Liveness Detection using Fingerprint Pores

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***Abstract*— The demand for accurate and fast user identification and authentication has increased with the tremendous increase in the growth of electronic transactions. Distributed system such as the ATM systems require high level of security. The level of security has advanced from PIN (Personal Identification Number) to Smart Card to Biometrics. With the advance in security level, the fraudulent activities too have advanced to match with them. The uniqueness of a biometrics is that it has intrinsic features that does not change throughout the life time of and most suitable miniaturization. But recent studies on biometric systems have proved that they are not as foolproof as once thought. There are cheap and easily accessible materials available to fool or spoof the fingerprint authentication. To overcome these hacking activities, the proposed work is developed to provide protection to the biometric templates and to enhance the security in the ATM systems using liveliness detection in fingerprints.**

Keywords*— Liveness detection, fingerprint spoofing, ATM security, pores and ridges, biometric authentication

I. INTRODUCTION

The popular Biometric used to authenticate a person is fingerprint which is unique and permanent throughout the person life. Fingerprint Recognition or fingerprint authentication refers to the automated methods of verifying a match between two human fingerprints, The history of science, establishing distinctive fingerprint features traces back to 1872, when Galton first quantified the uniqueness of fingerprints by conducting a probabilistic analysis of minutiae pattern. In 1912, Locard studied the use of pores for identification (or poroscopy), and showed that 20 to 40 pores should be sufficient to establish human identity.

Fingerprint identification information is generally divided into three levels. Level 1 (pattern) is macro detail such as ridge flow and pattern type. Level 2 (points) is the Galton characteristics, or minutiae points, such as bifurcations and endings. Level 3 (shape) includes all dimensional attributes of a ridge, such as ridge path deviation, width, shape, pores, edge contour, incipient ridges, breaks, creases, scars, and other permanent details.

Statistical analysis has shown that Level 1 features, or fingerprint pattern, though not unique, are useful for classification purpose, while Level2 features, or points, have sufficient discriminating power to establish the individuality of fingerprints. FBI has set the standard for fingerprint resolution to be 500dpi for forensic applications in order to reliably extract Level 2 features. However, human examiners perform not only quantitative (Level 2) but also qualitative (Level 3) examination since Level 3 features are also permanent, immutable and unique.

They focused on pore-based Level 3 matching using fingerprint fragments, but the alignment of the template and query fragments is either manually determined or predefined. Unlike these studies, our system uses the entire fingerprint for matching. Both pores and ridge contours are automatically extracted and aligned using the algorithm.

Level 3 Feature Extraction: It must be noted that Level 1, 2 and 3 features are not independent within the domain of fingerprint authentication. For example, the distribution of pores is not random, but naturally follows the ridge structure. Therefore, in order to reliably extract Level 3 features, namely, pores and ridge contours, we propose the following feature extraction algorithm by combining wavelet transform and Gabor filter enhancement.

II. BACKGROUND STUDY

Fingerprints are widely used in daily life for more than 100 years due to its feasibility, distinctiveness, permanence, accuracy, reliability, and acceptability. A large number of approaches to fingerprint matching and various algorithm and methods are behind their matching procedure, Fingerprint based security systems are implemented for secure access at various levels. Level-3 features are often defined as the dimensional attributes of the ridges and include sweat pores, ridge contours, and ridge edge features, all of which provide quantitative data supporting more accurate and robust fingerprint recognition.

Several pore based methods were proposed for liveness detection. The procedures include extraction of the ridge endings and bifurcations from the skeleton image by examining the local neighbourhood of each ridge pixel using convolution [1] [2]; usage of adaptive pore model APM, time-series detection of perspiration and pores location [3] [4]; techniques to identify fingers with a dry skin and sweaty fingers and to determine the system performance of the sensor, i.e., to distinguish false acceptance rate and the false rejection rate [5].

In their work, Peter Johnson and Stephanie Schuckers, used pore centers as features and are identified by searching the ridge segments for local maxima in gray level, satisfying certain threshold criteria. The extracted features are classified as live or fake using a support vector machine (SVM) classifier with a radial basis function (RBF) kernel. [6]. A fast and accurate approach to detect pores for both ridge reconstruction and fingerprint matching them using DPF is proposed [7].

Several automated pore detection approach is proposed that includes dynamic anisotropic pore model, pattern recognition, estimating dominant ridge orientations and periods using ridge and pore maps [8][9][10] and fusion of finger print pore and minutia information to have better accuracy [11].

III. PROPOSED WORK

Liveness detection is an emerging challenge in the field of fingerprint biometrics. This paper describes a 'liveness detection' technique of detecting the pores in fingerprint. The new approach first take input image and apply wavelet response for that then apply Gabor filter to the input image separately after that for pore enhancement linearly combine wavelet image and Gabor filter image then finally apply thresholding for that image to detects the pores. After location of the pores, they are identified in the original images. Finally, pores are classified for fingerprint identification.

A. *Pore Detection: Algorithm*

- Pore positions often give high negative frequency response as intensity values change abruptly from white to black. In order to capture this sudden change, we apply the Haar wavelet transform to the original image, where s is the scale factor (= 1.32) and (a, b) is the shifting parameter. Essentially, this wavelet is a band pass filter with scale s. After normalizing the filter response (0-255) using min-max rule, pore regions that typically have high negative frequency response are represented by small blobs with low intensities. Since pores are naturally distributed along the ridge, it is important to also identify the ridges such that no points in the valley are mis-classified as pores.

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- The Haar filter output is obtained in the resolution of 512 X 512 and the image is resized accordingly.

- By simply adding the Resized wavelet response to the Gabor enhanced image, we obtain "Optimal" Enhancement of pores and ridges. This also removes open and closed pores and therefore this is Pore enhancement process.

- Finally, an empirically determined threshold (=58) is applied to extract pores with blob size less than 40 pixels.

IV. RESULTS AND DISCUSSION

The work is implemented in matlab using 72dpi fingerprint impressions.

We introduced two separate methods using wavelet transform and gabor filter to extract the pores. With this technique we were able to extract the pore by linear addition of wavelet and gabor filter images. By applying threshold to the obtained image in pore enhancement technique we were able to identify the pores present along the ridges in the form of binary image.

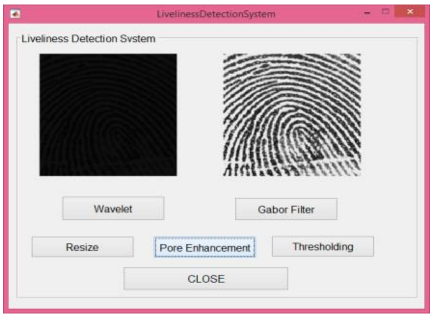
A. *Filtering using Haar wavelet S=2 ;* Pore positions gives high negative frequency response as intensity values that changes abruptly from white to black. In order to capture this sudden change in the frequency domain, we apply the Haar wavelet transform to the original image to obtain the frequency response w.

B. *Edge detection using gabor filter:* Since pores are naturally distributed along the ridge,to separate ridges from valleys we use the gabor filter ,2D Gabor filter which is a Gaussian kernel function in the spatial domain. From one parent wavelet all filters can be generated by dilation and rotation, thus the Gabor filters are self-similar. With eight different orientations of Gabor filter, features of the fingerprint are extracting and are combined.

C. *Resize Haar Image:* Resizing haar image is mandatory because linear addition for pore enhancement of haar wavelet image and gabor filter image should be in same size.

D. *Pore Enhancement:* In the pore enhancement we will add the wavelet response to the Gabor enhanced image, to obtain "optimal" enhancement of pores on the ridges. This procedure also removes the difference between open and closed pores and, therefore, simplifies the pore extraction process.

E. *Thresholding:* Thresholding is applied to the enhanced image with some threshold values, to extract pores and we can easily identify both closed pores and open pores.



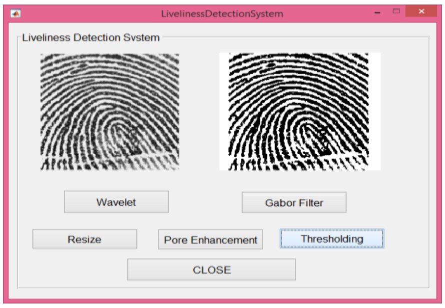


Fig. pore enhancement and thresholding stages

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