Commentary: Contactless and Pose Invariant Biometric Identification Using Hand surface

1. Introduction

Although the hand based biometric system obtained a commercial success, it still remains some issues to be addressed. The main problems are the constrained imaging set up, hygienic concerns when the user placing the hand on the identification machine and the shape features extracted from the hands contains limited information. Moreover, for the current methods, the pose invariant features are not extracted and none of the methods perform the 3-D pose normalization.

This paper addressed a new hand matching method to solve the significant hand pose variations and correcting the pose by using the 3-D hand data. Furthermore, A dynamic fusion method is proposed to combine the palm and hand features by any choice in order to make a more effective decision. This is important because the palm print area of the hand short off explicit feature points so it is unstable to estimate the homographic transformation and although 3-D pose changing has been well solved, there are lack of work done in the 3-D hand identification which means some challenges like landmark points are not well defined. Furthermore, the hand pose normalization just provides a rough estimation of the direction of the hand and the biometric identification needs accurate estimate of the hand pose. Because the error of the registration of the regions of interest will influence the performance of the matching system.

While these challenge be solved, the hand based biometric systems that needing images in contact-free and unconstrained will improve the performance and accuracy. Furthermore, these systems will be more friendly to the users especially for the elderly and limited dexterity.

The different between the new method to the current practice in the field is that it uses the dynamic fusion approach rather than the weighted sum rule to improve the performance. Moreover, it can deal with the large hand pose variations when in the verification of personal information. For the existed 2-D hand identification, it needs multiple landmark points but for the 3-D hand data, it just need a single point to evaluate the hand's pose.

2. Methods

Basically, the new approach is an uncontested and contact-free method by using textured 3-D hands to solve the pose invariant hand identification. For the new method, it is constructed by three parts, 2-D and 3-D hand pose normalization, hand feature extraction and dynamic fusion.

For normalization the main idea is that in center of the palm extracting the 3-D data points from the region around the palm and fit a plane. The first step is localizing the hand in the gained hand inputs. Using the Otsu's thresholding to localize the hand and using the morphological open operator to retain the binary image. I think the Otsu's thresholding is a good choice for this situation. Because it can provide a binary image and it can segment the image especially useful for object and background intensity are very different. And the morphological operator can remove bright noisy regions. Moreover, for the sake of locating the center of the palm, it initially uses a method based upon inter finger points but it can not detect the intersection of the two fingers. Therefore, a reliable distance transform based method are used to locate the center of the pam by calculating the Euclidean distance between each foreground pixel and the closest pixel in the hand contour. The center of the palm is the point that has the largest score for the distance transform. After extracting the interest 3-D points, it uses the IRLS to fit the 3-D plane. The IRLS can deal the outliers which caused by the bending and distortion of the hand. After pose correcting, it resamples the data on a uniform gird to convert to intensity and range data for the further processing.

For the hand feature extraction it has different method for 3-D and 2-D. For the 3-D palm print, it uses SurfaceCode 3D to extract local surface detail in the shape of wrinkle and depth and winding of palm lines. For 2-D palm print, it uses a competitive coding scheme based on the Gabor filtering to extract the discriminatory information on creases on the palm print and the orientation of the lines. For 3-D hand geometry, it collects from the segments of cross-section finger. For 2-D hand geometry, it collets from the binarized images of the hand like the width and length of the finger, the area, the circumference and the width of the palm.

For the dynamic fusion, combining the hand geometry features and the palm print selectively in the pose normalization step. Because the correction of the pose will cause the loss of finger edge information and the geometric features extraction is not complete in the region of interest. So, in this situation, depending on the palm print match score to decide and discard the hand geometric information. And use the dynamic combination to ignore and identify less hand geometry match score by the direction of the hand.

3. Results

Because there dose not exist a public 3-D hand dataset, therefore they create their own data set which get 1140 right hand 2-D and 3-D hand images from 114 objects with 5 rotated pose. It calculates the standard deviation and the absolute mean of the angles. However, the weakness of the dataset is that we can not get the accurate rotation of the hands which means it will cause the error for the experiment which is not convincible. So, I think it can make the dataset to be larger like collect more objects or collect more poses for each objects.

In order to show the usefulness of the dynamic fusion method and the pose correction, it sets two experiments, first is evaluating performance of using the pose amendment for the personal hand traits. Second is using hand features to evaluate the dynamic fusion method and compare it with the weighted sum rule based fusion. And a sample will match to all other remaining samples to get the best match score.

As a result, the pose normalization decreased the overlap of real and imposter matching points. And for proving this property improvement, For the two cases it uses the matching score to calculate the FRR and FAR and construct to the ROC curves. This shows that the pose normalization can be useful for the 2-D palm print features. And it also do the experiment for the 3-D palm print features. The result shows that for the hand geometric features, the 3-D features performance is better than the 2-D features. And uses the EER as the property indicator.

However, for the hand geometry features is not good because of the absorption around the finger edges, the geometry of the finger suffers from a loss of key data. And due to the finger's bending and movement, the palm and finger not always lies on a plane which will causes the bad property of the hand geometry traits.

Moreover, The dynamic fusion method is always better than the simply combination of the matching score using the sum rule. And the dynamic fusion method improves 60% in term of the EER than using the sum rule. And this method can decrease the effect of the consolidated match score on the poor hand geometry score , therefore help to improve the verification accuracy.

In order to convince the potential users, I think this method needs more samples. And I think it needs to compare more existed method to show the larger improvement of the performance. Furthermore, I think it can explore other combination of the dynamic fusion method and compare each combination to find the best one.

4. Conclusions

In conclusion, this article proposed a new method by using hand image acquired to perform pose steady biometric identification. This method uses the 3-D hand to measure the hand direction. And use this information to correct the pose of 2-D and 3-D hand. In order to extract 2-D and 3-D hand geometry and palm print features, it processed the range images of the hand and the pose corrected intensity. Moreover, it imported a dynamic method to bond the hand features and a few the low hand geometry matching score caused by the user's hand rotation which in the high degree.

As a result, before the matching, the pose normalization can improve identification accuracy. Moreover, combining the hand geometry matching with the palm print is always better than the weighted sum rule.

The strengths of the method is that it can deal with the large hand pose variation and improve the significant performance. Moreover, on the palm, using the 3-D data for getting the direction of the hand just need a detected point. The weakness of the method is that it uses the commercial 3-D scanner which has slow collecting speed, large fees, and it can not use for any online biometric applications.

Therefore for the future study, they can keep finding a substitution that deal the disadvantages and try to explore the dynamic feature level combinations. Try to apply these method on the online biometric applications and find a proper way to collect a more reliable dataset.