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HANDWRITTEN SIGNATURE VERIFICATION SYSTEM TECHNIQUES – A REVIEW

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ABSTRACT

A Signature, being a behavioural biometric, is characterised by behavioural trait that a writer learns and acquires over a period of time and shows unique identity of the person. In today's world, where forgery is monotonously increasing, fake signatures share the lion's part. A huge increase in forgery cases relative to signature leads to the need of efficient signature verification system. These systems can be online or offline depending upon the type of input taken by the system. This paper explains the significance of offline signature verification system and presents the survey of various approaches being followed in different areas.

1. INTRODUCTION

Nowadays, unique features of biometric identification method have led to its fast growth. Many routine activities such as boarding an aircraft, crossing international borders and entering a secure physical location, banking etc. requires reliable authentication and authorisation. A handwritten signature, being a biometric feature, is well accepted as a convenient mean of authorisation and identification. It is preferred among various biometrics for identifying an individual in daily operations such as automated banking transaction, electronic fund transfers, document analysis and access control. It plays an important role in preventing unauthorised access of the data. The goal of biometric verification is to achieve higher security levels with easier user interaction. Biometrics can be classified into two main categories i.e. Behavioural and Physiological

a. **Physiological features:-** This includes detection of various physiological features such as face, fingerprint, iris, ear, palm, retina, hand, DNA etc. Most of these are stable over time.
b. **Behavioural features:-**This includes detection of various behavioural features such as speaking, handwriting and signatures. These features change over time due to age and other factors.

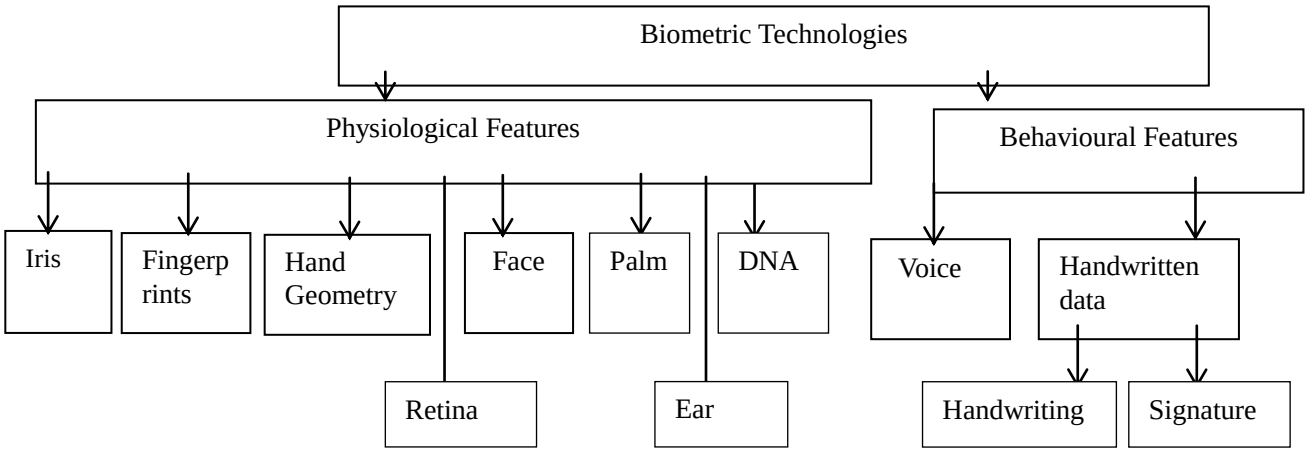

Fig1. Block diagram of various biometric technologies

Handwritten signature shows higher intra-class and time variability as compared to physical traits. Some signatures might be similar but there are many scientific methods to differentiate between them and to detect forged ones. There are three types of forgeries in signature verification system which are as follows:

Random Forgery: - The signer uses the name of the victim in his own style to create a forgery known as random forgery. This can be easily detected with the naked eye.

Simple Forgery:- In this type, signer copy the signature in his own style without any knowledge of the spelling and does not have any previous experience

Skilled Forgery:- It is the most difficult of all forgeries, created by professional imposters who have experience in copying the signature. These cannot be detected with naked eye, so verification techniques are required for forgery detection.

So, there is a need of signature verification system which not only identifies the original signatory but also tells the genuineness of signature. The system should be non-responsive to intra-personal variations, while being responsive to interpersonal ones. Handwritten signature verification system is categorised into two types i.e. online system and offline system.

Online Signature Verification System uses electronic device for signature acquisition and many dynamic features are extracted such as signature speed, pen pressure & inclination at each point, number of strokes etc. to check the authenticity of signature.

Offline Signature Verification System uses static images taken either from camera or from scanner. Offline verification system performs four basic operations for acquisition and matching of signatures: - signature acquisition, pre-processing, feature extraction & signature verification.

QUALITY PERFORMANCE MEASURES

For Handwritten Signature Verification, four quality performance parameters need to be calculated. These are false rejection rate (FRR) , false acceptance rate(FAR) , equal error rate (ERR) and average error rate (AER).

False Rejection Rate:- The FRR is the ratio of the genuine test signatures rejected to the total number of genuine test signatures submitted .It is also called as type I error.

FRR = total number of genuine test signatures rejected / total number of genuine test signatures submitted

False Acceptance Rate:- The FAR is the ratio of number of the forgeries accepted to the total number of forgeries submitted. It is also called type II error and is defined as,

FAR = total number of forgeries accepted / total number of forgeries submitted

Average Error Rate:- The average of FAR and FRR is called AER.

Equal Error Rate:- When the value of false acceptance rate and false rejection rate is equal, then the common value is referred to as the equal error rate. It is called as type III error.

TYPES OF FEATURES

The choice of features is the most important task in the recognition process. Features must be selected according to the type of the classifier being used. Signature features are categorised into two types:-

Global Features: -Global features describes the signature image as a whole like length , width , height , area , aspect ratio , density , centroid , number of edge points .The global features are less sensitive to noise and signature variations . So, in order to get high accuracy for detecting skilled forgeries, these features must be combined with other features such as local features, textural features and grid features etc.

Local Features: -Local features describe the properties of signature image in specific parts. They are calculated by partitioning the signature image into parts. Local features extract information in more detail and are more accurate as compared to global features but the computational time is high. Local features are divided into two groups:- statistical and geometrical features.

a. Statistical Features are taken from the pixel distribution of signature image. Local pixel density, slant features and critical points are statistical features

b. Geometrical Features describes the geometrical characteristics of the signature image .They have ability to tolerate with distortion, style variation. Centroid &Centre of gravity are geometrical features.

2. LITERATURE SURVEY

Offline signature verification is a well-researched topic, where many different features and classifiers have been studied. Various techniques have been employed for offline signature verification. In 2007, Tai-Ping et al. [1] used signature envelope curvature descriptor technique. Algorithm for feature descriptor extraction of signature is presented using the signature curvature sequence; average error rate of 17.17% was achieved.

In 2008, AsmaShaqil et al. [2] analysed effects of various feature's performance on Hidden Markov Model based online and offline signature verification system. For online HMM based signature verification system, features like velocity, pressure, acceleration and angle along trajectory were found good for discriminating between genuine and skilled forgeries and for offline HMM based signature verification system, angle and distance were found good in discriminating between genuine and skilled forgeries as compared to pixel density and centre of gravity.

In 2008, Ramachandra AC et al.[3] compared signatures using graph matching and Euclidean distance is calculated as the dissimilarity measure between them for reference signature set. Cross-validation principle is used. EER of skilled forgeries and random forgeries was improved by 5.8% and 1.08% respectively.

In 2008, Alen McCabe et al. [15] presented the handwritten signature verification system based on HMM for verifying handwritten signature data. Local features (both static and dynamic) were extracted for verification. OER of 3.5% was achieved in best case experimental. AbhayBansal et al. [18] presented the contour matching algorithm that tracks the basic characteristics pattern of sample signature and verifies it.

In 2009, MustafahAgil et al.[4] presented analysis of four different local features to distinguish between genuine and forged signature. The features are centre of gravity, pixel density, distance and angle. Analysis of Variance (ANOVA) technique was used for analysis. Jesus F.Vargas et al. [13] performed signature verification based on pseudo-cepstral coefficients from histogram of grey scale images.

In 2010, Dr.S.AdebayoDaramola et al.[20] proposed offline signature verification using DCT(Discrete Cosine Transform) and HMM(Hidden Markov Model).The signature image is divided into equal number of HMM states. Successful signature recognition rates of 99.2% can be achieved.

In 2011, Almudena et al. [5] extracted contour features for offline signature verification. MCYT database consisting of 2250 signatures were used. EERs for features based on direction (skilled & random forgeries) are 6.44% & for features based on length (skilled & random forgeries) are 1.18%.

In 2011, Swati Srivastava et al.[17] proposed offline signature verification using grid based feature extraction. The pre-processed signature image is segmented into grid of size 10x20 cells. The proposed method gives FAR of 9.7% and FRR of 17.9%. Mustafa BeskayYilmaz et al.[5] presented an automatic offline signature verification system in which signature is divided into zones where HOG(Histogram of Oriented Gradients)and LBP(Local Binary Pattern) features are calculated. Two different types of SVM classifiers (global and user-dependent) are trained to perform

verification.

In 2012, George S.Eskander et al. [7] proposed writer-independent classifiers to each specific user. The proposed approach decreased the classifier computational complexity to 99.5%. K V Arya et al. [12] presented the algorithm in which six different features of signature are used for signature verification. Guided filter is used for enhancement of signature image.

In 2013, Juan Hu et al. [9] presented an offline signature verification system based on three different pseudo-dynamic features (local binary pattern, grey level co-occurrence matrix & histogram of oriented gradients). Best results achieved are 5.66% & 9.94% EER in GPDS, 7.55% & 11.55% EER in CDS. MadhaviD.Markar et al.[16] proposed scheme based on pre-processing, feature point extraction, NN training and final verification. RameezWajid et al.[8] compared performance of seven different classifiers for offline signature verification based upon local binary pattern(LBP) feature set. Results shows that LS-SVM classifier performs best, achieving the EER = 13%. SurabhiGarhwal et al. [19] presented the survey of various approaches used for offline signature verification. Othman o-Khalifa et al.[21] proposed offline signature verification based on artificial neural network and compared the results with various techniques for offline signature verification. Indrajit Bhattacharya et al. [23] presented OSV using pixel matching technique. Performance of proposed method is compared with ANN(Artificial Neural Network) & SVM(Support Vector Machine) technique. FAR and FRR values of 0.88% and 0.12% in case of pixel matching technique were achieved which are comparable with the ANN (FAR=0.89% and FRR=0.11%) and SVM (FAR=0.84% and FRR=0.16%).

In 2014, K.N.Pushpalatha et al. [10] extracted transform domain feature using contourlets, textural features (energy, homogeneity, contrast) are also extracted .Five state HMM is used as classifier. SamanahAbdoli et al. [11] used grey levels and geometrical information of signature image for offline signature verification. Geodesic derivative pattern is used for geometrical and textural measuring of image. Kruthi C et al.[22] performed offline signature verification using support vector machine (SVM). Sample signature is taken,pre-processed and various features are extracted. System accuracy was 72.275%. UrmilaA.Jain et al. [14] presented the comparative study of various techniques used for offline signature verification.

In 2015, NarwadePradeep Narayan et al.[31] proposed a novel approach for signature verification based on curve matching using shape descriptor and Euclidean distance. Verification was performed on GPDS960 signature corpus database. Both FAR and FRR values were improved.

3. EVALUATION AND DISCUSSION

Various methods have been discussed for offline handwritten signature verification. Each method is suitable for a particular forgery level. It has been studied that offline handwritten signature verification can be carried out by

extracting both local as well as global features. Offline signature verification based on HMM that extracts DCT features provides estimation of system's performance more accurately and also reduces error rates. SVM approach is still not suitable for skilled forgery detection and suitable for simple and random forgeries only. Pseudo-dynamic features i.e. LBP, HOG and GLCM are insensitive to the type of language and also, the system performance improved after combining these three features for offline signature verification. System performance can be improved by combining both local and global features. NN is a widely used classifier for pattern recognition problems as instead of training the entire network only the three new small NNs needs to be trained when adding a new person or signature. Each technique has its different advantages and disadvantages depending on the feature set selected to get the optimum results.

4. CONCLUSION

The main advantage of using offline signature verification system are adaptability and implementation i.e. easy to use, low implementation cost. There are several approaches for offline signature verification .Each technique has its own advantages and disadvantages. This paper addresses a brief review of the offline signature verification system and the various techniques used by the researchers for offline signature verification. Even there are many approaches which can be used for accurate signature verification but the accuracy still needs to be improved in case of skilled forgeries. Future work includes combining both local and global features for more accurate results in case of skilled forgery detection.

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