OFFLINE AND ONLINE SIGNATURE VERIFICATION SYSTEMS: A SURVEY

Yogesh V.G.¹, Abhijit Patil²

¹Assistant Professor, Department of MCA, BKIT Bhalki, Karnataka, India ²Assistant Professor, Department of Computer Science, KASC Bidar, Karnataka, India

Abstract

In recent years, due to the extraordinary diffusion of the internet in our daily life and simultaneously growing need of personal verification in many daily applications has driven signature verification system as an important aspect. This paper presents the survey about the offline & online signature verification system. Feature extraction stage is the most important stage in both online & off-line signature verification. The successful implementation of any such verification system depends mainly on how effectively the features have been extracted & used for classification. The robust features yield a successful verification system. Hence, in this paper, we are focusing on to put up with various feature extraction techniques & classifiers employed by various authors to attempt signature verification system. This paper summarizes different techniques used in signature verification system with their merits and demerits.

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Keywords: offline, online, signature verification.

1. INTRODUCTION

In the past few decades the technology is rapidly growing at a very fast pace. Due to the advent of computers & internet lot of transactions are going online as well as offline. The increase in number of transactions is the boon of this latest cutting edge technology that can be done at a mind boggling speed.

The technology has increased the convenience but at the same time security is at the stake, lot of false transactions are going around because of forgeries done by some anti-social elements which is leading to huge financial loss to the concerned person & to the society as a whole. We need some mechanism by which we can verify that the concerned transaction is genuine & not the forged one.

One useful methodology is the biometric system. It is used to confirm & verify the identity of the concerned user. Biometric are of two types 1) Physical 2) behavioral. In physical biometric individual person's iris, palm, thumb impression can be used to recognize & verify the individual. Whereas the behavioral biometric could be signature, voice etc. However, if a single biometric of an individual is under study, then it is referred as unimodal biometrics. if more than one biometrics of an individual is used for verification is called as multimodal biometric. In unimodal biometric systems there exists number of problems such as noisy data, spoof attacks, restricted degrees of freedom, intra-class variations, non-universality, and unacceptable error rates. Multimodal biometric system that integrates the evidence presented by multiple sources of information of an individual and it is an alternative to overcome some of the limitations of the unimodal. There are number of algorithms have been presented on multimodal and uinimodal biometrics to deal the authenticity of an individual. However, in this paper, we

consolidated the gist of unimodal algorithms and their performance in signature verification system. Signature is an ultimate biometrics to authenticate an individual. The signatures are used in cheques, legal transactions etc to determine the individual identity. The legalization of any document takes place by putting a signature on it. This problem can be dealt in two ways:

- 1) Online signature verification
- 2) Offline signature verification

In some transactions online signatures are used where the user is provided with a pen based tablet. The user has to do his signature on that tablet then that signature will be recorded in the system/computer. Signature trajectory, pen pressure, pen downs & pen ups will be captured by the tablet & sent to the system/computer. Then it will verify with the database whether it is genuine or forged one.

On the other hand offline signature is the one which can be obtained by signing on the simple paper & then scanning it to the computer. Now the system will judge whether it is a genuine or forged one. Offline signature does not require any specific hardware whereas online signatures require a lot of hardware & software to determine genuineness.

As a rule it is impossible to know in advance which of the approaches is novel. In this paper, we have done a survey on the various methods used in offline & online signature verification with its accuracies.

1.1 Signature Characteristics

A signature is handwritten graphical representation which is used to authenticate individuality. Signature of a person may vary according to his mood, health etc. Even the genuine signer may not replicate his own signature as it is, some minor change will be there. Hence, it is difficult to distinguish that whether signature is genuine or forged one.

A person's signature often changes depending on some elements such as mood, fatigue, time etc. Great inconsistency can even be observed in signatures according to their country, habits, psychological or mental state, physical and practical conditions.

Signatures can be treated as an image because a person may use any symbol, line, Curve & letter or group of letters as a signature Shown in fig1. Hence it is a perfect candidate for image processing & pattern recognition.



Fig.1. A sample of signatures

2 METHODOLOGIES

The methodology employed for offline and online signature verification is depicted in Figure 2. The methodology involves signature acquisition, pre-processing, feature extraction and comparison with an enrolled signature template as a knowledge base to draw the decision between genuine and forged one. Each steps of the methodology is explained in the following Subsections.

2.1 Image Acquisition

Signature image acquisition is a crucial stage of any recognition system. The resolution, skew and isolated components of signature makes the problem more complex.

2.2 Pre-Processing (Noise Removal)

This involves Normalizing, Converting a grey scale image to a binary image or its vice-versa, removing of spurious pixels (noise) etc.

2.3 Feature Extraction

Features can be classified in to two types global & local. Global features describe the signature as a whole for ex: width & height of signature, width to height ratio. Local features are confined to a limited portion of the image/signature for ex: a grid of the signature.



Fig 2: signature verification system

Table -1: Different approaches used in offline sign	nature
verification	

Features	Classifiers	Dataset	Accurac
Random Transform & Fractal Dimension [1]	SVM	SVC- 2004	
Curve let Transform, edge detection, Hough Transform, [2]	Modular Neural Network(MNN)wi th Mandeni Fuzzy Inference System, Artificial Neural Network	Used 270 Images 210- Trannin g 60- Testing	96%
Projection &Local point ensity,COG, Spatial Frequency Distribution [4]	Euclidean Distance ,Least Square Error	100 Image	-
Statistical Analysis Using Chi- Square Test [6]	PSO –NN Algorithm Probability	GPDS	78%
Projection &Local point Density, COG, Spatial Frequency Distribution [3]	Feature Vector, Correlation, Mean & deviation	-	-
Radon Transformation Fractal Dimension With Kart method[5]	SVM Based on (SRM), SVM 3 kernels	SVC 2004	92.2% of FAR 10% of FRR
Interpolation Using NN	KNN, Learning Vector Quantization, Euclidean Distance Metric	945 Signs	94%
Energy method ,Directional Feature Method ,Chain Code used as a Directional Feature [8]	Neural Network	100 signs 50forge d 50 genuine	
Global & Local features, Distance Matrices ,Geometric Normalization [9]	Euclidean Distance, Gaussian Empirical Rule, CMC curve	5400 Signs	97.17%

Static Image	Euclidean	160Sign	FAR is
Processing,	Distance	s	1%
Novel Feature		80	FRR is
Extraction [10]		genuine	0.5%
		80	
		Skilled	
		forged	
Grid Features,	KNN Classifier,	600	FAR is
Global Features	Neural	sign	4.16
[11]	Network(NN)		FRR is
			7.51%
Binary Feature	Automatic		92% on
Vector ,	Classifier &	CEDA	CEDAR
Gradient	Manual Classifier	R &	,
Direction		GPDS	87% on
Extraction,			GPDS
Aquinas Spatial			
Pyramid [14]			
Discrete Wavelet	Registration by	90 sign	92.2%
Transformation,	finding COG &	-	
Image	with		
Registration ,	Euclidean		
Image Fusion	Distance		
[12]			
Graph	Euclidean		-
Matching(Biparti	Distance,		
te Graph),	Cross Validation,		
Radon	HMM ,		
Transformation	Hungarian		
[13]	Method		

Vigorous research has been pursued in signature verification System for a number of years. In the area of Signature verification, especially offline Signature verification, different technologies have been used and still the area is to be explored. The techniques used by different researchers differ in the type of features extracted, the training and testing methods used, and classification, verification model used.

2.4 Comparison/Classification:

This is based on an algorithm which is capable of deciding whether to accept or reject the Signature which is under test. False Acceptance Rate :the probability that the system incorrectly matches the input pattern to a non-matching template in the database. It measures the percent of invalid inputs which are incorrectly accepted. In case of similarity scale, if the person is an imposter in reality, but the matching score is higher than the threshold, then he is treated as genuine.

False Rejection Rate: the probability that the system fails to detect a match between the input pattern and a matching template in the database. It measures the percentage of valid inputs which are incorrectly rejected.

Table 1 depicts the different approaches used in offline sign verification along with its accuracy.

Table 2 depicts the different approaches used in online sign verification along with its accuracy

 Table -2: Different approaches used in online signature verification

Features & Classifiers	Dataset Users/Sig	Accuracy
BPNN,	SVC 2004	FRR=0.3
Probabilistic model &		FAR=0.5
Fusion [15]		
Dynamic time warping	SVC 2004	FRR=5.5
[16]		FAR=4.13
Support Vector	SVC 2004	ERR 6.84
Machines Based on		
LCSS Kernel		
Function[17]		
Neural Networks	20/600	FRR=21.5
Classifiers & Fuzzy		FAR=3.5,
Inference[24]		FRR=3.5
		FAR=0.0
HMM/ANN[18]	MCYT	ERR 0.12
PWC ,HMM [20]	MCYT	EER 6.67
		EER 2.12
Bp ANN	150	FRR:1.8
		FAR: 2
Bayes classifiers [22]	94/1247	FRR:2.19
		FAR: 3.5
	2/120	FRR:6.67
		FAR:0.0
	40/1440	FRR:9.94
HMM [21]		FAR:0.5
	2/1100	FRR:11.3
		FAR:2.0
String Matching [20]	102/1232	FRR:2.8
		FAR:1.6
PDF Classifiers [19]	5/25	FAR:5

3. OUR FUTURE WORK

As we could observe, despite the vast amount of work performed thus far for offline & online signature verification, there are still many challenges in this research area. Signatures may be written in different languages and we need to undertake a systematic study on this. One problem of this area is, for security reasons, it is not easy to get a signature dataset of real signatures (such as banking documents) available to the signature verification system. Publicly availability of signature datasets of real documents would make it possible to define a common experimentation protocol in order to perform comparative studies in this field. Researchers have used different features for signature verification. Combination of different classifiers as well as novel classifiers should be explored in future work to enhance performance.

4. CONCLUSIONS

According to our study, in the learning process & in the training process of the system there is still room for the enhancement of the result. As the above described study shows that the algorithm which is used to analyze complex strokes of the signatures is still not satisfying. There is still further scope of improvement. Accordingly in this survey we noted that all the published work is based on foreground information. A combination of background and foreground information may be considered for better results in the future.

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