International Journal on Emerging Technologies (Special Issue on NCRIET-2015) **6**(2): 63-67(2015)

ISSN No. (Print) : 0975-8364
ISSN No. (Online) : 2249-3255

Online Signature Verification Systems: A Survey

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(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: In recent years, due to the astonishing growth of the internet in our life and parallel growing need of personal verification in many web applications has driven signature verification system as an important aspect. This paper presents the survey about the online signature verification system. Feature extraction stage is the most important stage in any signature verification system. The successful implementation of any such verification system depends mainly on how effectively the features have been extracted & used for classification. Hence, in this paper, I am focusing on various feature extraction techniques & classifiers employed by various authors for signature verification system. The performance is also measured using FAR & FRR. This paper summarizes different techniques used in online signature verification system with their merits and demerits. This survey will pave way for the budding research aspirants for the new avenues.

Keywords: online, signature verification.

I. INTRODUCTION

In the past few decades the technology is rapidly growing at a very high speed. 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 hackers which is leading to huge loss to the concerned person & to the society as a whole. We need some mechanism by which we can verify that the concerned transaction & the person is genuine & not the forged one.

One useful methodology is the biometric system. The main benefit of using a biometrics is that it can't be easily , stolen, hacked, or forged 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 then it is called as multimodal biometric.

In unimodal biometric systems there exists number of problems such as noisy data, spoof attacks, restricted degrees of freedom, 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 that have been presented on multimodal and unimodal biometrics to deal the authenticity of an individual. However, in this paper, I have consolidated the general picture of unimodal algorithms and their performance in signature verification system. Signature is one of the 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/scanned in the computer. Signature trajectory, pen pressure, pen downs & pen ups will be captured by the tablet & sent to the 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 I am here focusing on various feature extraction techniques & classifiers employed by various authors for signature verification system. The performance is also measured using FAR & FRR.

A. 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.

The challenge associated specially with online signature verification system is the signing relies on a practiced, and repeatable motion. But, this motion may change over time, either due to age or illness thus generating another different signature.

The signatures signed with a different digitize pen and unfamiliar signing surface may also affect the consistency of replicating the similar signature.

II. 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.

A. Image acquisition

Online signature verification uses the signature which is captured by data acquisition devices like pressure sensitive tablet. Signature acquisition is a crucial stage of any recognition system. Commonly used data acquisition device is a digitizing tablet and digitize pen.

B. Pre-processing (Noise removal)

After signature acquisition, preprocessing steps are performed to improve the performance of the verification system. There are commonly three stages in the Pre-processing step namely:

1) **Smoothing.** Low resolution tablet suffer from discretization errors, resulting in jagged signature trajectories. Extracting local features from jagged signature trajectories and then using them for verification lead to poor performance. Hence, smoothing is required for low resolution tablets.

2) Normalization. Signature size normalization is frequently used as preprocessing technique. Comparing two signatures with the same shape but with different sizes would result in low similarity . Hence size normalization is applied to remove this effect.

3) Segmentation

Segmentation is an important preprocessing step, which influences all the successive phases of signature verification system. Signature segmentation is a complex task since different signatures produced by the same signer can differ from one another. Therefore utmost care should be taken while doing segmentation.

C. Feature Extraction

The efficiency of a signature verification system mainly depends on how efficiently the features have been extracted. Feature extraction techniques should be fast and easy to compute so that system has low turn around time & high response time.Features should be selected in such a manner that it should discriminate between genuine and forged signature.

There are two types of features that validate a signature namely:

Static features: These are extracted from signatures that are recorded as an image.

Dynamic features: These are extracted from signatures that are acquired in real time which provides the information about the number, order of strokes, the overall speed of the signature, the pen pressure at each point, pen downs & pen ups *etc.*
Features can be classified in to two types:
1) Global Features
2) Local Features

1) Global Features: These features describe the signature as a whole for ex: width & height of signature, width to height ratio.
2) Local features are confined to a limited portion of the signature for ex: a grid of the signature.
Based on the extracted features, local features can be divided into component-oriented parameters, which are extracted at the level of each component (i.e., height to width ratio of the stroke, relative positions of the strokes, stroke orientation, *etc.*), and pixel-oriented parameters, which are extracted at pixel level (i.e., grid-based information, pixel density, gray level intensity, texture etc).

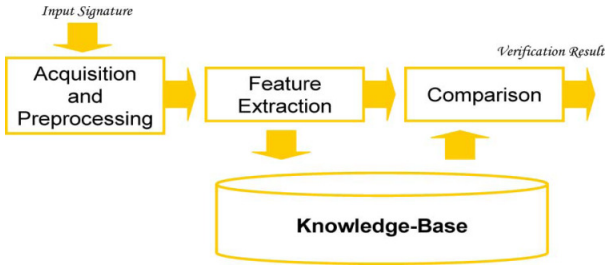

Fig. 2. Signature verification.

Vigorous research has been pursued in signature verification System for a number of years. In the area of Signature verification, especially online 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.

D. 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 percentage 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. *In a nutshell it is the percentage of the forgery signatures accepted 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. *In a nutshell it is the percentage of genuine signatures rejected as forgery*

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

Table 1: Different approaches used in online signature verification.

Features & Classifiers	Dataset Users/Sig	Accuracy
BPNN, Probabilistic model & Fusion [15]	SVC 2004	FRR=0.3 FAR=0.5
Dynamic time warping [16]	SVC 2004	FRR=5.5 FAR=4.13
Support Vector Machines Based on LCSS Kernel Function[17]	SVC 2004	ERR 6.84
Neural Networks Classifiers & Fuzzy Inference[24]	20/600	FRR=21.5 FAR=3.5, 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
HMM [21]	2/120	FRR:6.67 FAR:0.0
	40/1440	FRR:9.94 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

III. FUTURE WORK

As we could observe, despite the vast amount of work performed thus far for online signature verification, there are still many challenges in this research area. Signatures may be written in different languages & in different mood. Hence 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.

IV. CONCLUSION

According to my study, a person's signatures often change during their life due to age, illness and up to some extent the mood of the person. This makes it difficult for the researcher to achieve a better performance of the system.

In the learning process & in the training process lot of good work has been done but still there is a room for the enhancement of the result.

Lot of good work has been done in feature extraction & segmentation but still there is a room for improvements in these areas

The algorithm which is used to analyze complex strokes of the signatures is still not satisfying. There is still further scope of improvement.

REFERENCES

[1] K. N. Pushpalatha, Aravind Kumar Gautham, D. R.S Hashikumar, K. B. Shiva Kumar, and Rupam Das "Offline Signature Verification with Random and Skilled Forgery Detection Using Polar Domain Features and Multi Stage Classification-Regression Model", *International Journal of Advanced Science and Technology,* Vol. **59**, (2013), pp.27-40 . [2]. Omid Mirzaei , Hassan Irani and Hamid Reza Pourreza "Offline Signature Recognition using Modular Neural Networks with Fuzzy Response Integration", *2011 International Conference on Network and Electronics Engineering, IPCSIT* vol.**11** (2011) © (2011) IACSIT Press, Singapore.

[3]. Khamael Abbas, Al-Dulaimi "Handwritten Signature Verification Technique Based on Extract Features", *International Journal of Computer Applications (0975 – 8887),* Volume **30**– No.2, September 2011.

[4]. Priya Metri, Ashwinder Kaur, "Handwritten Signature Verification using Instance Based Learning", *International Journal of Computer Trends and Technology*- March to April Issue 2011.

[5]. Mehdi Radmehr, Seyed Mahmoud Anisheh, Mohsen Nikpour, Abbas Yaseri, "Designing an Offline Method for Signature Recognition", *World Applied Sciences Journal* **13**(3): 438-443, 2011,ISSN 1818-4952,© IDOSI Publications, 2011.

[6]. M Taylan Das, Canan Dulger, H. Ergin Dulger, "Offline signature Verification (SV) using the Chi-square statistics", *International Journal of Biometrics*, Volume **3** Issue 1, December 2011,Pages 2-12.

[7] Srikanta Pal, Michael Blumenstein, Umapada Pal," Automatic Off-Line Signature Verification Systems: A Review", *IJCA Proceedings on International Conference and workshop on Emerging Trends in Technology (ICWET*), (**14**): 20-27, 2011.

[8]. Minal Tomar and Pratibha Singh, "A Directional Feature with Energy based Offline Signature Verification Network", International Journal on Soft Computing (IJSC), Vol.2, No.1, February 2011.

[9]. Dakshina Ranjan Kisku, Phalguni Gupta, Jamuna Kanta Sing, "Offline Signature Identification by Fusion of Multiple Classifiers using Statistical Learning Theory", *International Journal of Security and Its Applications,* Vol. **4**, No. 3, July, 2010.

[10]. Dr. Daramola Samuel, Prof. Ibiyemi Samuel, "Novel Feature Extraction Technique For Off-line Signature Verification System", *International Journal of Engineering Science and Technology* Vol. **2**(7), 2010, 3137-3143.

[11]. Shashi Kumar D. R, K. B. Raja, R. K. Chhotaray, Pattanaik Sabyasachi," Off- line Signature Verification Based on Fusion of Grid and Global Features Using Neural Networks", *International Journal of Engineering Science & Technology,* vol. **2**(12), 2010, 7035-7044.

[12]. Samaneh Ghandali,Mohsen Ebrahimi Moghaddam,"Off-Line Persian Signature Identification and Verification Based on Image Registration & Fusion", *Journal of Multimedia*, Vol. **4**, No 3, (2009), 137,144, Jun 09.

[13] Ramachandra A C, Ravi J, K B Raja,Venugopal K R And L.M Patnaik,"Signature Verification using Graph Matching and Cross-Validation Principle", *International Journal of Recent Trends in Engineering*, Vol. **1**, No. 1, May 2009.

[14] Larkins, Mayo M.,"Adaptive Feature Thresholding for off-line signature verification", Image and Vision Computing New Zealand, 2008. IVCNZ 2008, 23rd International Conference, page no:1-6.

[15] Dr.Mohammed J. Alhaddad", Multiple Classifiers to verify the Online Signature", *World of Computer Science and Information Technology Journal* (WCSIT), ISSN: 2221- 0741 Vol. **2**, No. 2, 46-50, 2012.

[16] Ahmed Galib Reza,Hyotaek Lim & Md Jahangir Alam, "An Efficient Online Signature Verification Scheme Using Dynamic Programming Of String Matching", **ICHIT 2011, LNCS 6935**, pp.590- 597, 2011.

[17] Gruber C, Gruber T, Krinninger S, Sick B. "Online Signature Verification With Support Vector Machines Based on LCSS Kernel Functions", Published in: Systems, Man, and Cybernetics, Part B: Cybernetics, IEEE Transactions on (Volume:**40** , Issue:4), Biometrics Compendium, IEEE, Publication Year:2010, Page(s): 1088 – 1100.

[18] Zhong-Hua Quan**,** De-Shuang Huang, Kun-Hong Liu, Kwok-Wing Chau, "A Hybrid HMM/ANN Based Approach for Online Signature Verification", Published in:, Neural Networks, IJCNN 2007, page no 402- 405.

[19] Kiran, G.V., Kunte, R.S.R., Samuel, S. "On-line signature verification system using probabilisti feature modeling", Published in: *Signal Processing and its Applications, Sixth International, Symposium on 2001* (Volume:**1**), page no:355.

[20] A.K Jain, F.D Griess, & S.D. Connell," Online Signature Verification", Pattern Recognition, **35**(2002)2963- 2972.

[21] Mingfu Zou , Jianjun Tong , Changping Liu, Zhengliang Lou "On-line signature verification using local shape analysis" , Published in: Document Analysis and Recognition, 2003. Proceedings,page no:314-318,vol. 1.

[22] Alisher Kholmatov, Berrin Yanikoglu "Biometric Authentication Using Online Signatures ", In Proc. ISCIS, Springer LNCS-3280 (2004) 373– 380.

[23] Julian Fierrez Aguilar, Loris Nanni, Jaime Lopez "An OnLine Signature Verification System Based on Fusion of Local and Global Information", T. Kanade, A. Jain, and N.K. Ratha (Eds.): AVBPA 2005, LNCS 3546, pp. 523–532, 2005, Springer-Verlag Berlin Heidelberg 2005.

[24] M. Khalid, Hamam Mokayed, R.Yusof and Osamu Ono, "Online Signature Verification with Neural Networks Classifier and Fuzzy Inference", *Third Asia International Conference on Modelling & Simulation,* 2009, AMS09, page no: 236-241.

[25] Yogesh VG & Abhijit P.Offline and Online Signature Verification Systems: A survey *International Journal of Research in Engineering & Technology (IJRET)*2319-1163

[26] .Dr L. Basvaraj, Pratibha M K Online handwritten signature verification system: A Review *"International Journal of Emerging Trends & Technology in Computer Science*" (IJETTCS).