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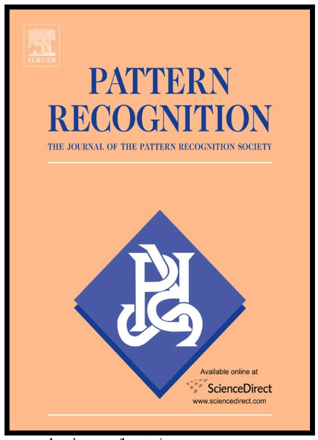

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Abstract

Extracting reliable finger-vein features directly from original finger-vein images is not an easy task since the captured finger-vein images are always poor in quality. This paper proposes an effective method of finger-vein feature representation based on adaptive vector field estimation. Considering that the vein networks consist of vein curve segments, a set of spatial curve filters (SCFs) with variations in curvature and orientation are first designed. To fit vein curves locally and closely, SCFs is then weighted using a variable Gaussian model. Due to the fact that finger veins vary in diameters naturally, an effective curve length field (CLF) estimation method is proposed to make weighted SCFs adaptive to vein-width variations. Finally, with CLF constrain, vein vector fields(VVF) are built for finger-vein network feature description. Experimental results show that the proposed method is highly powerful in improving finger-vein matching accuracy.

Keywords: Biometrics, finger-vein recognition, spatial curve filter, vector field

1. Introduction

The veins used for biometrics in finger are superficial vessels that are present between two layers of superficial fascia without accompanied arteries [1]. As veins are sheltered by the human skin, the superficial veins embedded in subcutaneous tissue can not be visualized clearly by visible light. The finger vein pattern is therefore very difficult to be illicitly falsified and stolen in practice, which can greatly improves the reliability and safety of finger-vein traits in real applications, such as ATMs, PC login, and access control.

Finger-vein images are often captured using the near infrared (NIR) light (700 - 900 nm) in a transillumination manner. The NIR light can transmit through a finger and be absorbed by tissues [2]. Since the hemoglobin in veins absorbs more NIR radiation than other tissues (such as muscle and bones), some darker "shadows" can be casted on an imaging plane. Thus, using a NIR camera, the finger-vein imageries can be recorded successfully.

The quality of finger-vein images is not always good owing to light attenuation in tissues. The NIR lights penetrating a human finger can be refracted, absorbed and scattered by the biological tissue [3, 4, 5]. Since the biological tissue can be viewed as a complex heterogenous optical medium, the NIR lights suffer from significant scattering in addition to absorbtion when they propagate into this medium [6, 7]. This can greatly reduce the contrast between the venous and nonvenous regions, and further impair the accuracy of finger-vein image matching. Hence, many methods, i.e. adaptive histogram equalization method [8], morphological method [9], line-tracking method [10], curvature-based method [11] and transform-based method [12, 13, 14], have been proposed for handling low-contrast finger-vein recognition problem.

Naturally, improving finger-vein image quality is helpful for increasing the finger-vein recognition accuracy. Therefore, to remove light scattering phenomenon caused by biological tissues, an depth-dependent point spread function (D-PSF) was proposed in [15, 16], and addressing the blurring issue in finger-vein imaging, we also proposed a scattering removal method based on a biological optical model [17, 18, 19]. However, the proposed scattering removal methods still can not handle the finger-vein restoration problems effectively and efficiently. Hence, the demand of directly extracting reliable finger-vein features from original finger-vein images is still more insistent in finger-vein recognition. Although the transform-based methods were reported to behave better than others in finger-vein information ex-