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Altered Fingerprint Detection Using Scar Feature

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Abstract : *This paper evaluates the use of scar feature for altered fingerprint detection. Scar is defined as absence of ridges and valleys in the fingerprint. The different fingerprint alteration processes like cutting and abrasion with blades and poring strong chemicals can produce the scar. In fact the scar is an important feature for alteration detection. Scar from altered fingerprint is detected by adaptive average filtering and thresholding. Feature vectors are created from detected scar and is fed into Support Vector Machine for alteration detection.*
Keywords - *Altered Fingerprints; Scar, Average filtering; Support Vector Mechine*

I. INTRODUCTION

Number of biometric traits is in use worldwide and selection of this trait depends on application. Over the last thirty years, fingerprint is the most widely used biometric trait for personal identification because of the fact that the pattern on fingerprint(FP) cannot change during the entire life time of the person [1]. One of the major threats to Fingerprint Automatic Identification System (AFIS) over the last few years is fake fingerprints and altered fingerprints. Fake fingerprints are made from glue or latex, on the other hand altered fingerprints are real fingerprints obtained by changing the ridge structure. The problem involving altered fingers falls under broader category of attacks known as biometric obfuscation. Obfuscation can be defined as a deliberate attempt by an individual to mask their identity from a biometric system by altering the biometric trait prior to its acquisition by the system [2]. By the subjective assessment of altered fingerprints, the alteration can be divided into three types. They are obliteration, distortion and imitation. Obliteration is performed by cutting, abrading, burning and poring strong chemicals into ridge pattern. Skin diseases are also obliterate the fingerprint. Obliteration is again divided into scar and mutilation. Fingerprint can be distorted by changing the ridge structure by plastic surgery, in which portions of skin are removed from the finger and grafted back in different positions. Imitation type of alteration is obtained by performing surgical procedure in such a way that the altered region looks like natural fingerprint..These surgeries may involve transplantation of large area of skin from other parts of body such as fingers, palms, toes and soles. It is very difficult to detect imitation type of alteration because of its similarity with natural fingerprints. In fact the imitation detection is one of the major challenges for the researchers working in these fields Figure 1 shows different types of altered fingerprint images. Different methods have been developed for fingerprint alteration detection by the analysis of ridge orientation field, minutiae distribution, reliability of ridge orientation, density of singular points [2] [3] [4] [5].

Proposed method utilizes scar for altered fingerprint detection. Adaptive average filtering is used to extract the scar feature. Average filtering is adaptive in the sense that the window size is changed with respect to dryness of the fingerprint. Thresholding is used to separate the scar form filtered image.

Rest of the paper is organized as follows. Proposed method starts from section 2. Section 3 explains scar extraction from altered fingerprint images. . Creation of feature vector and classification using SVM is given in 4. Results and discussion is given in 5 and conclusion is given in 6.

II. PROPOSED METHOD

Proposed method starts with the development of adaptive average filtering. The quality of fingerprint changes with the dryness of the fingers being scanned. The lack of moisture in the finger is the cause of dry fingerprint. This leads to broken ridges and valleys in the fingerprint image. Excess of moisture in the fingertip causes the wet images. The ridges and valleys in the wet images are not well separated. Figure 2 shows the wet, dry and good quality FP images. It is clear that ridges and valleys are not well separated in wet image while dry fp contains broken ridges and valleys. In fact first step in average filtering is to find the window size for dry, wet and good quality fingerprint image.

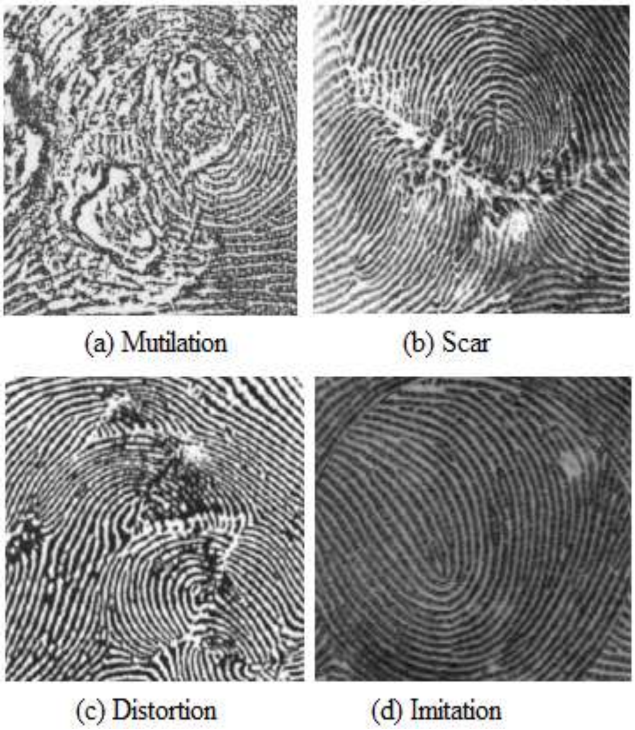


Fig.1. Different types of altered fingerprint images

a) Dry FP (b) wet FP (c) Normal FP

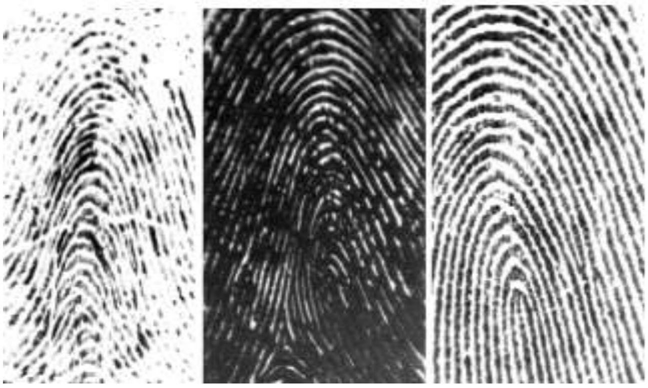


Fig 2. Different quality fingerprints

III. Selection of Window Size

After performing the segmentation of the FP image, the mean of the pixel intensity is found. The mean varies for dry, wet and good quality images. Pixel intensity mean for dry FP varies between 190 to 250 while for wet images, it lies in between 30 and 120. For good quality normal fingerprint images, the pixel intensity lies between 120 and 190.

IV. Analysis of SACR

Apart from the long cuts in the scar, the absence of ridges and valleys in a fingerprint is also known as scar. Scar is an important feature in scar type of obliteration. Other types of alteration except imaitation and highly mutilated fingerprint also consist of absence of ridges and valleys. Scars often appear along the cuts on the ridges and it gives important information about alteration. Scar is present in obliteration and distortion type of alteration. The scar in the distortion should span small amount of area than obliteration type of alteration.

Average filtering for scar detection is given in [6]. In this work, we made the filtering adaptive with respect to the dryness of the fingerprint Following steps are performed for scar detection.

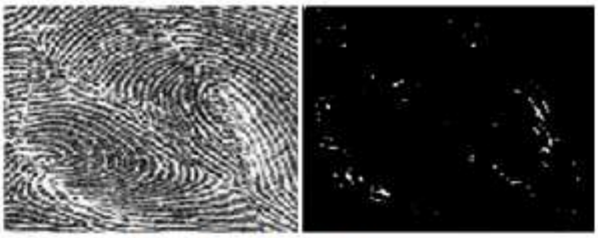
4.1. Histogram Equalization

The first step in the scar detection is the normalization of the fingerprint image so that it has a pre-specified mean and variance. This results in maximum span of the gray scale variation in the image, with the help of spreading of the histogram of the image across the entire spectrum. This is done by histogram equalization.

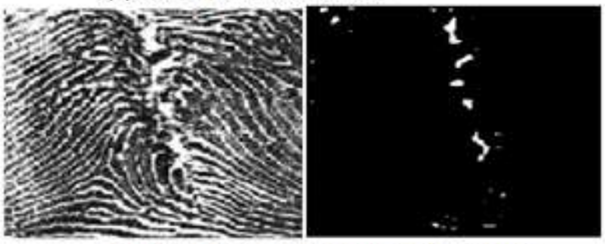
4.2. Adaptive Average Filtering

The averaging filter preserves the sharp edges in the image. Thus the image is convolved with average filter in the spatial domain to accentuate the present scars. The dryness on the fingerprint will affect the preservation of scars in the fingerprint. This difficulty is solved by changing the window size by setting a threshold for mean for the pixel intensity of the image. Thus the filter is adapted to the dryness of the fingerprint. We set a window size of 3×3, 5×5 and 7×7 for wet, normal and dry fingerprints respectively.

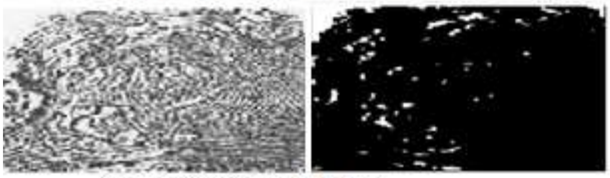
Fig.4 highly mutilated image and detected scar. Scar is not present.



(a) Scar from distortion



(b) Scar from scar type obliteration



(c) Scar form mutilation

4.3. Thresholding

Thresholding is used for segmenting the scars from the filtered fingerprint image. Figure 3 shows the segmented scars from the altered fingerprint images. It is clear from the figure that scars are present at the altered regions except imitation type. Scar is not present for highly mutilated type of alteration. This is shown in figure 4 below.

V. FEATURE EXTRACTION AND CLASSIFICATION

Support Vector machine is used for classification. SVMs basically based on supervised learning models in which it classifies a set of data into two classes based on training data set. The formulation of SVM uses Structural Risk Minimization (SRM) principle whereas Neural Networks (NNs) are based on traditional Empirical Risk Minimization (ERM). SVMs evolved from the sound theory to implementation and experiments while NNs are evolved from applications and experiments to theory [7]. SVM performs the classification task by constructing hyperplanes in multidimensional space that separates the cases of different class labels. The data for two class learning problem consists of objects labeled with one of the two labels corresponding to the two classes; +1 for positive class and -1 for negative classes [8].The feature vectors from scar image is constructed by local histograms in 3 × 3 cells. After combining all these features by concatenating local histograms in each cell is fed into SVM for classification [1].

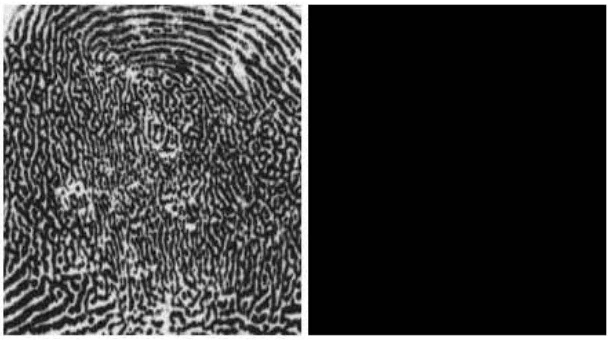


Fig.4 highly mutilated image and detected scar. Scar is not present.

VI. RESULTS AND DISCUSSIONS

A database of 60 altered fingerprint images consisting of all types of alteration obtained from NIST SD14 database is used for the experiments. Imitation type in the database is obtained by synthetic alteration. Normal fingerprint images are obtained from FVC 2004 database. By subjective assessment, all images are categorised into obliteration, distortion and imitation. Simulation is performed for all types of alteration. Scar is extracted from altered and normal fingerprint and local histograms are created from the extracted features. These histograms are concatenated to form feature vectors. Some of the images from the database are used for training the support vector machine. Finally the feature vectors are fed into SVM for classification. Table 1 shows the percentage of detection in terms of True Positive Rate (TPR) and False Positive Rate (FPR). Altered FP is taken as positive class. Then the detection of altered FP as altered one belongs to TPR and detection of normal FP as altered FP belongs to FPR.

TABLE 1. Altered FP detection

Item	TPR in %	FPR in %
Altered FP detection	93	30

VII. CONCLUSION

In this paper, we developed a method for detecting altered fingerprints by making use of absence of ridges and valleys known as Scars(S). This feature is extracted and constructed the feature vectors for feeding into SVM. Scar is detected by adaptive average filtering and thresholding. .From the results, it is concluded that FPR is high which reduces the performance of the method. In order to compensate this, more features are needed to use along with scar. Normal fingerprints sometimes have the natural scar. Thus there is a need of method for separating scar of altered fingerprint from that of natural fingerprints

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