AN OFFLINE SIGNATURE RECOGNITION AND VERIFICATION SYSTEM BASED ON NEURAL NETWORK

Sameera Khan[1], Avinash Dhole[2]

[1]M-Tech IV Semester, CSE, RITEE, Raipur, India
[2]Associate Professor, Department of Computer Science and Engineering, RITEE, Raipur, India

Abstract

Various techniques are already introduced for personal identification and verification based on different types of biometrics which can be physiological or behavioral. Signatures lies in the category of behavioral biometric which can distort or changed with course of time. Signatures are considered to be most promising authentication method in all legal and financial documents. It is necessary to verify signers and their respective signatures. This paper presents an Offline Signature recognition and verification system(SRVS). In this system signature database of signature images is created, followed by image preprocessing, feature extraction, neural network design and training, and classification of signature as genuine or counterfeit.

Keywords: *biometrics, neural network design, feature extraction, classification etc.*

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1. INTRODUCTION

Signatures are widely accepted as a official means to verify legal documents, financial documents and also for personal identification. Due to the same signatures are most popular behavioral biometric used for authentication and verification. So it is necessary to create a robust and efficient verifier which can help in keeping a track on increasing frauds and crimes related to signatures. Every individual has different signature with some unambiguous behavioral traits. Since it is a behavioral biometric, it is seldom identical. Signatures are sometimes nothing more than the set of some unreadable alphabets or a pattern consisting of lines, curves, blobs etc. That is why it is considered as a special case of pattern matching.

Signatures are accepted as a biometric because it possess properties like-universal use and acceptance, have some measurable properties, unique for every individual, easy to compare, and reliability.

There are two types of signature verification processes-online and offline. When signatures are captured live with the help of some digitizing devices like stylus operated PDAs, the systems are known as online verification system whereas if static images of signatures are used to represent input data set, it is known as offline verification system.

Both types of the verification system consists of phases like data acquisition, image preprocessing, feature extraction, designing and training of the classifier and classification.

Selection of powerful feature set is a vital process. Proper features can be used to identify different types of forgeries. A combination of appropriate feature set and type of classifier can yield better results.

This paper presents an offline approach for signature recognition and verification based on radial basis function network. A set of nine global features is used to generate feature vector.

2. METHODOLOGY

Offline approach uses static image patterns of signatures for generating data set. Five images are taken from each individual for training the network.In preprocessing stage, images are cleaned in order to get rid of any useless information present in it. Preprocessing involves image resizing, gray scale conversion, noise reduction, thresholding, and skeletonization.

Some global features are extracted from the preprocessed image in feature extraction phase. In this system nine features are extracted. These extracted feature set is characterized by a matrix to form a feature vector which is the condensed depiction of the input data set. This feature vector acts as an input to the neural network for training.

Artificial neural network used in this system is the radial basis function network which uses supervised learning i.e. target values are also provided to the network besides the feature vector. Radius of the neurons is set using the value of spread constant.

A new signature image under examination is selected and all nine features are extracted and fed to the RBFN classifier which classifies it as genuine or forged signature based on the output and tolerance limit. Signatures are not always same even when made by same signer. Due to the same features extracted each time may vary. That is why some tolerance limit is necessary.

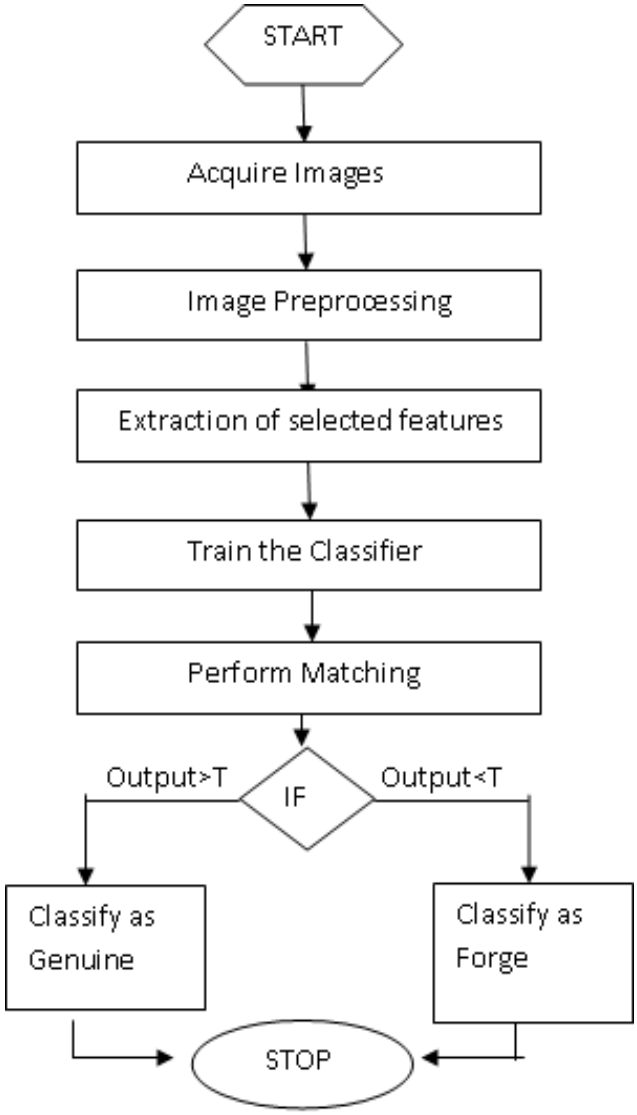


Fig -1: Flowchart of SRVS

3. DATA ACQUISITION

Data acquisition is the method of sampling signals that figure out real world physical conditions and digitizing resulting samples that can be easily processed. There are two wide classifications of acquisition models:

1) Static Model: In this model features are extracted from a earlier stored images. Image is characterized as function of x and y.

$$f\ (x, y) = 1 \text{ for each recorded coordinate else } = 0;$$

2) Dynamic Model: In this model features are achieved online from the individual signer. Image is represented as function of distance, time and pressure.

$$f\ (t) = \{ x(t), y(t), p(t)\};$$

Given that this system is an offline signature verification technique, it uses static model for data acquisition.the dataset is generated by the images of signatures. These signatures are done on a piece of paper by a signer. Each signer is asked to give ten specimens of their signatures and a scanned copy of these signatures is stored in an image database. 63 points X 17 characters bounding box is used as reference.

4. PREPROCESSING

Preprocessing is basically an image enhancement technique. The signature images saved in a signature database are preprocessed so as to improve the quality of dataset, to obtain better reult and to make the classification task simpler. Image preprocessing includes operations like gray scale conversion, resizing, thresholding, Noise Reduction and Skeletonization.

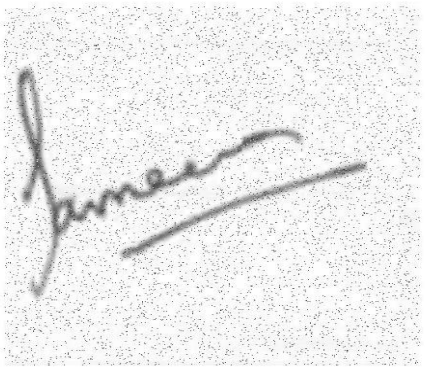
4.1 Grayscale Conversion

Since we are interested only in the signature pattern and not in its color, color information is irrelevant. That is why a color signature image is converted into grayscale image. . Gray images are composed exclusively of shades of gray, varied from black at the weakest intensity to white at the strongest.

Fig -2: color and gray signature images

4.2 Noise Reduction

Due to the presence of insufficient light, dirt in camera lens, fault in scanner or quality of paper some disturbances can occur as noise in image signal. A filtering function is used to eliminate the noises in the image.



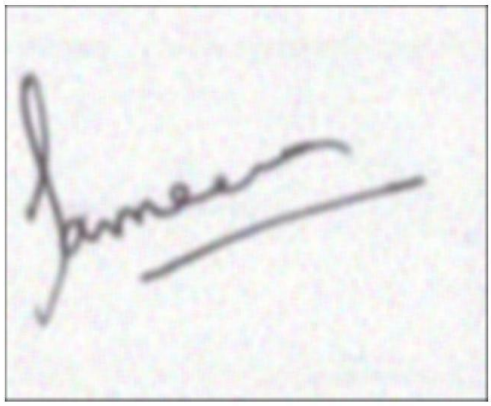
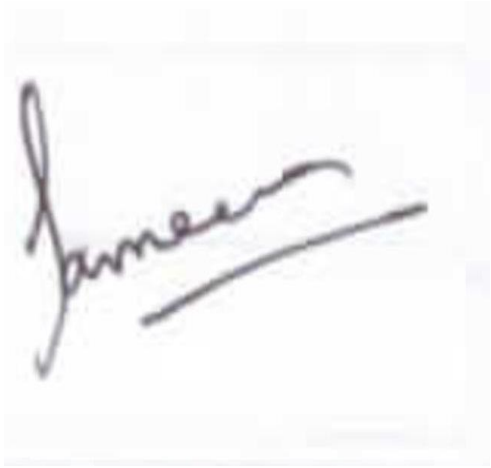


Fig 3: Noisy and filtered signature images

4.3 Skeletonization

It is also known as medial axis transformation. It reduces the width of objects to single pixel. Skeletonization is done by recursive erosion over the image until its medial axis remains. It is also known as thinning. The outcome of skeletoniztion is a binary image constituiting only of the objects medial axis.



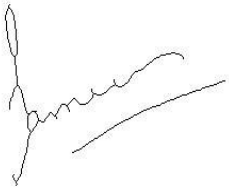


Fig 4: Original and skeletonized signature images

4.4 Thresholding

It is a segmentation technique. In Thresholding reference value T is set which is known as threshold, any pixel having intensity greater than T will be assigned a highest value in the gray scale whereas any pixel having intensity value less than T will be assigned a lowest value in the gray scale. Thesholding gives a binary image i.e. it consists of two gray levels.

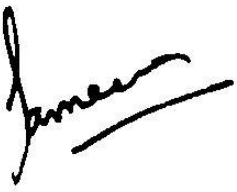


Fig 5: Original and thresholded signature images

5. FEATURE EXTRACTION

For pattern matching process, one important aspect is feature extraction. In this process the input data set is represented on the basis of values of some features. These feature values are presented in form of matrix to create a feature vector.

In this system a set of nine global features are used which are described as follows-

- Image Area: total number of black pixels in the test image.
- Signature pure width: maximum of exact number of black pixels present in each horizontal scan line.
- Signature pure Height: maximum of exact number of black pixels present in each vertical scan line.
- Aspect ratio.: Ratio of width to height component of an image is known as aspect ratio.

  Aspect Ratio= pure width/ pure Height

- Maximum Vertical Projection: sum of all the pixels along the columns in a skeletonized image is vertical projection. The vertical projection is define as :

  $$V(j)=\sum I(i,j)$$

- Maximum Horizontal Projection: sum of all the pixels along the row in a skeletonized image is horizontal projection. The horizontal projection is define as :

  $$H(i)= \sum I(i,j)$$

- Number of Edge Point (En): An edge point is defined as a signature point that has only one 8-connected neighbor.
- Centroid x-coordinate: Centroid can be defined as the center of mass of any geometric object. Any pixel location is identified by an ordered pair. Centroid x-coordinate represents x coordinate value of the calculated location of center of mass
- Centroid y-coordinate: Centroid y-coordinate represents y coordinate value of the calculated location of center of mass.

6. NETWORK DESIGN AND TRAINING

Artificial neural networks are very promising in the field of pattern matching. In this signature verifier, radial basis function network is used as classifier. RBFNs are trained by using supervised learning i.e. feature vector and the target vectors both are needed. Sensitivity of network is set by using spread constant value which signifies the width of transfer function plot. Higher the value of spread lower is the sensitivity and vice versa.

7. CLASSIFICATION

With the specified feature vector, target vector and spread constant value a network is trained. This trained network is now set for classification of the new signatures in one of the input classes. A test signature is used to extract the features and the newly extracted features are fed to the trained network which classifies it as genuine or forge with respect to the output value in the corresponding class and a preset threshold value. Threshold value is used to specify tolerance limit of the network.

8. RESULTS

In the above discussed system, an offline signature verification system is designed using radial basis function network. Each signer provides five specimen signatures which are saved in the database, a set of nine global features are extracted from this database to generate feature vector and a network is trained using these features. Observed FAR and FRR are . The results are shown as follows-

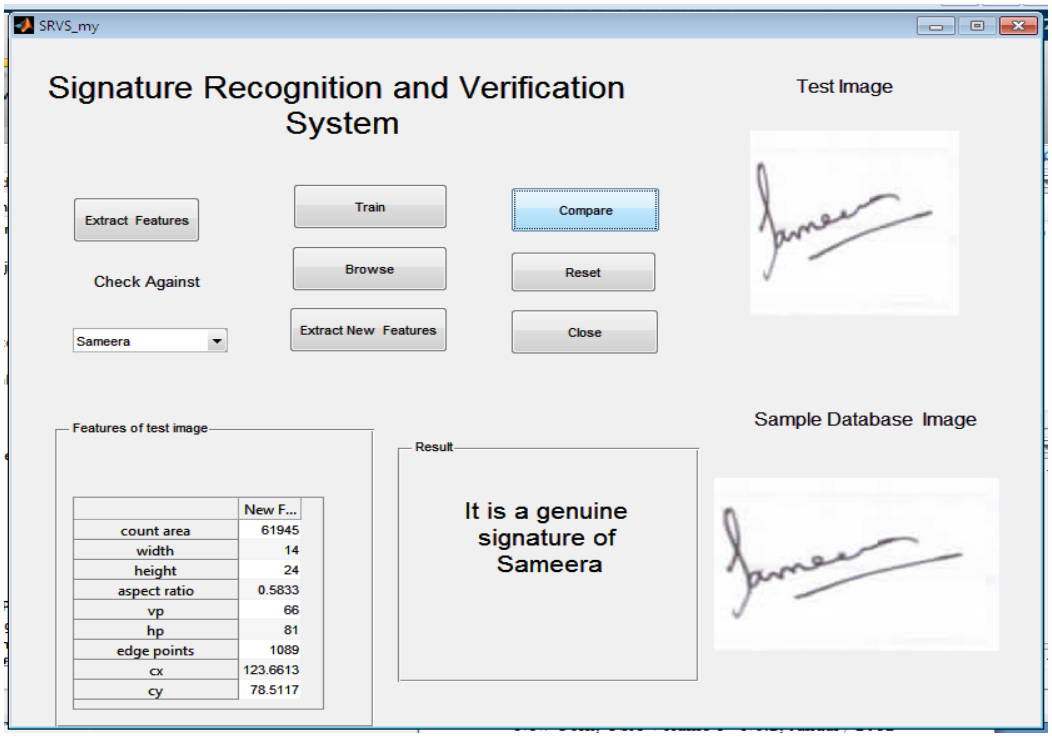


Fig 6: Output Screen showing classification result

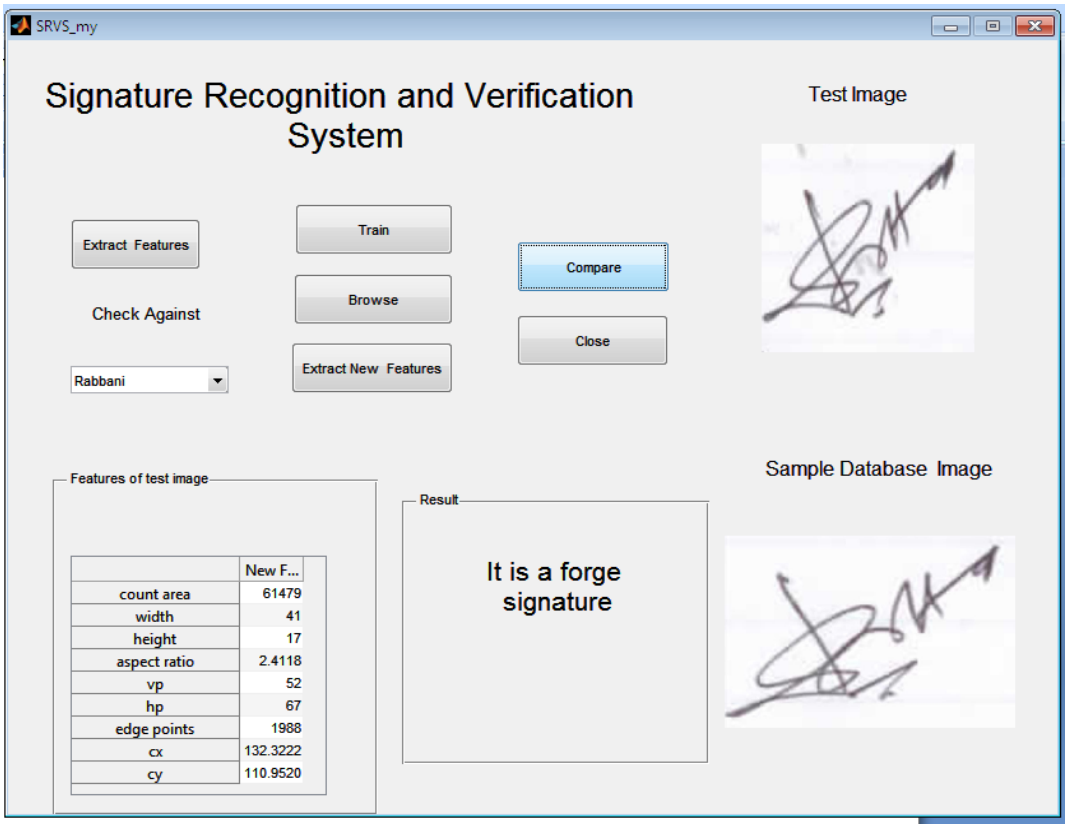


Fig 7: Output Screen showing classification result of forged signature

9. CONCLUSION

This paper presents design and implementation of an effective offline signature recognition and verification system using radial basis function network. The false acceptance rate (FAR) or type-I error is found to be 5% and false rejection rate (FRR) or type-II error is found to be 7%.

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BIOGRAPHIES

Sameera Khan is a P. G Student (M. Tech) in the Department of Computer Science and Engineering, Raipur Institute of Technology, Raipur(C.G). She received her Bachelor of Engineering (CSE) in 2008 from Raipur Institute of Technology, Raipur affilated to Pt.Ravishankar University,Raipur (C.G).Her research interest are Image Processing and neural network.

Avinash Dhole is an Associate Professor and Head in Computer Science and Engineering Department, in Raipur Institute Of Technology, Raipur, (C.G.) . His research interests include Digital Image Processing, Compilers, Automata Theory, Neural Network, Artificial Intelligence, Information and Network Security