, sparsity and temporal/spatial coherence, where observations from different classes are well separated. Unfortunately, finding this proper representation is a challenging problem which has taken a huge interest in machine learning and computer vision communities.

Representation learning methods can be organised in two main groups: 'intra-class' and 'inter-class'. In the first group, the techniques seek to extract useful information from the raw data itself. They broadly range from conventional hand-crafted feature design based on the human knowledge about the target application (SIFT, Local Binary Patterns, HoG, etc.), to dimensionality reduction techniques (PCA, linear discriminant analysis, Factor Analysis, isometric mapping, Locally Linear Embedding, etc.) and feature selection (wrapper, filter, embedded), until the recent deep representations which achieved state-of-the-art performances in many applications.

The 'inter-class' techniques seek to find a structure and relationship between the different data observations. In this group, we can find metric/kernel learning, investigating the spatial or temporal relationship among different examples, while subspace/manifold learning techniques seek to discover the underlying inherent structural property.

The objective of this special issue is to provide a stage for worldwide researchers to publish their recent and original results on representation learning for robust biometric systems.

There are in total eight articles accepted for publication in this Special Issue through careful peer reviews and revisions.

### 1 | ARTICLES IN THE SPECIAL ISSUE

Li et al. introduced a watermarking algorithm based on an accelerated-KAZE discrete cosine transform (AKAZE-DCT) to address the poor robustness of the image watermarking algorithms to geometric attacks. Firstly, the extracted features using AKAZE-DCT are combined with the perceptual hashing, then, the watermarking image is encrypted with logistic chaos dislocation, finally, the watermarking is embedded and extracted with the zero-watermarking technique. The experimental results showed that the algorithm can effectively extract the watermark under conventional and geometric attacks, reflecting better robustness and invisibility.

Gong et al. proposed a novel deep learning-based robust zero-watermarking algorithm. Indeed, they designed a Residual-DenseNet, which took the low-frequency features. The proposed algorithm neither modified the original image in the watermark generation stage nor required the original image in the watermark extraction stage. Moreover, the proposed algorithm is also suitable for multiple watermarks. Experimental results show that the proposed algorithm showed robust performance under both conventional and geometric attacks.

Parashar and Shekhawat proposed a reversible gait anonymisation pipeline that modifies gait geometry by morphing the images. The modified data prevents hackers from making use of the dataset for adversarial attacks. The obtained findings open new research directions regarding the adversarial attacks and privacy protection related to gait recognition data sets.

Li et al. proposed a palmprint recognition method based on the line feature local tri-directional patterns. First, the line features of palmprint images, including orientation and magnitude, are extracted. Then, the directional features are encoded as tri-directional patterns. The tri-directional patterns reflect the direction changes in the local area. Finally, the

features are constructed by the tri-directional patterns, orientation and magnitude features. Experiments on PolyU, PolyU Multi-spectral, Tongji, CASIA and IITD palmprint databases showed that the proposed technique achieved promising results.

Wu et al. established a pen-holding hand pose (PHHP) image dataset representing the largest vision-based PHHP dataset ever collected. A coarse-to-fine PHHP recognition network consisting of a coarse multi-feature learning network and a fine pen-grasping-specific feature learning network was also introduced. Experimental results showed that the proposed method can achieve a very competitive PHHP recognition performance when compared with the baseline recognition models.

Aguiar de Lima et al. investigated the effects of languages on speaker identification systems and the phonetic impact on their performance. The experiments were performed using three widely spoken languages: Portuguese, English, and Chinese.

Sun et al. proposed a novel classification algorithm based on Convolutional Neural Network to improve the diagnostic performance for breast cancer on mammography. The experimental results showed that the proposed algorithm greatly improves the classification performance and diagnostic speed of mammographic breast mass, which is of great significance for breast cancer diagnosis.

Parashar et al. proposed an approach based on pose features to attempt gait recognition of people with an overcoat, carrying objects, or other covariates. It aims to estimate human locomotion using Convolutional Neural Networks. The experiments showed very promising results.

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#### DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article as no new data were created or analysed in this study.

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**Imad Rida:** received the Ph.D. degree in computer science from Normandy University, MontSaint-Aignan, France, in 2017. He is currently an Associate Professor with the University of Technology of Compiègne, Compiègne, France. His research interests include biometrics, machine learning, pattern recognition, and signal/ image processing.



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received multiple best paper awards in key conferences around biometrics, and multiple world-class research distinctions, including: 2006 EBF European Biometrics Industry Award, EURASIP Best PhD Award 2012, Miguel Catalan Award 2015 to the Best Researcher under 40 in the Community of Madrid in the general area of science and technology, and the 2017 IAPR Young Biometrics Investigator Award, given to a single researcher worldwide every two years under the age of 40, whose research work has had a major impact in biometrics. He is now Associate Editor of the IEEE Trans. on Information Forensics and Security, the IEEE Trans. on Image Processing, and Elsevier Information Fusion.