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EPRO BIOM - 001	Deep learning with ultrasound physics for fatal skull segmentation.

2D ultrasound (US) is still the preferred imaging method for fetal screening. However, 2D biometrics are significantly affected by the inter/intra-observer variability and operator dependence of a traditionally manual procedure. 3DUS is an alternative emerging modality with the potential to alleviate many of these problems. This paper presents a new automatic framework for skull segmentation in fetal 3DUS. We propose a two-stage convolutional neural network (CNN) able to incorporate additional contextual and structural information into the segmentation process. In the first stage of the CNN, a partial reconstruction of the skull is obtained, segmenting only those regions visible in the original US volume. From this initial segmentation, two additional channels of information are computed inspired by the underlying physics of US image acquisition: an angle incidence map and a shadow casting map. These additional information channels are combined in the second stage of the CNN to provide a complete segmentation of the skull, able to compensate for the fading and shadowing artefacts observed in the original US image. The performance of the new segmentation architecture was evaluated on a dataset of 66 cases, obtaining an average Dice coefficient of 0.83 ± 0.06. Finally, we also evaluated the clinical potential of the new 3DUS-based analysis framework for the assessment of cranial deformation, significantly outperforming traditional 2D biometrics (100% vs. 50% specificity, respectively).

EPRO BIOM - 002	Improving Periocular Recognition by Explicit Attention to Critical Regions in Deep Neural Network.

Periocular recognition has been emerging as an effective biometric identification approach, especially under less constrained environments where face and/or iris recognition is not applicable. This paper proposes a new deep learning-based architecture for robust and more accurate periocular recognition which incorporates attention model to emphasize important regions in the periocular images. The new architecture adopts multi-glance mechanism, in which part of the intermediate components are configured to incorporate emphasis on important semantical regions, i.e., eyebrow and eye, within a periocular image. By focusing on these regions, the deep convolutional neural network is able to learn additional discriminative features, which in turn improves the recognition capability of the whole model. The superior performance of our method strongly suggests that eyebrow and eye regions are important for periocular recognition, and deserve special attention during the deep feature learning process. This paper also presents a customized verification-oriented loss function, which is shown to provide higher discriminating power than conventional contrastive/triplet loss functions. Extensive experiments on six publicly available databases are performed to evaluate the proposed approach. The reproducible experimental results indicate that our approach significantly outperforms several state-of-the-art methods for the periocular recognition.

EPRO BIOM - 003	Approximate computing for biometrie security systems: A case study on iris scanning.

Exploiting the error resilience of emerging data-rich applications, approximate computing promotes the introduction of small amount of inaccuracy into computing systems to achieve significant reduction in computing resources such as power, design area, runtime or energy. Successful applications for approximate computing have been demonstrated in the areas of machine learning, image processing and computer vision. In this paper we make the case for a new direction for approximate computing in the field of biometric security with a comprehensive case study of iris scanning. We devise an end-to-end flow from an input camera to the final iris encoding that produces sufficiently accurate final results despite relying on intermediate approximate computational steps. Unlike previous methods which evaluated approximate computing techniques on individual algorithms, our flow consists of a complex SW/HW pipeline of four major algorithms that eventually compute the iris encoding from input live camera feeds. In our flow, we identify overall eight approximation knobs at both the algorithmic and hardware levels to trade-off accuracy with runtime. To identify the optimal values for these knobs, we devise a novel design space exploration technique based on reinforcement learning with a recurrent neural network agent. Finally, we fully implement and test our proposed methodologies using both benchmark dataset images and live images from a camera using an FPGA-based SoC. We show that we are able to reduce the runtime of the system by 48 χ on top of an already HW accelerated design, while meeting industry-standard accuracy requirements for iris scanning systems.

EPRO BIOM - 004	Design of Biometric Recognition Software Based on Image Processing.

In order to improve the biological characteristic analysis and recognition efficiency, biometric image analysis method is used for biological recognition, the design of biometric identification software is carried out to improve the dynamic recognition ability of biological images, a design method of biometric recognition software based on image processing is proposed. First of all, the infrared optical scanning technology is used to scan the biological images, and the edge contour features of the collected biological images are extracted. Texture feature information is extracted from biological images, the extracted biometric information is input into the embedded software system. In the design of biometric identification software, biological feature recognition software uses real time trigger PXI-6713 for biological image acquisition, software development is taken under the embedded Linux drive kernel, the software system of biometric identification is developed by using DSP and logic programmable PLC, and the optimization design of biometric software is completed. The test results show that the biometric identification system designed in this paper has a good ability to identify biological images, and the accuracy of biometric recognition is high.

EPRO BIOM - 005	Selective fuzzy ensemble learner for cognitive detection of bio-identifiable modality spoofing in MCPS.

Biometric features are widely used for user authentication and equally important to national and global technology systems. Various forms of biometric features, such as face, iris, fingerprint, are commonly used while more recently palm, vein and gait are also getting attention. Simultaneously various spoofing approaches have also been developed over time, which are capable of failing traditional biometric detection systems. Image synthesis with play-doh, gelatin, ecoflex etc. are some of the ways used in spoofing bio-identifiable property. Success of traditional detection systems are related to custom tailored solutions where feature engineering for each attack type must be developed. This is not a feasible process when we consider countless attack possibilities. Also, a slight change in the attack can cause the whole system to be redesigned and therefore becomes a limiting constraint. The recent success of machine learning inspires this paper to explore weak and strong learners with ensemble learning approaches using AdaBoost. Therefore, the paper proposes a selective ensemble fuzzy learner approach using Ada Boost, feature selection and combination of weak and strong learners to enhance the detection of bio-identifiable modality spoofing. Our proposal is verified on real dataset, LiveDet 2015, with a focus on fingerprint modality spoofing detection that can be used for authentication in Medical Cyber Physical Systems (MCPS).

EPRO BIOM - 006	Development of elements of two-level biometrie protection based on face and speech recognition in the video stream.

This paper presents the results obtained when creating a prototype of a software complex that implements speech recognition in the video stream by the motion of the lips with the help of a neural network. This speech recognition based on lip's motions is considered as a stage of two - level biometric authentication. The construction of a neural network model based on LSTM layers is also described here, which is basis of speech recognition's realization. To train this model we assembled and processed database containing recordings of words from a given set of classes. To process and extract the words from the video, the lip model was developed and optimized, described by the time variation of the geometric coordinates of the main points of the image of the lips. As result we achieved model that can recognize words from a given set of classes with an accuracy of 73.1%.

EPRO BIOM - 007	Aiding biometrie system based on fingerprint enhancement and matching.

In this paper, a technique to showcase the performance of a fingerprint based biometrie system is presented by evaluating it on different statistical parameters; so that it can be depicted that how much a particular biometric system have the level of authentication, security, capability of rejection, detection of intruder's fake attempts and of course the processing time. Gabor filtering is applied for the enhancement of fingerprint images and for matching a traditional technique i.e. cross correlation based matching is performed. Morphological operations facilitate extraction of features such as minutiae points. In order to increase the degree of similarity; optimized alignment of extracted minutiae points is achieved by translating the minutiae points and rotating the orientation fields. Algorithm is applied on FVC2002 and FVC2000 fingerprint databases and a comparison of performance of algorithm is performed on these databases. An estimate of performance of a given biometric system is achieved by calculating sensitivity, specificity, accuracy, etc., as equal error rate is not an exhaustive measure to adapt. The used technique completely characterizes the usability, interoperability and suitability of a biometric system according to the desired environment.

EPRO BIOM - 008	GHCLNet: A generalized hierarchically tuned contact lens detection network

Iris serves as one of the best biometrie modality owing to its complex, unique and stable structure. However, it can still be spoofed using fabricated eyeballs and contact lens. Accurate identification of contact lens is must for reliable performance of any biometric authentication system based on this modality. In this paper, we present a novel approach for detecting contact lens using a Generalized Hierarchically tuned Contact Lens detection Network (GHCLNet). We have proposed hierarchical architecture for three class oculus classification namely: no lens, soft lens and cosmetic lens. Our network architecture is inspired by ResNet-50 model. This network works on raw input iris images without any pre-processing and segmentation requirement and this is one of its prodigious strength. We have performed extensive experimentation on two publicly available data-sets namely: 1) IIIT-D 2)ND and on IIT-K data-set (not publicly available) to ensure the generalizability of our network. The proposed architecture results are quite promising and outperforms the available state-of-the-art lens detection algorithms.

EPRO BIOM - 009	Iris Recognition with Off-the-Shelf CNN Features: A Deep Learning Perspective.

Iris recognition refers to the automated process of recognizing individuals based on their iris patterns. The seemingly stochastic nature of the iris stroma makes it a distinctive cue for biometric recognition. The textural nuances of an individual's iris pattern can be effectively extracted and encoded by projecting them onto Gabor wavelets and transforming the ensuing phasor response into a binary code - a technique pioneered by Daugman. This textural descriptor has been observed to be a robust feature descriptor with very low false match rates and low computational complexity. However, recent advancements in deep learning and computer vision indicate that generic descriptors extracted using convolutional neural networks (CNNs) are able to represent complex image characteristics. Given the superior performance of CNNs on the ImageNet large scale visual recognition challenge and a large number of other computer vision tasks, in this paper, we explore the performance of state-of-the-art pre-trained CNNs on iris recognition. We show that the off-the-shelf CNN features, while originally trained for classifying generic objects, are also extremely good at representing iris images, effectively extracting discriminative visual features and achieving promising recognition results on two iris datasets: ND-CrossSensor-2013 and CASIA-IrisThousand. We also discuss the challenges and future research directions in leveraging deep learning methods for the problem of iris recognition.

EPRO BIOM - 010	Semantic Face Signatures: Recognizing and Retrieving Faces by Verbal Descriptions.

The adverse visual conditions of surveillance environments and the need to identify humans at a distance have stimulated research in soft biometric attributes. These attributes can be used to describe a human's physical traits semantically and can be acquired without their cooperation. Soft biometrics can also be employed to retrieve identity from a database using verbal descriptions of suspects. In this paper, we explore unconstrained human face identification with semantic face attributes derived automatically from images. The process uses a deformable face model with keypoint localisation which is aligned with attributes derived from semantic descriptions. Our new framework exploits the semantic feature space to infer face signatures from images and bridges the semantic gap between humans and machines with respect to face attributes. We use an unconstrained dataset, LFW-MS4, consisting of all the subjects from view-1 of the LFW database that have four or more samples. Our new approach demonstrates that retrieval via estimated comparative facial soft biometrics yields a match in the top 10.23% of returned subjects. Furthermore, modelling of face image features in the semantic space can achieve an equal error rate of 12.71%. These results reveal the latent benefits of modelling visual facial features in a semantic space. Moreover, they highlight the potential of using images and verbal descriptions to generate comparative soft biometrics for subject identification and retrieval.

EPRO BIOM - 011	Cancelable speaker verification system based on binary Gaussian mixtures.

Biometrie systems suffer from non-revocabilty. In this paper, we propose a cancelable speaker verification system based on classical Gaussian Mixture Models (GMM) methodology enriched with the desired characteristics of revocability and privacy. The GMM model is transformed into a binary vector that is used by a shuffling scheme to generate a cancelable template and to guarantee the cancelabilty of the overall system. Leveraging the shuffling scheme, the speaker model can be revoked and another model can be reissued. Our proposed method enables the generation of multiple cancelable speaker templates from the same biometric modality that cannot be linked to the same user. The proposed system is evaluated on the RSR2015 databases. It outperforms the basic GMM system and experimentations show significant improvement in the speaker verification performance that achieves an Equal Error Rate (ERR) of 0.01%.

EPRO BIOM - 012	Towards More Accurate Matching of Contactless Palmprint Images under Less Constrained Environments.

Contactless personal identification using biometrics characteristics brings multifaceted advantages with improved hygiene, user security, and the convenience. Such imaging also generates deformation-free palmprint images which can lead to higher matching accuracy as the ground truth information is better preserved as compared with those from contact-based imaging. Advancement of palmprint identification technologies for new domains requires research using larger palmprint databases that are acquired from more realistic populations, under contactless, ambient, and indoor and outdoor environments. This paper presents such a new contactless palmprint database acquired from 600 different subjects, which is the largest to date and is also made available in the public domain. Unlike contactless fingerprints, contactless palmprint images often illustrate pose deformations along the optical axis of the camera, which also degrades the matching accuracy. This paper also introduces a new approach for matching contactless palmprint images using more accurate deformation alignment and matching. The experimental results are validated on three publicly available contactless palmprint databases. Comparative experimental results presented in this paper indicate consistently outperforming results over competing methods in the literature and validate the effectiveness of the investigated approach. These results also serve as baseline performance to advance much needed further research using the most challenging and largest database introduced from this paper.

EPRO BIOM - 013	Visual Classification with Multikernel Shared Gaussian Process Latent Variable Model.

Multiview learning methods often achieve improvement compared with single-view-based approaches in many applications. Due to the powerful nonlinear ability and probabilistic perspective of Gaussian process (GP), some GP-based multiview efforts were presented. However, most of these methods make a strong assumption on the kernel function (e.g., radial basis function), which limits the capacity of the real data modeling. In order to address this issue, in this paper, we propose a novel multiview approach by combining a multikernel and GP latent variable model. Instead of designing a deterministic kernel function, multiple kernel functions are established to automatically adapt various types of data. Considering a simple way of obtaining latent variables at the testing stage, a projection from the observed space to the latent space as a back constraint has also been simultaneously introduced into the proposed method. Additionally, different from some existing methods which apply the classifiers off-line, a hinge loss is embedded into the model to jointly learn the classification hyperplane, encouraging the latent variables belonging to the different classes to be separated. An efficient algorithm based on the gradient decent technique is constructed to optimize our method. Finally, we apply the proposed approach to three real-world datasets and the associated results demonstrate the effectiveness and superiority of our model compared with other state-of-the-art methods.

EPRO BIOM - 014	Biometrie identification using photoplethysmography signal.

Due to the increase in the importance of the electronic data nowadays, finding a way to protect this data from hacking became a must. In this paper, the Photoplethysmographic signal known as the PPG signal is used as a biometric technique due to its several advantages, most importantly its unique form that differs between individuals. The PPG signal is taken using the Spo2 sensor which is a non-invasive method used for measuring the oxygen saturation from either the finger or the ear using 2 light emitting diodes (LEDs); using this PPG signal and its 2 derivatives 40 features depending on the signals' dimensions were extracted by Matlab, and then the K-nearest neighbor classifier was applied after tuning 2 parameters (the constant k and the distance metric) to check the efficiency of this method. The proposed algorithm was tested on dataset having signals previously processed. In future work, this technique is going to be implemented to unlock computers instead of using a password.

EPRO BIOM - 015	Fringe projection profilometry based secured fingerprint sensor.
In this paper, we demonstrate the application of fringe projection profilometry (FPP) for secured 3D biometric fingerprint recognition system. For the extraction of texture as well as high frequency information in a practical biometric system simple Fourier filtering methods have been used. We also address the issue of 2D photo and video attacks, which implies presenting a photograph or video before authentication system to get un-authorize access. Using the developed spoof detection technique, the recognition system becomes more credible and secure, and can be used for different commercial and non-commercial applications.	

EPRO BIOM - 016	Outsourced Biometric Identification With Privacy.
Biometric identification typically scans a large-scale database of biometric records for finding a close enough match of an individual. This paper investigates how to outsource this computationally expensive scanning while protecting the privacy of both the database and the computation. Exploiting the inherent structures of biometric data and the properties of identification operations, we first present a privacy-preserving biometric identification scheme which uses a single server. We then consider its extensions in the two-server model. It achieves a higher level of privacy than our single-server solution assuming two servers are not colluding. Apart from somewhat homomorphic encryption, our second scheme uses batched protocols for secure shuffling and minimum selection. Our experiments on both synthetic and real data sets show that our solutions outperform existing schemes while preserving privacy.	

EPRO BIOM - 017	Facial biometric presentation attack detection using temporal texture co-occurrence.

Biometrie person recognition systems based on facial images are increasingly used in a wide range of applications. However, the potential for face spoofing attacks remains a significant challenge to the security of such systems and finding better means of detecting such presentation attacks has become a necessity. In this paper, we propose a new spoofing detection method, which is based on temporal changes in texture information. A novel temporal texture descriptor is proposed to characterise the pattern of change in a short video sequence named Temporal Co-occurrence Adjacent Local Binary Pattern (TCoALBP). Experimental results using the CASIA-FA, Replay Attack and MSU-MFSD datasets; the proposed method shows the effectiveness of the proposed technique on these challenging datasets.

EPRO BIOM - 018	Robust Feature-Based Automated Multi-View Human Action Recognition System.

Automated human action recognition has the potential to play an important role in public security, for example, in relation to the multiview surveillance videos taken in public places, such as train stations or airports. This paper compares three practical, reliable, and generic systems for multiview video-based human action recognition, namely, the nearest neighbor classifier, Gaussian mixture model classifier, and the nearest mean classifier. To describe the different actions performed in different views, view-invariant features are proposed to address multiview action recognition. These features are obtained by extracting the holistic features from different temporal scales which are modeled as points of interest which represent the global spatial-temporal distribution. Experiments and cross-data testing are conducted on the KTH, WEIZMANN, and MuHAVi datasets. The system does not need to be retrained when scenarios are changed which means the trained database can be applied in a wide variety of environments, such as view angle or background changes. The experiment results show that the proposed approach outperforms the existing methods on the KTH and WEIZMANN datasets.

EPRO BIOM - 019	Normalization and Weighting Techniques Based on Genuine-Impostor Score Fusion in Multi-Biometric Systems.

The performance of a multi-biometric system can be improved using an efficient normalization technique under the simple sum-rule-based score-level fusion. It can also be further improved using normalization techniques along with a weighting method under the weighted sum-rule-based score-level fusion. In this paper, at first, we present two anchored score normalization techniques based on the genuine and impostor scores. Specifically, the proposed normalization techniques utilize the information of the overlap region between the genuine and impostor scores and their neighbors. Second, we propose a weighting technique that is based on the confidence of the matching scores by considering the mean-to-maximum of genuine scores and mean-to-minimum of impostor scores. A multi-biometric system having three biometric traits, fingerprint, palmprint, and earprint, is utilized to evaluate the performance of the proposed techniques. The performance of the multi-biometric system is evaluated in terms of the equal error rate and genuine acceptance rate @0.5% false acceptance rate. The receiver operating characteristics are also plotted in terms of the genuine acceptance rate as a function of the false acceptance rate.

EPRO BIOM - 020	Liveness Detection and Automatic Template Updating Using Fusion of ECG and Fingerprint.

Fingerprints have been extensively used for biometric recognition around the world. However, fingerprints are not secrets, and an adversary can synthesis a fake finger to spoof the biometric system. The mainstream of the current fingerprint spoof detection methods are basically binary classifier trained on some real and fake samples. While they perform well on detecting fake samples created by using the same methods used for training, their performance degrades when encountering fake samples created by a novel spoofing method. In this paper, we approach the problem from a different perspective by incorporating electrocardiogram (ECG). Compared with the conventional biometrics, stealing someone's ECG is far more difficult if not impossible. Considering that ECG is a vital signal and motivated by its inherent liveness, we propose to combine it with a fingerprint liveness detection algorithm. The combination is natural as both ECG and fingerprints can be captured from fingertips. In the proposed framework, the ECG and fingerprint are combined not only for authentication purpose but also for liveness detection. We also examine automatic template updating using ECG and fingerprint. In addition, we propose a stopping criterion that reduces the average waiting time for signal acquisition. We have performed extensive experiments on the LivDet2015 database which is presently the latest available liveness detection database and compare the proposed method with six liveness detection methods as well as 12 participants of LivDet2015 competition. The proposed system has achieved a liveness detection equal error rate (EER) of 4.2% incorporating only 5 s of ECG. achieved by the participants of the LivDet2015 competition.

EPRO BIOM - 021	Feature Extraction Methods for Palmprint Recognition: A Survey and Evaluation.

Palmprint processes a number of unique features for reliable personal recognition. However, different types of palmprint images contain different dominant features. Instead, only some features of the palmprint are visible in a palmprint image, whereas the other features may not be notable. For example, the low-resolution palmprint image has visible principal lines and wrinkles. By contrast, the high-resolution palmprint image contains clear ridge patterns and minutiae points. In addition, the three dimensional (3-D) palmprint image possesses curvatures of the palmprint surface. So far, there is no work to summarize the feature extraction of different types of palmprint images. In this paper, we have an aim to completely study the feature extraction and recognition of palmprint. We propose to use a unified framework to classify palmprint images into four categories: 1) the contact-based; 2) contactless; 3) high-resolution; and 4) 3-D palmprint images. Then, we analyze the motivations and theories of the representative extraction and matching methods for different types of palmprint images. Finally, we compare and test the state-of-the-art methods via the widely used palmprint databases, and point out some potential directions for future research.

EPRO BIOM - 022	Exploring Recurrent Neural Networks for On-Line Handwritten Signature Biometrics.

Systems based on deep neural networks have made a breakthrough in many different pattern recognition tasks. However, the use of these systems with traditional architectures seems not to work properly when the amount of training data is scarce. This is the case of the on-line signature verification task. In this paper, we propose a novel writer-independent on-line signature verification systems based on Recurrent Neural Networks (RNNs) with a Siamese architecture whose goal is to learn a dissimilarity metric from the pairs of signatures. To the best of our knowledge, this is the first time these recurrent Siamese networks are applied to the field of on-line signature verification, which provides our main motivation. We propose both Long Short-Term Memory (LSTM) and Gated Recurrent Unit (GRU) systems with a Siamese architecture. In addition, a bidirectional scheme (which is able to access both past and future context) is considered for both LSTMand GRU-based systems. An exhaustive analysis of the system performance and also the time consumed during the training process for each recurrent Siamese network is carried out in order to compare the advantages and disadvantages for practical applications. For the experimental work, we use the BiosecurID database comprised of 400 users who contributed a total of 11,200 signatures in four separated acquisition sessions. Results achieved using our proposed recurrent Siamese networks have outperformed the state-of-the-art on-line signature verification systems using the same database.

EPRO BIOM - 023	Palmprint Identification Using an Ensemble of Sparse Representations.

Among various palmprint identification methods proposed in the literature, sparse representation for classification (SRC) is very attractive offering high accuracy. Although SRC has good discriminative ability, its performance strongly depends on the quality of the training data. In particular, SRC suffers from two major problems: lack of training samples per class and large intra-class variations. In fact, palmprint images not only contain identity information but they also have other information, such as illumination and geometrical distortions due to the unconstrained conditions and the movement of the hand. In this case, the sparse representation assumption may not hold well in the original space since samples from different classes may be considered from the same class. This paper aims to enhance palmprint identification performance through SRC by proposing a simple yet efficient method based on an ensemble of sparse representations through an ensemble of discriminative dictionaries satisfying SRC assumption. The ensemble learning has the advantage to reduce the sensitivity due to the limited size of the training data and is performed based on random subspace sampling over 2D-PCA space while keeping the image inherent structure and information. In order to obtain discriminative dictionaries satisfying SRC assumption, a new space is learned by minimizing and maximizing the intra-class and inter-class variations using 2D-LDA.

EPRO BIOM - 024	Matching Contactless and Contact-Based Conventional Fingerprint Images for Biometrics Identification.

Vast databases of billions of contact-based fingerprints have been developed to protect national borders and support e-governance programs. Emerging contactless fingerprint sensors offer better hygiene, security, and accuracy. However, the adoption/success of such contactless fingerprint technologies largely depends on advanced capability to match contactless 2D fingerprints with legacy contact-based fingerprint databases. This paper investigates such problem and develops a new approach to accurately match such fingerprint images. Robust thin-plate spline (RTPS) is developed to more accurately model elastic fingerprint deformations using splines. In order to correct such deformations on the contact-based fingerprints, RTPS-based generalized fingerprint deformation correction model (DCM) is proposed. The usage of DCM results in accurate alignment of key minutiae features observed on the contactless and contact-based fingerprints. Further improvement in such cross-matching performance is investigated by incorporating minutiae related ridges. We also develop a new database of 1800 contactless 2D fingerprints and the corresponding contact-based fingerprints acquired from 300 clients which is made publicly accessible for further research. The experimental results presented in this paper, using two publicly available databases, validate our approach and achieve outperforming results for matching contactless 2D and contact-based fingerprint images.

EPRO BIOM - 025	Finger Vein Presentation Attack Detection Using Total Variation Decomposition.

Finger vein recognition is an emerging biometric technique for personal authentication that has garnered considerable attention in the past decade. Although shown to be effective, recent studies have revealed that finger vein biometrics is also vulnerable to presentation attacks, i.e., printed versions of authorized individual finger vein images can be used to gain access to facilities or services. In this paper, given that both blurriness and the noise distribution are slightly different between real and forged finger vein images, we propose an efficient and robust method for detecting presentation attacks that use forged finger vein images (print artifacts). First, we use total variation regularization to decompose original finger vein images into structure and noise components, which represent the degrees of blurriness and the noise distribution. Second, a block local binary pattern descriptor is used to encode both structure and noise information in the decomposed components. Finally, we use a cascaded support vector machine model for classification, by which finger vein presentation attacks can be effectively detected. To evaluate the performance of our approach, we constructed a new finger vein presentation attack database. Extensive experimental results gleaned from the two finger vein presentation attack databases and a palm vein presentation attack database show that our method clearly outperforms state-of-the-art methods.

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