Multimodal Biometrics Using Fingerprint, Palmprint, and Iris With a Combined Fusion Approach

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ABSTRACT
Multimodal biometrics is the frontier to unimodal biometrics as it integrates the information obtained from multiple biometric sources at various fusion levels i.e. sensor level, feature extraction level, match score level, or decision level. In this article, fingerprint, palmprint, and iris are used for verification of an individual. The wavelet transformation is used to extract features from fingerprint, palmprint, and iris. Further the PCA is used for dimensionality reduction. The fusion of traits is employed at three levels: feature level; feature level combined with match score level; and feature level combined with decision level. The main objective of this research is to observe effect of combined fusion levels on verification of an individual. The performance of three cases of fusion is measured in terms of EER and represented with ROC. The experiments performed on 100 different subjects from publicly available databases demonstrate that combining feature level with match score level and feature level with decision level fusion both outperforms fusion at only a feature level.

KEYWORDS
Feature Level Fusion, Fingerprint, Iris, Multimodal Biometrics, Palmprint

1. INTRODUCTION
As compare to traditional personal authentication methods like token-based authentication (key or id) or knowledge based authentication (password), biometrics provides more security (Chin, 2013). Biometrics verifies or identifies the persons based on measurement of their physiological or behavioral characteristics (Luque-baena, 2013). With biometrics, user has to physically interact with the system which makes biometrics stronger from security point of view. Unimodal biometrics employs a single biometric feature to authenticate the person but use of just single biometrics feature has to face with some problems like trouble with noisy data, lack of universality and lack of distinctiveness etc. By considering these bottlenecks of unimodal, biometric research community is now shifting to multimodal biometrics which uses multiple biometric features to authenticate the person (Conti, 2010, Sanjekar, 2013). The multibiometric system can be categorized as multi-sensors systems, multi-algorithm systems, multi-instance systems, multi-sample systems or multi-modal systems (Unar, 2014). The information gained from multiple biometric resources can be merged at

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various levels like sensor level, feature level, matching score level or decision level. The sensor level fusion and feature level fusion are the types of pre-classification fusion that means the modals are combined prior to classification phase. The match score level fusion, rank level fusion and decision level fusion are post-classification types of fusion where modals are integrated after classification phase. The fusion at feature level involves the consolidation of feature vectors from different biometric resources and forming the new feature vector for matching process. The integration of these feature vectors may lead to the very large feature vector also it may be very difficult to combine the feature vectors that are incompatible with each other (Ross, 2005, Dinca, 2017, Joshi, 2009). The feature level fusion can be categorized as serial feature fusion and parallel feature fusion. In former case simply concatenation of feature vectors one after another is carried out while later combines feature vectors into complex vectors (Haghighat, 2016). In feature level fusion there is a need of normalization of the features to convert them into same range which allows use of same threshold during matching process. The feature level fusion consists of rich information as compared with match score level fusion and decision level fusion.

In match score level fusion, the scores generated from each modal are integrated by means of fusion techniques like sum, product, weighted product etc. As the scores generated from different modals are of different range, normalization of these scores is required before integration of scores. The Min-max, tan-h, z-score, MAD, mathematical normalization methods can be used for normalization the scores. Finally, in case of decision level fusion the decision given by individual modality (may be identity or accept/reject) is considered for final output of the system. One can use AND, OR, Majority voting or weighted majority voting etc methods in decision level fusion. Proper fusion of the traits is a key to the success of multimodal biometrics (Sanjekar, 2019). In this paper, feature level fusion is applied on the three different biometrics traits i.e. fingerprint, palmprint and iris. The fusion at feature level is expected to give high performance as features contain much richer information (Haghighat, 2016). However, matching score and decision level fusion both are much addressed in the literature than feature level fusion. In proposed work, the performance of the biometric system is measured with feature level fusion. Along with this, performance of the system is also measured with combination of different fusion levels. The fusion of traits is employed at: (i) feature level; (ii) feature level combined with match score level; (iii) feature level combined with decision level. Next section will cover the far-reaching survey of literature.

2. BACKGROUND

Till date a lot of multimodal biometric systems were introduced by many researchers. (Xin et al., 2018) have given an approach of multimodal biometrics using face, fingerprint and finger-vein with feature level fusion. Simple concatenation of features is performed. The liveness detection is also appended to their system. The experiments are carried out on database of 50 persons and they got 88% recognition accuracy. (Sujatha et al., 2018) have given an approach of match score level fusion with iris, finger-vein and fingerprint modals. The Particle Swarm Optimization and Genetic Algorithm are used for optimization. With this hybrid approach they got very considerable performance with 99% accuracy.

(Kavitha et al., 2018) have proposed multimodal biometric system using palmprint, hand geometry, knuckles and speech biometric features. Further, data level fusion and feature level fusion is also carried out. With these modals they got considerable performance. (Gowda et al., 2017) introduced face, palmprint, finger-vein and hand-vein based multimodal biometric system. The fusion of all modals is performed at sensor, feature, match score and decision level. The features are extracted by Local Phase Quantization. With experimentation on database of 100 subjects, at feature level fusion at 0.01% FAR, 92.5% accuracy is achieved. Results suggested that the fusion at post-classification is more accurate than pre-classification. (Gayathri et al., 2015) have developed palmprint and iris based multimodal system with feature level fusion. They first extracted the features of palmprint and
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www.igi-global.com/chapter/edge-detection-maximum-entropy/77038?camid=4v1a

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