

A Novel Finger-Vein Recognition Based on Quality Assessment and Multi-Scale Histogram of Oriented Gradients Feature

Junying Zeng, Department of Information Engineering, Wuyi University, Guangdong, China

Yao Chen, Department of Information Engineering, Wuyi University, Guangdong, China

Yikui Zhai, Department of Information Engineering, Wuyi University, Guangdong, China

Junying Gan, Department of Information Engineering, Wuyi University, Guangdong, China

Wulin Feng, Department of Information Engineering, Wuyi University, Guangdong, China

Fan Wang, Department of Information Engineering, Wuyi University, Guangdong, China

ABSTRACT

Inferior finger vein images would seriously alter the completion of recognition systems. A modern finger-vein recognition technique combined with image quality assessment is developed to overcome those drawbacks. By the quality assessment, this article can discard the inferior images and retain the superior images which are then transferred to the recognition system. Different from previous methods, this article assesses the quality features of the image for the purpose of distinguishing whether the image contains rich and stable vein characteristics. In light of this purpose, the quality assessment is implemented: first, the finger vein image is automatically annotated; second, the finger vein image is cut into image blocks to expand the training set; third, the average quality score of multiple image blocks from an image is the final quality score of the image in the course of testing. Next, the Histogram of Oriented Gradients (HOG) features are extracted from the four transformed high-quality sub-images, whose features are cascaded into the multi-scale HOG feature of an image. Finally, two modules, the quality assessment module using Convolutional Neural Networks (CNN) and finger vein recognition module which make full use of multi-scale HOG, are perfectly combined in this article. The test results have demonstrated that light-CNN can identifies inferior and superior images accurately and the multi-scale HOG is feasible and effective. What's more, this article can see the robustness of this combined method in this article.

KEYWORDS

Automatic Labeling, CNN, Finger-Vein Recognition, Multi-Scale Directional Gradient Histogram (HOG), Quality Assessment

1. INTRODUCTION

In recent years, finger vein, as the popular 2nd generation biometric identification tools, has drawn the attention of more and more scholars (Kumar & Zhou, 2012; Lee, Jung & Kim, 2011). At the same time, finger vein image quality has also made certain research progress (Xie, Zhou, Yang, Lu, & Pan, 2013; Peng, Li, & Niu, 2014; Lee, Khalil-Hani, Bakhteri & Nambiar, 2017). Due to individual differences, changes in the collection environment, and differences in the performance of

DOI: 10.4018/IJEIS.2019010106

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acquisition equipment, the quality of some collected images is not ideal. In the recognition system, inferior images will seriously affect feature extraction and feature matching. Therefore, in order to filter low-quality images and select high-quality images to input finger vein recognition system, it is necessary to realize accurate and rapid quality assessment after collecting the finger vein images.

According to different purposes of establishing the quality assessment models, existing finger vein image quality assessment schemes can be roughly classified to three categories: (1) This method have fused several quality feature parameters which are manually designed by researchers (Ma, Wang, Fan & Cui, 2012; Yang, Yang, Yin & Xiao, 2013; Qin, Chen & He, 2017); (2) the method is performed on the basis of the number of vein points with vein pattern detection (Nguyen, Park & Shin, 2013; Huang, Kang, Wu, Zhao & Jia, 2016); (3) the method is based on feature representation of deep learning (Qin & Yacoubi, 2015; Qin & Yacoubi, 2017). The first method aims to establish the model which is basically consistent with the evaluation effect of human visual system. This kind of method has to first analyze the factors which may affect the quality of finger veins. After that, the corresponding characteristic parameters are proposed and the features that can characterize the quality of the finger veins are designed manually. It is challenging to realize an effective and robust finger vein quality feature extraction. The second method considers that the quality of the finger vein image mainly relates to whether the satisfactory finger vein feature can be extracted, instead of the judgment result of the human visual system. Therefore, whether or not a large number of clear venous points can be detected becomes an indicator of the quality in such methods. Furthermore, some complicated pre-processing work must be carried out in order to detect the vein points accurately, and the detection process is also comparatively time-consuming in such methods. The third method uses the convolutional neural network to assess the images. For example, the literature (Qin & Yacoubi, 2015) have put forward a hypothesis that the image which was erroneously rejected in the verification scheme are poor images, under such hypothesis, images are automatically labeled the quality. In particular, the labeling is not robust in literature (Qin & Yacoubi, 2015) because it involves only one finger vein image authentication system. That is to say, the model from literature (Qin & Yacoubi, 2015) can effectively distinguish whether the finger vein image can be correctly recognized by this verification system, but not necessarily for other identification systems.

According to different methods of extracting finger vein feature, the existing finger vein recognition methods can be roughly categorized into four parts (Yin, Yang & Yang, 2015): (1) the vein patterns extracted from grayscale images are used for identification in this method (Huang, Dai, Li, Tang & Li, 2010; Song, Kim, Kim, Choi, Kong & Lee, 2011; Qin, Qin & Yu, 2011; Miura, Nagasaka & Miyatake, 2004; Miura, Nagasaka & Miyatake, 2007); (2) some minutia points such as bifurcation points, endpoints and other minutia points extracted from images are used to describe the main features of the finger veins in this method (Yu, Qin, Zhang & Cui, 2009; Pang, Yin, Yang & Li, 2012; Liu, Yang, Yin & Wang, 2014; Peng, Wang, El-Latif, Li & Niu, 2012); (3) vein pattern areas and non-textured areas are not distinguished and some information such as grayscale, derivatives and gradient is extracted in the neighborhood of each pixel in this method based on local feature (Lee, Kang, Lee & Park, 2010; Lee, Jung & Kim, 2011; Rosdi, Shing & Suandi, 2011; Lu, Xie, Yoon & Park, 2013; Lu, Yoon, Xie, Yang, Wang & Park, 2014; Meng, Yang, Yin & Xiao, 2012; Yang, Xi & Yin, 2012; Xi, Yang, Yin & Meng, 2013); (4) the model is trained to learn finger vein characteristics from large amounts of data in this method based on machine learning and deep learning (Liu, Ling, Liu, Shen & Gao, 2018; Qin & El-Yacoubi, 2017; Hong, Lee & Park, 2017; Fang, Wu & Kang, 2018; Xie & Kumar, 2017; Xi, Yang & Yin, 2017). However, vein patterns have to be segmented from the raw image in the method based on finger vein pattern and the method based on minutia points. The quality problems such as blurring and low contrast will make it difficult to do the segmentation. Moreover, the training needs a large amount of data and the fine-tuning work is not easy during the training process in the method based on machine learning and deep learning. Therefore, feature extraction based on local features has become the most commonly used feature extraction method.

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