Offline Signature verification scheme using DTI and NN classifiers

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Abstract - Signature detection have a major issue in digital verification of signature without using online help. Handwritten signature is one of the most vastly accepted personal attributes for identity verification. The main area of research on signature verification is in the field of pattern recognition and image processing. Earlier different method of feature detection and classifications has been used for the same purpose. We propose a novel approach in which we are doing vigorous feature detection and using Classifiers like Decision tree induction and Neural Networks. We setup a simulation environment in matlab for both feature detection and classification.

Keywords: DTI (Decision tree), NN (Neural Network), NA (Normalised Area), CA (Convex Area), AR (Aspect Ratio), SNR (Signal to Noise Ratio), MSE (Mean-Squared Error)

I. INTRODUCTION

In Offline mode, it is complex to divide signature strokes due to highly stylish and unconventional writing styles. All of the complexity joined causes large intra-personal variation among signatures. Biometric are automated methods of identifying a person or verifying the identity of a person based on a physiological or behavioural characteristic. Biometrics is an ever expanding field because of its unique modalities such as hand geometry, fingerprints and signatures [5].Biometrics offers many benefits over more commonly used authentication methods which provide a wide data material for study. More common such as photo ID cards or magnetic stripe cards can be lost, stolen, duplicated or even just left at home. Another common means of authentication is the use of passwords. There various things that can be go wrong with a password and in today’s fast paced world, people are enforced to remember a multiple of passwords for many things. Biometrics holds the promise of fast, easy to use, accurate and reliable authentication. Biometrics has benefit of being more difficult to get around than normal security measures. Signature verification is an important way of research as signatures themselves are the most vastly accepted biometric for identity verification in routine use. It has been used in authentication documents and for forcing binding contracts in paper based documents for centuries.[4]

The characteristic of the signature is that this paper works with an automated method of verification an off line signature recognition by extracting features. The way of starts by scanning images into the computer, then changing their quality through image enhancement and noise reduction, followed by feature extraction and neural network training, and finally verifies that a signature is original or fake.

Figure 1: Different Sample signature signatures
II. RELATED WORK

A. NEURAL NETWORK

[1] A signature verification system that can authenticate a signature to avoid forgery cases. In the real world environment, it is often very difficult for any verification system to handle a huge collection of data, and to detect the genuine signatures with relatively good accuracy. Consequently, some artificial intelligence technique are used that can learn from the huge data set, in its training phase and can respond accurately, in its application phase without consuming much storage memory space and computational time. In addition, it should also have the ability to continuously update its knowledge from real time experiences. One such adaptive machine learning technique called a Multi-Layered Neural Network Model (NN Model) is implemented for the purpose of this work. Initially, a huge set of data is generated by collecting the images of several genuine and forgery signatures. The quality of the images is improved by using image processing followed by further extracting certain unique standard statistical features in its feature extraction phase. This output is given as the input to the above proposed NN Model to further improve its decision making capabilities. The performance of the proposed model is evaluated by calculating the fault acceptance and rejection rates for a small set of data. Further possible developments of this model are also outlined.

B. FEATURE EXTRACTION

[2] An offline signature verification system based on a signature's local histogram features. The signature is divided into zones using both the Cartesian and polar coordinate systems and two different histogram features are calculated for each zone: histogram of oriented gradients (HOG) and histogram of local binary patterns (LBP). The classification is performed using Support Vector Machines (SVMs), where two different approaches for training are investigated, namely global and user-dependent SVMs. User-dependent SVMs, trained separately for each user, learn to differentiate a user's signature from others, whereas a single global SVM trained with difference vectors of query and reference signatures' features of all users, learns how to weight dissimilarities. The global SVM classifier is trained using genuine and forgery signatures of subjects that are excluded from the test set, while user dependent SVMs are separately trained for each subject using genuine and random forgeries. The fusion of all classifiers (global and user-dependent classifiers trained with each feature type), achieves a 15.41% equal error rate in skilled forgery test, in the GPDS 160 signature database without using any skilled forgeries in training.

III. PROPOSED WORK

A. PROPOSED ALGORITHM

Our proposed work consists of features like area, Convex area, Normalised area and aspect ratio. The flow diagram of our methodology is as given above. In our proposed work we are using 5 sample images of different signatures on which we are applying our algorithm of feature extraction and classification. The accuracy of both algorithms is compared.
Step 1: Data Collection: In this phase we collect few of images of signature which can be used in research work. We require image for reference sample and then image to be verified.

Step 2: Preprocessing: Preprocessing involves majorly two operations as under.

a. Filtering Image for Noise removal: We have used median filter for noise removal in the image.

b. Morphological operations: We have used opening and closing as morphological operations for better results in the processing section.

Step 3: Feature detection

a. Area: Signature Area is defined as no of black pixel in pre-processed image.

b. Convex Area: Convex area is no of total pixels in the image i.e. resolution of image. Let an image has X height and Y width, then

\[ \text{CA} = X \times Y \text{ Sq. unit} \] (1)

c. Normalised Area: The normalized area (NA) of the signature is the ratio of the area that makes up the signature to the area occupied by that signatures bounding box.

\[ \text{NA} = \frac{\text{Area of signature}}{\text{Area of bounding Box}} \] (2)

d. Aspect Ratio: The aspect ratio (AR) is the ratio of the width of the image to the height of the image.

Step IV: Classification

a. DTI: An alternative approach is to use a multistage or sequential hierarchical decision scheme. The basic idea involved in any multistage access is to break up a difficult decision into a set of several simple decisions, hoping the final solution achieved in this way would simulate the expected desired solution. Hierarchical classifiers are special type of multistage classifier that allows rejection of class labels at intervening stages.

b. NN: A neural network is a application of artificial intelligence, where a computer application is trained to think like a human being or even better. A neural network is an information processing paradigm that is inspired by the way biological nervous systems, such as the brain, process information. The main part of this paradigm is the novel structure of the information processing system. It is claimed of a large number of highly interconnected processing elements (neurons) working in unison to solve specific problems.

Step V: Comparison of verification using DTI and NN:

In this phase we compare two output put by NN and DTI. Hence find out the efficiency of each algorithm. MSE and SNR are parameters to compare these. Two commonly used measures are Mean-Squared Error and Peak Signal-to-Noise Ratio. The mean-squared error (MSE) between two images \( g(x, y) \) and \( g'(x, y) \) is:

\[ \text{E}_{\text{MSE}} = \frac{1}{MN} \sum_{n=1}^{M} \sum_{m=1}^{N} [g(n, m) - g(n, m)]^2 \] (3)

One problem with mean-squared error is that it depends strongly on the image intensity scaling. A mean-squared error of 100.0 for an 8-bit image (with pixel values in the range 0-255) looks dreadful; but a MSE of 100.0 for a 10-bit image (pixel values in \([0,1023]\)) is barely noticeable.

Peak Signal-to-Noise Ratio (PSNR) avoids this problem by scaling the MSE according to the image range:

\[ \text{PSNR} = 10 \log_{10} \frac{S}{\text{E}_{\text{MSE}}} \] (4)

where \( S \) is the maximum pixel value. PSNR is measured in decibels (dB). The PSNR measure is also not ideal, but is in common use. Its main failing is that the signal strength is estimated as \( S^2 \), rather than the actual signal strength for the image. PSNR is a good measure for comparing restoration results for the same image, but between-image comparisons of PSNR are meaningless.

B Pseudo code

Step 1: Set no. of Signature image N1
Step 2: for loop 1 -> N1;
\%Feature extraction
Step 3 : extract properties of Signature image
Step 4 : Area = A;
Step 5 : Convex area = C;
Step 6 : Normalised area = N;
Step 7 : Aspect Ratio = R;
Step 8 : end for loop
\%Classification starts here
Step 9 : if ( LWL<A<UWL && LWL<C<UWL && LWL<N<UWL && LWL<R<UWL) \% This compares the existence of the the value of other properties in a particular window.
Step 10 : Signature matched;
Step 11 : end if ;
Step 12: Repeat Steps 9, 10 and 11 for all other Signature images;  
Step 13: Repeat Steps 9, 10, 11 and 12 for all other classifiers;  

IV. RESULTS AND SIMULATIONS  

During our simulation we have found features and classification of signatures were done we used data set of 8 different signatures. Accuracy with DTI and NN were calculated. Performances of both the graphs are compared as under in figure 7.  

Figure 3: Template image  

Figure 4(a) & (b): Input image 1 and 2  

In the figure 3 there is sample or template sign for the record in order to match it with test input image that is it act as reference image for the verification. Here figure 4(a) and (b) are the input test images on which the process of signature verification is to be carried out. The result is shown in figure 5(a) and (b) for respective test images 1 & 2 using NN algorithm figure 6(a) and (b) shows the result of the verification using DTI as we know that DTI give the result true even if single feature is matched. While NN algorithm returns to if and only if all the conditions of extracts features are matched otherwise it returns false. So, NN algorithm is much better than DTI algorithm.
V. CONCLUSION

From the results of the simulation we can infer that the features that we detected were decent enough for the vigorous feature detection that we intended to improve. Our work was to compare the accuracy of two prime classifiers. We can end up this discussion by saying that in terms of classification accuracy the Neural network leads the Decision tree induction by a big margin. Moreover in order to have more complex computing we need to improve upon the memory of a particular classifier by training it, in this context also the NN dominance prevails over the DTI.

VI. FUTURE SCOPE

In future we would like to improve upon the background inclusion, to be indulged in the work so that the situationality of work that is it needs images either with no background or with removed background can be removed.

REFERENCES


