Computers and Electrical Engineering 72 (2018) 53–78

Contents lists available at ScienceDirect

Computers and Electrical Engineering

journal homepage: www.elsevier.com/locate/compeleceng

Multiple feature fusion for unconstrained palm print authentication☆

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ARTICLE INFO

Article history:
Received 16 July 2017
Revised 4 September 2018
Accepted 5 September 2018

Keywords:
Biometrics
Palm print
Fractional mask
Sift
Vector quantization
Principal subspace learning
SVM

ABSTRACT

Over the last decade, palm print recognition has emerged as the strongest technology for human authentication in many aspects. To carry out an effective recognition, this paper presents a feature level fusion of block-wise scale invariant feature transform and texture code co-occurrence matrix based features. Initially, an attempt to access the quality of extracted region of interest image is made. This is followed by application of fractional differential mask resulting in improvement of textural detail. In order to select the most discriminate palm features, a feature transformation algorithm inspired by subspace learning is employed. It led to reduction in computation time and feature dimensions, along with higher level of performance. A trained support vector machine utilizes the selected features to determine whether image belongs to genuine or imposter class. Comparative experimental analysis described in this paper indicates customarily outperforming results than competing methods and validate efficacy of proposed approach.

1. Introduction

Automatic e-biometric solutions are supposed to be definitive substitute for traditional authentication methods which can be easily duplicated, cracked, or stolen, like smart card, passwords, tokens, PIN codes etc. Biometric systems offer the advantage that they provide security based on “what you own” rather than “what you know” (password/PIN) or “what you have” (smart card). The foremost aim of biometric technology is to extract one or more physiological, behavioral and/or anatomical (medical) features to ensure their trustworthiness in differentiating an authorized individual from an imposter [1]. The commonly known, human genetic features such as iris, signature, fingerprint, gait, speech, face, etc. have been extensively explored and studied for numerous personnel security applications [2]. However, hand biometric traits can be used instead of other popular modalities due to their higher acceptance among the users. Some of them have been well established over the years such as fingerprint, hand geometry, and palm print, while few of them like finger knuckle print, inner knuckle print, nail bed, hand vein etc. are still not matured enough [3]. Fig. 1(a) depicts an overview of different hand biometric traits, whereas various line features present in anatomical structure of palm print are shown in Fig. 1(b). More recently, research in hand biometrics has migrated towards exploring utility of palm print for realworld scenarios like smartphone/ notebook/ ATM applications [4]. The inbuilt mobile camera offers the facility to capture palm print conveniently, so

☆ Reviews processed and recommended for publication to the Editor-in-Chief by Associate Editor Dr. R.C. Poonia.

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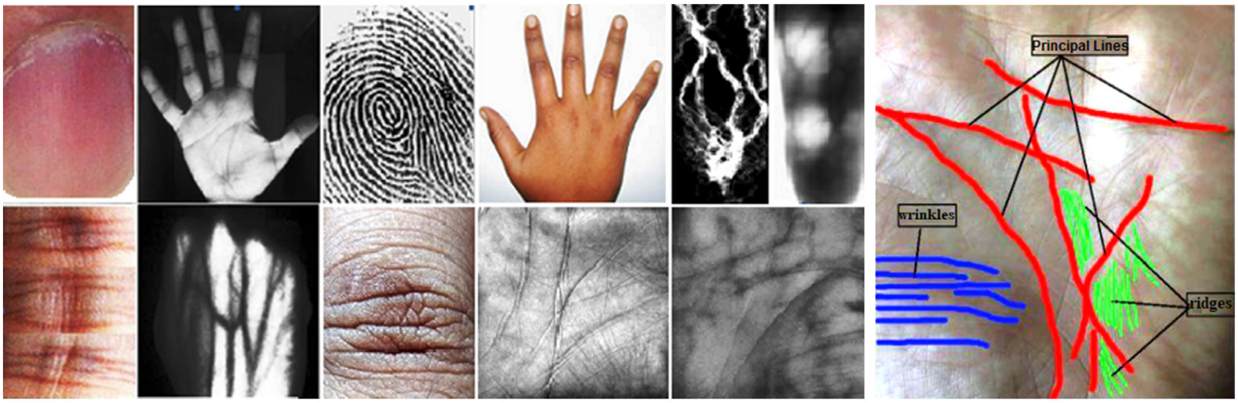
https://doi.org/10.1016/j.compeleceng.2018.09.006
0045-7906/



(a) (b)

Fig. 1. (a) Hand biometric traits. (b) Structure of palm print [26].

as to grant user access to device as well as the mobile apps. For instance, Biolink APIS (Automated Palm Print Identification System) has been utilized all over the world in forensic case studies and law enforcement [2].

1.1. Motivation and challenges

Palm print is the region between fingers and wrist of human hand, consisting of distinct patterns [4]. The patterns on palmer surface contain sufficient discriminatory information in form of lines (few dominant, others thin and asymmetrical), geometry, ridges and valleys providing several singular and minutiae points. These help palm print to achieve sufficient uniqueness and thereby fulfills the fundamental criterion for a biometric identifier. In addition to this, palm print obeys other qualities of a potential physiological authentication trait, such as (i) cost-effective low-resolution acquisition (ii) large palmer surface for extracting features (iii) difficult to circumvent (iv) stable under physiological and emotional changes. Thus, its terrific characteristics have provided the main inspiration to do work on the problems of palm print recognition. A high resolution (>400) sensor is required to capture thin ridges, singular points and minutiae in palm for high security applications while low-resolution (<100) line features of palm contain sufficient discriminative information for its use in commercial applications [5,6]. The most recent studies in palm print recognition have been exploring its feasibility for online access control, and e-commerce applications under unconstrained background and illumination conditions [4]. However, the main issue is related to mounting of extra hardware so as to embed a biometric sensor in a smart phone or portable device. The new hardware designs take time to perfect and are costly, hence it usually postpone market entry of new biometric technology. But the normal camera (webcam) on latest devices has the capability to capture good quality palm print image. Despite such benefits of contactless imaging, there are risks of intra class variations i.e., positional change of image texture in different palms of the same person. This results in inconsistent ROI (region of interest) segmentation and non-uniform reflection throughout all the subjects. The poor segmentation and reflection cause lower recognition performance and pose limitation to palm usages in various modern security applications.

1.2. Major contribution

The foremost goal of the proposed work is to diminish the effects of factors such as scale, noise, rotation, and illumination that degrade the performance of unconstrained palm print image recognition systems. In particular, to solve these issues, a solitary multi-algorithmic approach which can overcome all fundamental challenges has been presented in this work. Independent studies have been carried out and salient improvement has been achieved at each module. The primary research contribution of the proposed biometric approach is summarized in the following steps:

1. In the preprocessing stage, an improved ROI extraction method based on Bresenham line algorithm is introduced which extracts a square shape region with a maximum size over the palm surface.
2. The quality of raw palm images is estimated and identified based on trait specific quality attributes viz. Reflection (R), Ridge Density (D), and Orientation Certainty Level (OCL).
3. A fractional Grunwald–Letnikov (G–L) differential mask is applied to enhance the edges, corners as well as the weak texture of the palm region.
4. The scale and rotation invariant features extracted by block-wise scale invariant feature transform (SIFT) and the statistical features computed by texture code co-occurrence matrix (TCCM) are concatenated using feature level sum fusion rule.