



Identity Verification using Shape and Geometry of Human Hands

Expert Systems with Applications, Elsevier, 2015

Shefali Sharma¹, Shiv Ram Dubey², Satish Kumar Singh², Rajiv Saxena³ and Rajat Kumar Singh²

¹Jaypee University of Engineering and Technology Guna, ²Indian Institute of Information Technology Allahabad, ³Jaypee University Anoopshahr



Introduction

- A multimodal biometric system for identity verification is designed by fusing shape and geometry features at score level.
- Shape and geometry features are derived with the help of only contour of the hand image.
- Two shape based features are extracted using distance and orientation of hand contour points and wavelet decomposition.
- Seven distances are used to encode the geometrical information of the hand.
- All processing is done w.r.t. a stable reference point at wrist line which is more stable as compared to the centroid [1].

Preprocessing

A thresholding and morphological operators are used to get the hand mask binary image from the original hand image. In this process, if any portion of hand gets disjoint from the rest of the hand portion then the scheme illustrated in Fig.1 is used to fix it for each disjoint portion.

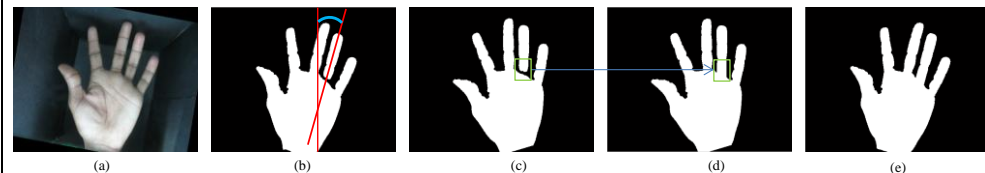


Fig.1. Process of joining the disjoint finger to the hand, (a) original hand image, (b) generated hand mask using pre-processing, the ring finger is disjoint from hand, (c) hand mask is rotated such that ring finger became vertical, (d) ring finger is extended such that it became attached with the remaining hand, and (e) the hand mask is rotated to its original orientation back.

Method

The framework to find out rotation invariant hand contour with the peaks and valleys of each finger is demonstrated in Fig.2 with the help of an example hand image. Fig.3 shows the robustness of the reference point extraction over wrist boundary of the hand.

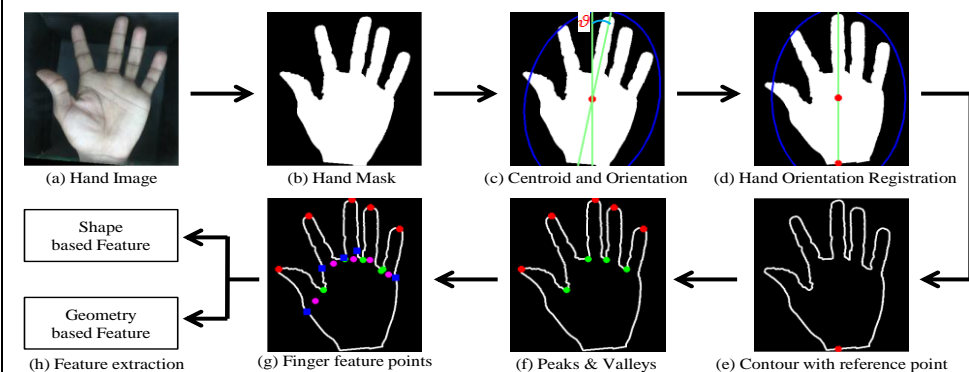


Fig.2. Localization of rotation invariant hand contour and finger feature points such as peaks, valleys and mid-point of two adjacent valleys.

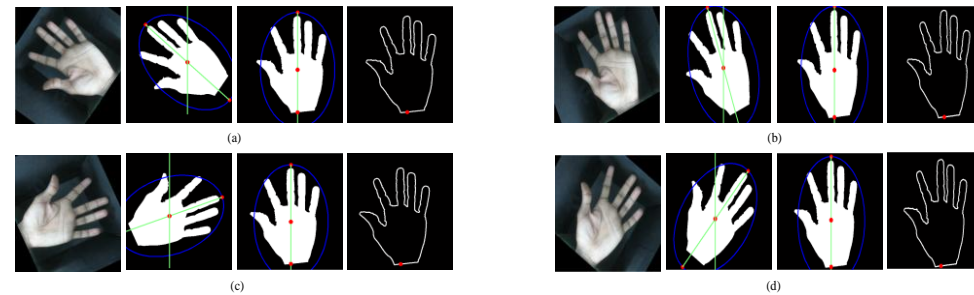


Fig.3. Robustness of the stable and rotation invariant reference point extraction over wrist boundary of the hand.

The finger points obtained in Fig.2(g) is used to extract the geometrical feature as depicted in Fig.4. The ratio of each pair of distances is combined into a feature vector.

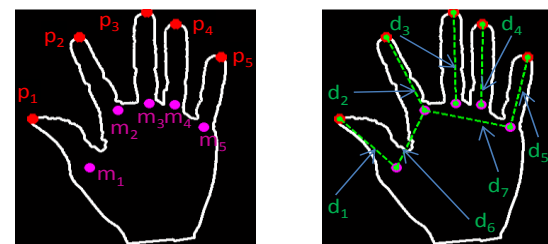


Fig.4. Calculation of geometrical features, (a) hand contour with finger feature points and (b) 7 distances used as geometrical features.

The finger registration is performed to align each finger at a fixed orientation (i.e. 60, 30, 10, -10, and -30 degrees from thumb to baby finger) from the vertical axis as illustrated in Fig.5. The updated contour after finger alignment is used to extract the shape features in terms of the wavelet decomposition of distance and orientation of each point of contour w.r.t. the reference point. A wavelet decomposition (1-D) at level 5 using Daubechies-1 wavelet filter is used in this work [2].

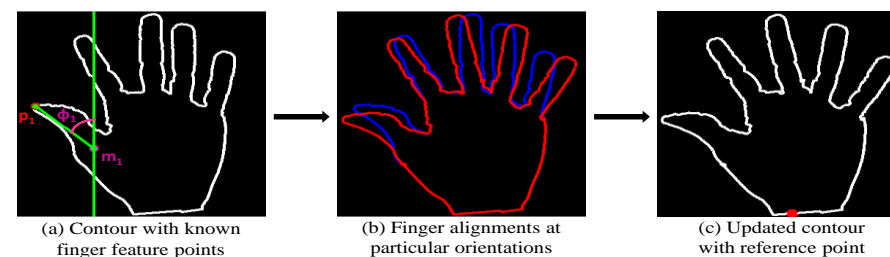


Fig.5. Finger registration at a fixed orientation from the vertical axis.

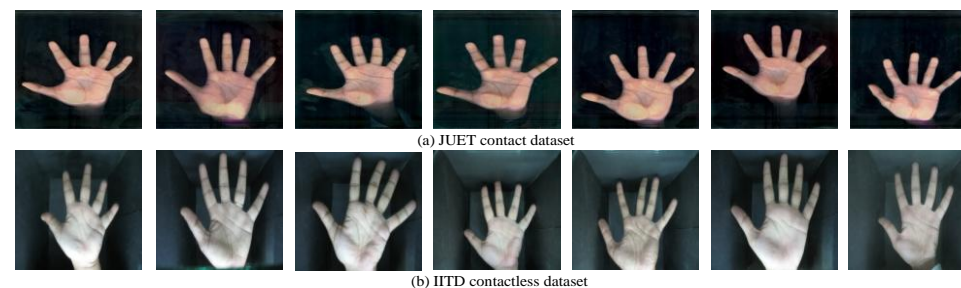


Fig.6. Example images from (a) our dataset and (b) IITD dataset.

Performance Evaluation

The experiments of identity verification are done over two datasets one created by us and other one is created by IITD [3]. The IITD dataset is having contactless hand images, whereas images in our dataset are captured after contacting the hand over a simple scanner. Our dataset consists of 250 images (5 images from 50 subjects). The 240 subjects with 5 images each are considered from IITD dataset.

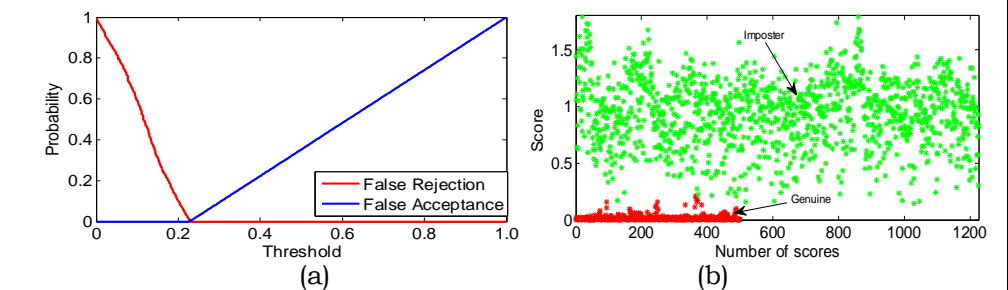


Fig.7. Analysis over our hand dataset: (a) false rejection (FA) and false acceptance (FA) with different thresholds, and (b) genuine and imposter scores after score fusion of all three modalities.

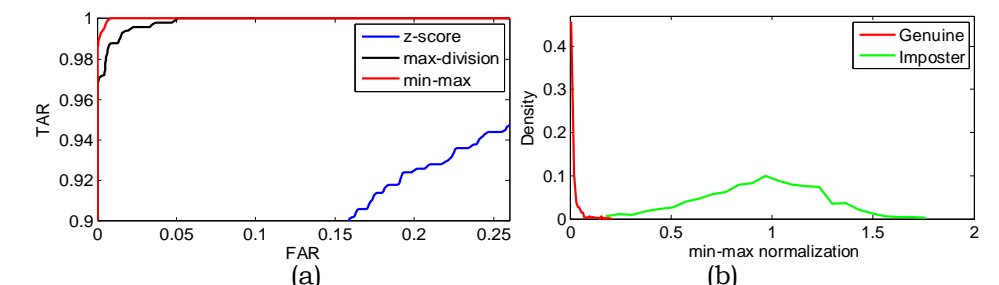


Fig.8. Effect of score normalization method over our hand dataset: (a) ROC plot using different score normalization methods, (b) the min-max normalized score density distribution.

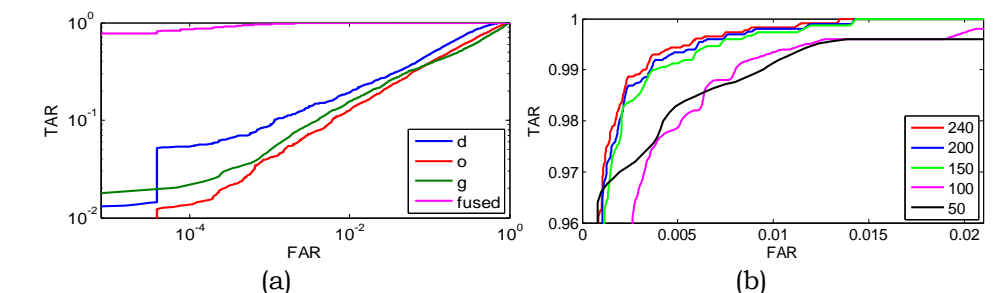


Fig.9. Results over IITD hand dataset: (a) ROC curve of score fusion and (b) performance comparison with varying number of subjects. Here, 'd', 'o', and 'g' represent the distance, orientation, and geometrical features.

References

- [1]E. Yoruk, E. Konukoglu, B. Sankur, and J. Darbon, "Shape-based hand recognition", *IEEE TIP*, 15(7): 1803-1815, 2006.
- [2]S.G. Mallat, "A theory for multiresolution signal decomposition: the wavelet representation", *IEEE TPAMI*, 11(7): 674-693, 1989.
- [3]A. Kumar, "Incorporating cohort information for reliable palmprint authentication", *Sixth ICVGIP*, 2009.