System and Methods for Online Signature Verification on Mobile devices

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***Abstract* - Handwritten signature is the most widely accepted biometric to identity verification. In the proposed system five parameters are taken in to account. Features of the signature can be extracted using proposed feature extraction method. Corresponding to every signature a unique feature will be extracted and this will be quantized using quantization step size vector. Both the feature vector and quantization vector are to be stored using template generator. To verify the test signature Manhattan distance (score) will be taken between the test signature and the reference signature. If score is less than the predefined threshold then the test signature is said to be genuine signature and if score is more than the predefined threshold then it is said to be forged signature**.

***Keywords* - False Rejection Rate, equal error rate, signature verification system.**

I. Introduction

The term "biometrics" comes from the Greek words bio (life) and metric (to measure). Bioscience means that the automated identification of someone supported his/her physiological or behavioral characteristics. This methodology of verification is most popular over ancient ways involving passwords and PIN numbers for its accuracy and case sensitiveness. A biometric system is actually a pattern recognition system that makes a private identification by crucial the legitimacy of a particular physiological or behavioral characteristic possessed by the user. These characteristics square measure measurable and distinctive. These characteristics mustn't be consistent. A vital issue in coming up with a sensible system is to work out however a private is known. Reckoning on the context, a biometric system shown in Figure one will be either a verification (authentication) system or Associate in identification system.

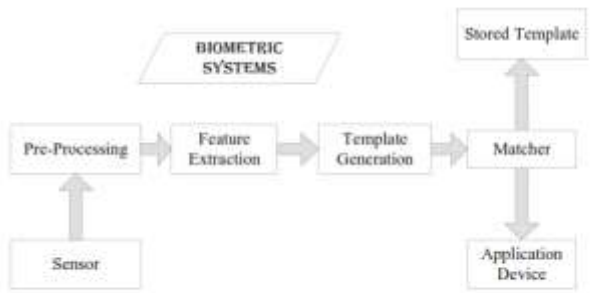

Figure 1. Biometric System

There is always a need for the reliable and efficient system for identity verification. Several biometric features have been studied and proved useful, including signature, fingerprint, face, speech, iris, and retina pattern. Among them handwritten signature verification method has been well accepted for a long time. Handwritten signature verification system comes under the research area of signal processing. There are two types of signature verification systems: offline and online systems. Before the development in the computer era we were using only the offline system but with the technological advancements man has developed the system of online verification. In an offline system , image of the signature of the user has to be acquired not the other features but in an online system, other features of the signature have to be acquired which are like x-y coordinates, pressure, number of strokes, altitude etc. Therefore we can say online system is more accurate and reliable than that of offline system. But on the other hand there is always a scope for the better results and also to compare the one method of feature extraction with the other. Hence there is still a lot more work can be done on this research topic.

Online signature verification system includes several steps: Signature input, Preprocessing, Feature extraction and matching (verification). Preprocessing is required to remove the fluctuations in the signing process. Feature extraction techniques are required to get the unique features of every signature and after that a unique feature vector is to be made. Here different feature extraction techniques can be used like histogram, discrete cosine transform, Fourier transform etc. In matching, score is to be finding out that is a threshold is to be predefined with which the input signature is to be verified with the reference (stored) signature. Matching techniques can be of different types like Manhattan distance, Euclidian distance etc.The performance of signature verification system is measured in terms of false rejection rate (FRR), false acceptance rate (FAR) and equal error rate (EER).

II. Literature survey

In this paper, **YasmineGuerbai** et al. [6] proposed the implementation on field-programmable gate arrays of associate degree embedded system for on-line signature verification. The proposed system consists of a vector floating-point unit, specifically designed for fast the floating-point computations concerned during this biometric modality.

Miguel A Ferrer et al. [12] proposed the signature verification system ought to extract the distinctive options of what has been signed. Essentially biometric authentication deals with characteristic someone whereas verification deals with police investigation whether or not the signature is real or forgery.

MandeepKaur et al. [8] proposed the One of the foremost evident effects of the quality of signature generation and implementation processes is that the great deal of non-public variability that may be measured in written signatures, even once dead by an equivalent signer.

In this paper, **Muhammad Reza** et al. [10] proposed the client-entropy live has been planned to cluster and characterize dynamic signatures in classes that may be associated with signature variability.

In this paper, **Srikanta pal** et al. [2] proposed the planned Multi-script offline signature identification within which the signatures of Bengali, Hindi and English are thought of for Identification method. In feature extraction stage gradient feature and Zernike moment feature are used.

In this paper, **MdAsraful** et al. [11] proposed the planned add that they need used one-class SVM for hand written signature verification. Usually bi-c1ass SVM are accustomed distinguish between real and solid signature.
D. Impedovo et al. [14] proposed the planned model to live gray level options hardiness once the signature is distorted by a fancy background and conjointly propose additional stable options. The set of various cheques and invoices with variable background quality is mixed with MCYT and GPDS signatures**.**

J. J. Igarza et al. [13] proposed the planned a method to extract the feature set from the pre-processed image. The feature set is extracted victimisation fusion of concentric squares having geometric options like variety of cross points, Euler's variety mass, final analysis angle, center of mass, zone primarily based slope and slope angle.

G. Pirlo et al. [7] features of foreground as well as back ground components. Zernike moment feature is also used for signature samples.

V. Di Lecce et al. [5] proposed the GPU-based SVM classifier. Our proposed approach is effective both in terms of the feature selection and also in the GPU based SVM classifier. We obtained excellent results on the identification of an individual's signature despite the fact that a generic classifier configuration is difficult to achieve.

G. Dimauro et al. [4] proposed the scope of biometric analysis; an important problem is to distinguish between genuine and forged signatures, which are a hard task. In this paper, a GPU based effective model selection methodology has been presented that contributes to circumvent this problem and a robust classifier capable of handling many different groups of features. The robustness brings a good trade-off between the False Positive Rate and False Discovery Rate while the computational cost is substantially reduced.

Srikanta Pal et al. [3] proposed the survey and an outline regarding the progressive of this biometric modality. Signature verification techniques are often roughly classified into 3 groups: guide, applied mathematics and structural matching. Guide matching techniques are supported an easy comparison between the options of a captured signature and a guide hold on in a very info.

NasirMemon [2] evolved a method that uses position similarly as pressure terms for secure guide that uses a mixture of 1D and 2nd histograms. A most a Posteriori Adaptation technique is employed here to enhance the results.

Mariano, et al. [9] approached to an additional real time implementation with the employment of techniques like GPU, embedded systems and alternative hardware's.

III. Methodology

To start with, the vectors X^1, Y^1, and P^1 including their derivatives are computed as follows,

$$X^1 = \{x^1_i | x^1_i = x_i + 1 - x_i\}, \quad (1a)$$

$$Y^1 = \{u^1_i | y^1_i = y_i + 1 - y_i\}, \quad (1b)$$

$$P^1 = \{p_i\}, \quad (1c)$$

And

$$X^k = \{x^k_i | x^k_i = x^{k-1}_{i+1} - x_i^{k-1}\}, \quad (1d)$$

$$Y^k = \{y^k_i | y^k_i = y^{k-1}_{i+1} - y_i^{k-1}\}, \quad (1e)$$

$$P^k = \{p^k_i | p^k_i = p^{k-1}_{i+1} - p_i^{k-1}\}, \quad (1f)$$

Where k > 1 and i = 1, 2, . . . , n − k.

Note that, by computing the differences between every pair of the successive points, the vectors X^1 and Y^1 capture location invariant features of signature. To repeat the process of taking the differences k times yields the k^{th} order derivative, X^k and Y^k , of original X and Y sequences respectively.

Then, a series of vectors V = {v_i∗ |i = 1, 2, . . . , n}, is generated where an each vector element, v_i∗ = {v_i^1 ∥ . . . ∥v^j_i } is a concatenation of v^k_i that is five-tuple containing the k^{th} order derivative of cartesian and polar coordinates and pressure attributes are following below:

$v^k_i= (x^k_i , y^k_i , r^k_i , \theta^k_i , p^k_i)$
Where $\theta^k_i = \tan^{-1} (y^k_i /x^k_i)$, $r^k_i = (x^k_i)^2 + (y^k_i)^2$ and i = 1, 2, . . . , n − k.

TABLE I: DESCRIPTIONS OF THE HISTOGRAMS THAT ARE USED IN PROPOSED TECHNIQUE

No.	Histogram	Input Attributes	Min	Max	Number of bins	Output Attributes
1	Φ^1	$\{\theta^1_1,\ldots,\theta^1_n\}$	$-\pi$	π	16	Relative frequency
2	Φ^2	$\{\theta^2_1,\ldots,\theta^2_n\}$	$-\pi$	π	24	Relative frequency
3	$<\Phi^1, \Phi^1_{\theta(1,3)}>$	$\{\theta^1_1,\ldots,\theta^1_{n-1},\theta^1_2,\ldots,\theta^1_{n-2}\}$,	$-\pi$	π	8	Absolute frequency
		$\{\theta^1_1,\ldots,\theta^1_n,\theta^1_2,\ldots,\theta^1_n\}$	$-\pi$	π	8	
4	R^1	$\{r^1_1,\ldots,r^1_n\}$	0	$\mu+3\sigma$	16	Absolute frequency
5	R^2	$\{r^2_1,\ldots,r^2_n\}$	0	$\mu+3\sigma$	16	Absolute frequency
6	X^1	$\{x^1_1,\ldots,x^1_n\}$	$\mu-3\sigma$	$\mu+3\sigma$	8	Relative frequency
7	Y^1	$\{y^1_1,\ldots,y^1_n\}$	$\mu-3\sigma$	$\mu+3\sigma$	8	Relative frequency
8	X^2	$\{x^2_1,\ldots,x^2_n\}$	$\mu-3\sigma$	$\mu+3\sigma$	8	Relative frequency
9	Y^2	$\{y^2_1,\ldots,y^2_n\}$	$\mu-3\sigma$	$\mu+3\sigma$	8	Relative frequency
10	$<X^1, X^2>$	$\{x^1_1,\ldots,x^1_n\}$	$\mu-3\sigma$	$\mu+3\sigma$	6	Relative frequency
		$\{x^2_1,\ldots,x^2_n\}$	$\mu-3\sigma$	$\mu+3\sigma$	4	
11	$<Y^1, Y^2>$	$\{y^1_1,\ldots,y^1_n\}$	$\mu-3\sigma$	$\mu+3\sigma$	6	Relative frequency
		$\{y^2_1,\ldots,y^2_n\}$	$\mu-3\sigma$	$\mu+3\sigma$	4	
12	$<\Phi^1, R^1>_{(1)}$	$\{\theta^1_1,\ldots,\theta^1_{\lfloor n/2\rfloor}\}$,	$-\pi$	π	8	Relative frequency
		$\{r^1_1,\ldots,r^1_{\lfloor n/2\rfloor}\}$	0	$\mu+3\sigma$	4	
	$<\Phi^1, R^1>_{(2)}$	$\{\theta^1_{\lfloor n/2\rfloor},\ldots,\theta^1_n\}$,	$-\pi$	π	8	Relative frequency
		$\{r^1_{\lfloor n/2\rfloor},\ldots,r^1_n\}$	0	$\mu+3\sigma$	4	
13	$<\Phi^2, R^2>_{(1)}$	$\{\theta^2_1,\ldots,\theta^2_{\lfloor n/2\rfloor}\}$,	$-\pi$	π	8	Relative frequency
		$\{r^2_1,\ldots,r^2_{\lfloor n/2\rfloor}\}$	0	$\mu+3\sigma$	4	
	$<\Phi^2, R^2>_{(2)}$	$\{\theta^2_{\lfloor n/2\rfloor},\ldots,\theta^2_n\}$,	$-\pi$	π	8	Relative frequency
		$\{r^2_{\lfloor n/2\rfloor},\ldots,r^2_n\}$	0	$\mu+3\sigma$	4	
14	$<\Phi^1, R^2>_{(1)}$	$\{\theta^1_1,\ldots,\theta^1_{\lfloor n/2\rfloor}\}$,	$-\pi$	π	8	Relative frequency
		$\{r^2_1,\ldots,r^2_{\lfloor n/2\rfloor}\}$	0	$\mu+3\sigma$	4	
	$<\Phi^1, R^2>_{(2)}$	$\{\theta^1_{\lfloor n/2\rfloor},\ldots,\theta^1_n\}$,	$-\pi$	π	8	Relative frequency
		$\{r^2_{\lfloor n/2\rfloor},\ldots,r^2_n\}$	0	$\mu+3\sigma$	4	
15	$P^1_{(1)}$	$\{p^1_1,\ldots,p^1_{\lfloor n/2\rfloor}\}$	0	$\mu+3\sigma$	8	Absolute frequency
	$P^1_{(2)}$	$\{p^1_{\lfloor n/2\rfloor},\ldots,p^1_n\}$	0	$\mu+3\sigma$	8	Absolute frequency
16	$P^2_{(1)}$	$\{p^2_1,\ldots,p^2_{\lfloor n/2\rfloor}\}$	$\mu-3\sigma$	$\mu+3\sigma$	8	Relative frequency
	$P^2_{(2)}$	$\{p^2_{\lfloor n/2\rfloor},\ldots,p^2_n\}$	$\mu-3\sigma$	$\mu+3\sigma$	8	Relative frequency

IV. Conclusion

In evaluating the performance of a signature verification system, there are two important factors: the False Rejection Rate (FRR) of genuine signatures and the False Acceptance Rate (FAR) of forgery signatures. As these two errors are inversely related, the equal error rate (EER) where FAR equals FRR are often reported. A more comprehensive information is the Receiver Operating Characteristic (ROC) curve of the system, which is obtained by plotting FRR vs. FAR, while changing the acceptance threshold used to discriminate between genuine & forgery signatures.

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