Classification of Skin Diseases and Their Impact on Fingerprint Recognition

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Abstract: This article describes different skin diseases which could have the influence to the process of fingerprint acquirement. There are many people, who suffer under such diseases and are therefore excluded from the set of users of a biometric system and could not e.g. get a visa to the USA or use an access biometric system installed in a company, where they work.

1 Introduction

Skin diseases represent a very important, but often neglected factor of the fingerprint acquirement. It is impossible to say in general how many people suffer from skin diseases, because there are so many various skin diseases – please refer e.g. to [1][2][3][4][5], but we must admit that such diseases are present in our society. When discussing whether the fingerprint recognition technology is a perfect solution capable to resolve all our security problems, we should always keep in mind those potential users who suffer from some skin disease.

In the following text, several skin diseases are introduced, which attack hand palms and fingertips. These are divided into three subcategories (the list is however more longer – see [7]): diseases affecting a) only the papillary line structure, b) only the skin color and c) both papillary line structure and skin color.

The subcategory of skin diseases affecting only the skin color are the least dangerous for the quality of the fingerprint image [9][10]. In fact, only one fingerprint technology can be considered as sensitive to such diseases – the optical technology, but if FTIR-based (Frustrated Total Internal Reflection) optical sensors are used, the change of skin color may have no influence on the quality of the resulting images. The case of the other two subcategories is different. If the structure of papillary lines has changed, it is often impossible to recognize the original curvatures of papillary lines and therefore it is impossible to decide whether the claimed identity is the user’s identity.
The situation after successful recovery of a potential user from such skin diseases is, however, very important for the possible further use of fingerprint recognition devices. If the disease has attacked and destroyed the structure of papillary lines in the epidermis layer of the skin, the papillary lines will not grow in the same form as before (if at all) and therefore such user could be restricted in his/her future life by being excluded from the use of fingerprint recognition systems, though his fingers don’t have any symptoms of a skin disease any more.

2 Examples – Change of Papillary Line Structure

We can put the following diseases as examples of change of papillary line structure: *furuncle* (Fig. 1a) [6] is an acute, round, tender, circumscribed perifollicular staphylococcal abscess that generally ends in central suppuration; *Pitted keratolysis* (Fig. 1b+c) [6][4] is a bacterial infection of the plantar stratum corneum; *Fingertip eczema* (Fig. 1d) [1] is a very dry, chronic form of eczema of the palmar surface of fingertips; it may be the result of an allergic reaction or may occur in children and adults as an isolated phenomenon of unknown cause; *Verruca vulgaris* (Fig. 2a) [6] – common warts are a significant cause of concern and frustration of certain patients. The prevalence reaches 50% in those persons with the direct contact with meat; *Scleroderma* [4] is a multisystem disorder characterized by inflammatory, vascular, and sclerotic changes of the skin and various internal organs, especially the lungs, heart, and gastro-tract (Fig. 2b); *Cellulitis* [121] is manifested by tender, warm, erythematous plaques with ill-defined borders. Occasionally, linear red macules proximal to the large plaque are seen too.

![Fig. 1 (from left): a) Staphylococcal abscess in a diabetic patient [6]; b) Pitted keratolysis [6]; c) Palmar pits [4]; d) Fingertip eczema [1].](image)

3 Examples – Change of Skin Color

We can put the following diseases as examples of change of skin color: *Hand-Foot-and-Mouth disease* (HFMD) (Fig. 2c) [6] is usually a mild illness. It primarily affects children from 2 to 10, but exposed adults may also develop the disease; *Infective endocarditis*, sepsis and septic shock [4] (Fig. 2d) are very serious systematic infections with high associated morbidity and mortality rates. Groups of risk [4] are people at the age of 30 to 40, elderly people with valve sclerosis and patients with intravascular prostheses; *Tinea of the hand* (Fig. 2e) [1] has the same appearance as the dry, diffuse, keratotic form of tinea on the soles.
4 Examples – Change of Papillary Line Structure and Skin Color

We can put the following diseases as examples of change of papillary line structure and skin color: *Hand eczema* [1][3] is an inflammation of the hands (Fig. 3a). Hand dermatitis is common in industrial occupations: it can threaten job security if inflammation cannot be controlled; *Pompholyx (dyshidrosis)* [1] is a distinctive reaction pattern of unknown etiology presenting as symmetric vesicular hand and foot dermatitis. Pustular *psoriasis* [8][3] (Fig. 3b) of the palms and soles may resemble pompholyx; *Psoriasis* (Fig. 3c) [3][4] is thought to be a hereditary disorder that requires an interplay of genetic and environmental factors for full clinical expression; *Raynaud’s phenomenon* (RP) [4] is digital ischemia that occurs on exposure to cold and/or as a result of emotional stress (Fig. 3d).

5 Summary

It is clear from each subsection that either the color of the skin or the structure of papillary lines on the fingertip could be influenced. If only the color has changed, some of optical fingerprint scanners might be influenced and so this change is not crucial. On the other hand, the change of skin structure is very significant, because if papillary lines are damaged, it is impossible to find the minutiae and therefore to recognize the person. If we are unable to recognize/enroll a person, then such person cannot use the biometric system based on the fingerprint recognition technology, and therefore the implementing company has a big problem – how to authorize such person, if they don’t want to use PINs (Personal Identification Numbers) or other authorization methods.
Some of these diseases are only temporary, i.e. after the healing of such disease, the papillary line structure or color is restored and the user is again able to use his/her fingers for the fingerprint recognition in authorization tasks in security systems. However, some diseases leave irrecoverable finger damage restraining a new growth of papillary lines and respective user is then unable to use his/her fingerprints for appropriate recognition tasks in automated fingerprint security systems.

Another problem regarding the papillary lines has been published in [11], where the influence of medicine Xeloda® (against cancer – see http://www.xeloda.com) is discussed that this has a destructive influence on papillary lines. Patients using this medicine are not able to be enrolled or verified in the biometric systems using fingerprint recognition. However, there are other drugs with possibly similar influence (where the occurrence of hand-and-foot syndrome has been described), e.g. Cytosar-U®, FUDR®, Idamycin® or Doxil®.

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