A Survey of Handwritten Signature Verification System Methodologies

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Abstract : Signature is a biometric trait of humans which is used to confirm human identity. Signature is used in authentication and authorization for many official transactions such as bonds, cheques, and card transactions. There are two types of signatures: 1) Online signature, 2) Offline signature. Online signature generates dynamic parameters like velocity, pressure, intensity, force, etc. Offline signature verification consists of mainly 4 components: preprocessing, feature extraction, recognition, and verification. This paper presents a review of offline signature verification methodologies. This paper concentrates the most on the neural network for recognition and verification of signatures.

Index Terms - **signature verification, preprocessing, feature extraction, matching techniques, recognition rate, FAR, FRR, EER, Neural Networks;**

I. INTRODUCTION

Signature is behavioural biometric which is used to check human identity. Among all biometric traits, handwritten signatures are mostly used because of the fact that handwriting is a process done unconsciously and some pen gestures are invariant and not simply altered when forgery is done [18]. Signature verification is a process of authenticating a person's identity by checking his signature with the samples present in the database.

There are three kinds of forgeries:

1) Random forgery: The person has no knowledge about the person whose signature is to be forged and has never seen the signature before.

2) Simple forgery: The person knows the name of a person but knows nothing about the signature.

3) Skilled forgery: The person has the original signature and has practiced it [3].

As to verify a person's genuine signature a proper verification system is required. Many studies have been performed for creating such a system.

II. PROPOSED METHODS

The methodology has mainly five phases:

1. Data Gathering
2. Preprocessing
3. Feature extraction
4. Data training
5. Verification.

A. Preprocessing

Preprocessing is used to improve the properties of the signature. This phase eliminates noise and errors in the image [8]. The following steps are used

a) RGB to Grayscale
b) Binarization
c) Noise Reduction
d) Cropping.

RGB to Grayscale:-In this step, an image is converted to grayscale for eliminating saturation and hue information.

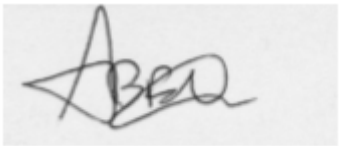

Fig 1 Normal Image[8]

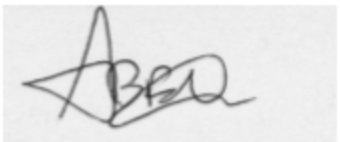

Fig 2 Grey Scale Image[8]

Binarization: -A grayscale image is converted into binary to count the number of black pixels which helps in feature extraction.

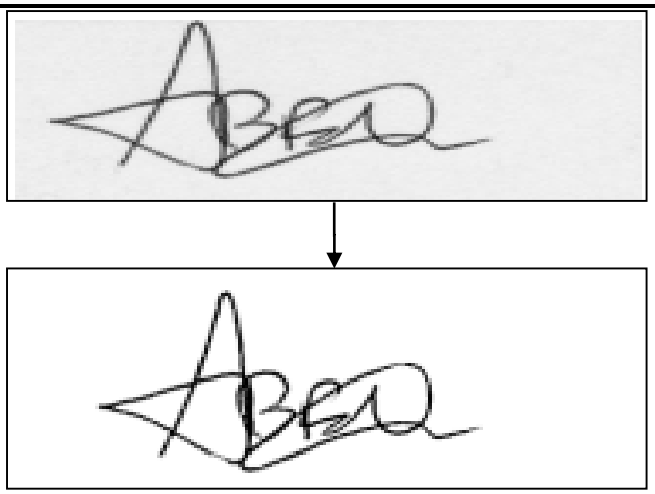

Fig 3 Binarization[8]

Noise reduction:-Removing the marks on the image other than the signature which is not required for the verification process.
Cropping:-Removal of the unwanted part in the image which increases the unnecessary pixels and size of the signature image.
The image can be enhanced for better visual using the Image Processing Tool (IPL) in MATLAB. Noise reduction can be done using Medfilt2 filter of 3x3 size in MATLAB. Median filtering is used to reduce "salt and pepper" noises. For binarization, "rgb2gray" function of MATLAB can be used. Cropping can be done using MATLAB function, it detects edges of written characters and removes unwanted spaces from the background of the image [18]. Gaussian noise can be removed using a weinner2 filter of size 5x5.
Available data sets for the experiment are

1. Persian Signature samples from UTSig dataset.
2. GPDS dataset
3. CEDAR dataset
4. MCYT datasets
5. Dutch SigComp2011 offline competition data set
6. FUM-PHS dataset.

If we don't want to use the available dataset, we can form our own datasets as per our convenience.

B. Feature Extraction

The feature means similar characteristics and extraction refers to accurately retrieving those features. The determination of features to be used is one of the most fundamental issues in signature verification. There are mainly 2 features local and global: - Local features:- Dividing the image into parts and extracting features. Global features: - Height, width, etc.[4].

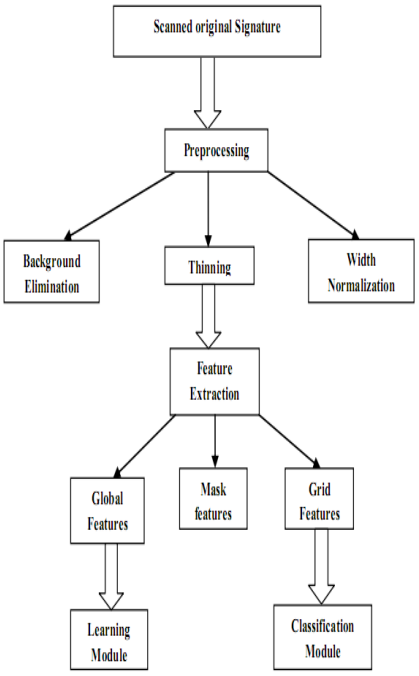

Fig 4 Block Diagram [9]

C. Data training

Training can be done in many ways using different classifiers but we have studied about ANN classifier. Other classifiers can be OC-SVM (Support Vector Machine), HMM (Hidden Markov Model), Deep Learning NN, CNN, etc.
Artificial Neural Network (ANN):- An Artificial Neural Network (ANN) is inspired by the way biological nervous systems, such as the brain, process information. The key element of this is the structure of the information processing system. It is composed of a large number of highly interconnected processing elements (neurons) working in unison to solve specific problems. ANNs, like people, learn by example. An ANN is configured for a specific application, such as pattern recognition or data classification, through a learning process. Learning in biological systems involves adjustments to the synaptic connections that exist between the neurons.

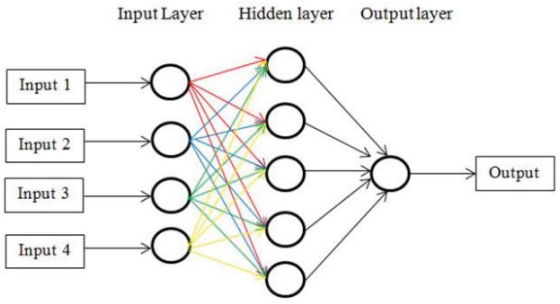

Fig 5 Feed Forward Neural Network[17]

From the handwritten signature perspective, ANN solves complicated signature recognition problems using parallel operation of neurons due to their generalization capability. The most widely used ANN architectures for pattern recognition includes Multilayer perceptron (MLPs) and Radial Bases Functions (RBFs).
SVM: - In machine learning, we use this technique for various purposes like face detection, text and hypertext recognition, classification of images, and bioinformatics.These all come under supervised learning i.e., SVM is a technique for supervised learning. In our project, after histograms are made using those points we start the training process and classification process using SVM.

KNN: - K Nearest Neighbor(KNN) is a very simple, easy to understand, versatile and one of the topmost machine learning algorithms. In KNN, K is the number of nearest neighbors. The number of neighbors is the core deciding factor. K is generally an odd number if the number of classes is 2. When K=1, then the algorithm is known as the nearest neighbor algorithm.

Following are the table of comparison between different methods used.

TABLE 1[14]
COMPARISON TABLE WITH USING OTHER ALGORITHMS FOR SIGNATURE IDENTIFICATION

Ref.	Features	Classifier	Test Accuracy
[22]	Contourlet coefficient	SVM	96.5%
[23]	Geometric features	SVMRBF	96%
[24]	Distinctive feature	ANN-SVM	96.57%
[25]	Shape Context Descriptors	SVMRBF	96%
[26]	Fractal dimensions	KNN	95%
[13]	HOG	GRNN	98.33%

III. IMPLEMENTATION

1. Preprocessing:-

a) RGB to Gray scale

Fig 6 RGB to Gray scale

b) Gray to Binary

Fig 7 Grayscale image to binary

c) Cropping

Fig 8 Cropping Signature image

2. Feature Extraction

Fig 9 HOG Feature Extraction

Fig 10 LBP Feature Extraction

The table below shows the comparison of the methods we have implementation and checked accuracy of its results.

TABLE 2
COMPARISON TABLE WITH USING OTHER ALGORITHMS FOR SIGNATURE IDENTIFICATION

Number of Dataset	Features	Classifier	Accuracy
40	Euclidean Distance	KNN	94.87%
40	LBP	KNN	92.25%
50	Contour_Feature	SVM	70%
100	Euclidean Distance	KNN	75.5%
200	Euclidean Distance	KNN	73.75%
400	Euclidean Distance	KNN	69.49%

III. FUTURE SCOPE

It is better if future study extracts more features that may provide a combination to achieve higher accuracy. Future works should include the use of different features and classifiers such as deep learning neural network. By increasing the numbers of hidden layers, the performance of the neural network can be expected to be better but time for training and testing may increase.

IV. CONCLUSION

Studying all the methodologies for all the steps to detect offline signature we have chosen this method. This method is the latest method being researched and has a better future scope for improvement. Improvements are found in increasing the accuracy of finding similarities in signatures and better help in concluding if the signature is real or forged.

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