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Signature Recognition using Statistical-ANN Hybrid Technique

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Abstract:

There exist a number of biometrics methods today e.g. Signatures, Fingerprints, Iris etc. There is considerable interest in authentication based on handwritten signature verification system as it is the cheapest way to authenticate the person. Fingerprints and Iris verification require the installation of costly equipments and hence cannot be used at day to day places like Banks etc. As Forensic experts cannot be employed at every place, there has been considerable effort towards developing algorithms that could verify and authenticate the individual's identity. Many times the signatures are not even readable by human beings. Therefore a signature is treated as an image carrying a certain pattern of pixels that pertains to a specific individual. Signature Verification Problem therefore is concerned with determining whether a particular signature truly belongs to a person or not. The system proposed for Offline Signature Recognition utilizes a dual hybrid approach where features are extracted using statistical approach and classifier is based on neural network approach. The system can be tested available signature database.

Keywords **— signature recognition, biometrics, statistical approach, neural network, MATLAB.**

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I. INTRODUCTION

The signatures are a special case of handwriting in which special characters and flourishes are viable. Signature Verification is a difficult pattern recognition problem as because no two genuine signatures of a person are precisely the same. Its difficulty also stems from the fact that skilled forgeries follow the genuine pattern unlike fingerprints or irises where fingerprints or irises from two different persons vary widely. Ideally interpersonal variations should be much more than the intrapersonal variations. Therefore it is very important to identify and extract those features which minimize intrapersonal variation and maximize interpersonal variations. There are two approaches to signature verification, online and offline differentiated by the way data is acquired. In offline case signature is obtained on a piece of paper and later scanned. While in online case signature is obtained on an electronic tablet and pen. Obviously dynamic information like speed, pressure is lost in offline case unlike online case. The fact that the signature is widely used as a means of personal identification tool for humans require that the need for an automatic verification system. Verification can be performed either Offline or Online based on the application. However human signatures can be handled as an image and recognized using computer vision and neural network techniques. There are three different types of forgeries to take into account. Signature forgery still represents a great challenge to financial institutions, which makes accurate signature verification inevitable. On the other hand, computer technology and information processing areas witness remarkable qualitative improvements associated with significant costs reduction. This boosted the usage of machine vision techniques [1].

1. **Random Forgery:** Random forgery which is written by the person who doesn't know the shape of original signature.
2. **Simple Forgery**: Simple forgery which is represented by a signature sample, written by the person who knows the shape of original signature without much practice.
3. **Skilled Forgery**: Skilled forgery represented by a suitable imitation of the genuine signature model.

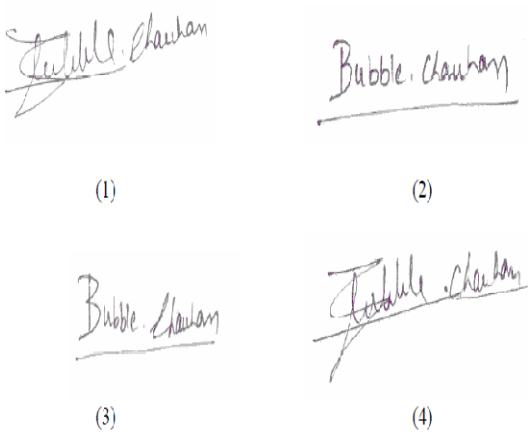

Fig. 1 (1) Original Signature, (2) Random Forgery, (3) Simple Forgery and (4) Skilled Forgery

With modern computers, there is need to develop fast algorithms for signature recognition. Handwritten signature is one of the most widely accepted personal attributes for identity verification of the person. The written signature is regarded as the primary means of identifying the signer of a written document based on the implicit assumption that a person's normal signature changes slowly and is very difficult to erase, alter or forge without detection. The handwritten signature is one of the ways to authorize transactions and authenticate the human identity compared with other electronic identification methods such as fingerprints scanning and retinal vascular pattern screening. It is easier for people to migrate from using the popular pen-and-paper signature to one where the handwritten signature is captured and verified electronically. There are two main streams in the signature recognition task. First approach requires finding information and can recognize signature as the output of the system and it is seen that in a certain time interval, it is necessary to make the signature. This system models the signing person and other approach is to take a signature as a static two-dimensional image which does not contain any time-related information. In short, signature recognition can be divided into two groups: Online and offline. The online signature recognition is where signatures are acquired during the writing process with a special instrument, such as pen tablet. So far there have been many widely employed methods developed for online signature recognition for example, Artificial Neural Networks (ANN), dynamic time warping (DTW) and the hidden Markov models (HMM). The off-line recognition just deals with signature images acquired by a scanner or a digital camera. In general, offline signature recognition& verification is a challenging problem. Unlike the on-line signature, where dynamic aspects of the signing action are captured directly as the handwriting trajectory, the dynamic information contained in off-line signature is highly degraded. Handwriting features, such as the handwriting order, writing-speed variation, and skillfulness, need to be recovered from the grey-level pixels. The system proposed for Offline Signature Recognition utilizes a dual hybrid approach where features are extracted using statistical approach and classifier is based on neural network approach using MATLAB. The system can be tested on available signature database.

The problem is formulated as he input signature is taken from a standard signature database. The preprocessing algorithm provides the required data suitable for the final processing. In the feature extraction phase the invariant moment vectors are used to extract the feature for the classification purpose.

In classification an Artificial Neural Network is used to provide high accuracy and less computational complexity in training and testing phase of the system. The main merits of using

artificial neural networks in the signature verification scheme

Expressiveness: neural networks utilize attributes based representation and are well suited for pattern recognition problems.

Self-Organization: An ANN can create its own organization or representation of the information it receives during learning time.

Execution speed: The training phase in neural networks is quite a time taking procedure. However this is a single time cost and is compensated in the long run.

Fault Tolerance via Redundant Information Coding: Partial destruction of a network leads to the corresponding degradation of performance. However, some network capabilities may be retained even with major network damage.

The main objectives are:

- To acquire the Signature images from a signature database to create a train and test dataset.
- To perform image pre-processing to remove noise and blurring.
- To extract the various features of stored images using statistical approach based on invariant moment method.
- To use these features to train the neural network classifier.
- To employ unknown Signature image and extract its features.
- To perform the pattern matching with data set.
- To do the classification and classify as genuine or forge.
- To analyze the results for statistical feature extraction efficiency and accuracy.
- To analyze the results for artificial neural network classifier optimization approach.

II. LITERATURE REVIEW

M. B. Yilmaz et. al. publish that signature verification task needs relevant signature representations to achieve low error rates. Many signature representations have been proposed so far. In this work we propose a hybrid user-independent/dependent offline signature verification technique with a two-channel convolutional neural network (CNN) both for verification and feature extraction. Signature pairs are input to the CNN as two channels of one image, where the first channel always represents a reference signature and the second channel represents a query signature. [2]. Jameel Malik et.al. focused on in-air signature is a new modality which is essential for user authentication and access control in noncontact mode and has been actively studied in recent years. However, it has been treated as a conventional online signature, which is essentially a 2D spatial representation. Notably, this modality bears a lot more potential due to an important hidden depth feature. Existing methods for in-air signature verification neither capture this unique depth feature explicitly nor fully explore its potential in verification. Moreover, these methods are based on heuristic approaches for fingertip or hand palm center detection, which are not feasible in practice. Inspired by the great progress in deep-learning-based hand pose estimation, authors propose a real-time in-air signature acquisition method which estimates hand joint positions in 3D using a single depth image. The predicted 3D position of fingertip is recorded for each frame [3]. Utkarsh Shukla et. al. publish that when it comes to information security, biometric systems play a significant role in it. Signature verification is a popular research area in field of pattern recognition and image processing. It is a technique used by banks, intelligence agencies and high-profile institutions to validate the identity of an individual by comparing signatures and checking for authenticity. In this paper, the approach for the verification of signatures is based on Conventional Neural Network (CNN). This method saves time and energy and also helps to prevent human error during the signature process and lowers chances of fraud in the process of authentication [4]. Henali Patel et. al. publish that a mark or sign made by an individual on an instrument or document to signify

knowledge, approval, acceptance, or obligation. Signature recognition is a behavioral biometric that identifies an individual on the basis of their handwritten text. The authors have given description about signature recognition methods and have compared all the methods [5]. Sumedha Tanajirao Panchal et. al. present a method for Offline Verification of signatures using a set of simple shape based geometric features. The features that are used are Area, Euler's Number, Eccentricity, Standard deviation, Centroid, Skewness, Kurtosis and Orientation. Before extracting the features, preprocessing of a scanned image is necessary to isolate the signature part and to remove any spurious noise present. The system is initially trained using a database of signatures obtained from those individuals whose signatures have to be authenticated by the system [6]. Md. Hasan Hasnain Nashif et. al. proposed a system that has three sub-systems. The three subsystems focus on offline recognition of handwritten English alphabetic characters (uppercase and lowercase), numeric characters (0 - 9) and individual signatures respectively. The system includes several stages like image preprocessing, the post-processing, the segmentation, the detection of the required amount of the character and signature, feature extraction and finally Neural Network recognition. At first, the scanned image is filtered after conversion of the scanned image into a gray image. Then image cropping method is applied to detect the signature. Then an accurate recognition is ensured by post-processing the cropped images. MATLAB has been used to design the system [7].

III. METHODOLOGY

The proposed framework is illustrated in Fig.2. This system presents an off-line signature recognition and verification system which is based on moment invariant method and ANN. Two separate neural networks are designed; one for signature recognition, and another for verification (i.e. for detecting forgery). Both networks use a four-step process. First step is to separate the signature from its background. Second step performs normalization and digitization of the original signature. Moment invariant vectors are obtained in the third step. And the last step implements signature recognition and verification.

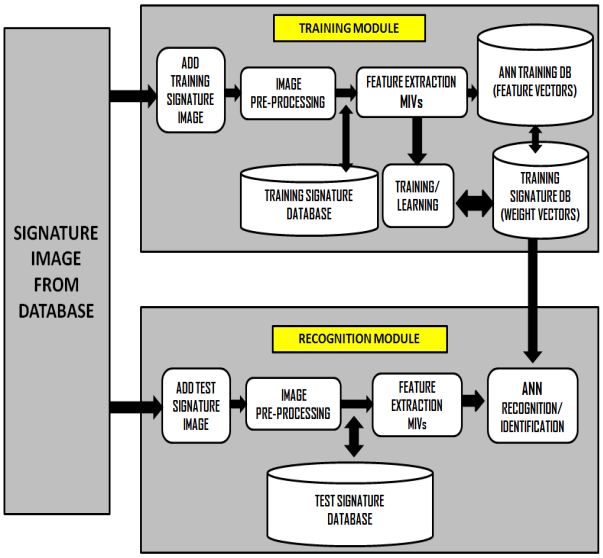

Fig.2 The Proposed ANN-MIV Recognition System

At present, a method based on moment invariant method and Artificial Neural Network (ANN) which uses a four-step process: separates the signature from its background, normalizes and digitizes the signature, applies moment invariant vectors and finally implements signature recognition and verification, was successful in the verification of signatures that ANN was trained for, but has a poor performance when ANN was not trained for.

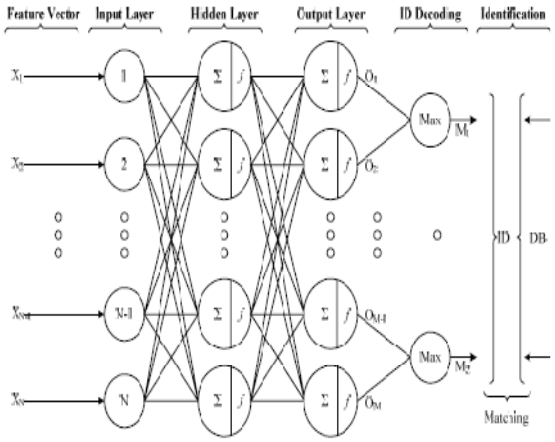

Fig.3 Two Layer Neural Network

Neural network with back propagation is more efficient. Off-line signature recognition & verification using back propagation neural network is proposed, where the signature is captured and presented to the user in an image format. There are several algorithms that can be used to create an artificial neural network, but the Back propagation was chosen because it is probably the easiest to implement, while preserving efficiency of the network. Backward Propagation Artificial Neural Network (ANN) use more than one input layers usually 3(input layer, output layer and hidden layer). The non-linear property of multi-layered neural networks is useful for analysis of complicated signature variable relationships which have traditionally been difficult to model analytically. Hence, an enhanced back-propagation algorithm for training multi-layered neural network, based on selective retraining and a dynamic adaptation of learning rate and momentum, is employed to recognize the signature.

An automated pattern recognition system minimally contains an input subsystem that accepts sample pattern vectors and a decision-maker subsystem that decides the classes to which an input pattern vector belongs. If it also classifies, then it has a training phase in which it learns a set of classes of the population from a sample of pattern vectors, namely, it partitions the population into the subpopulations that are classes.

As described above, a multi-layered feed-forward neural network is employed here to train and recognize the human signature. Figure 3 shows the network architecture used within this study. In the figure, **X** is the input feature vector with *N* elements, and **O** is the output vector with *M* elements. The neural network has one hidden layer of sigmoid nodes followed by an output layer of linear nodes To train the network, the enhanced back-propagation algorithm is used. Also, the nodes of output layer are divided into two groups, and information about a maximum output node of each group is used to decode the output to an identification code of signature.

IV. RESULTS

The snapshot of Application Graphical User Interface for ANN-MIV Signature Recognition System which was developed using MATLAB GUIDE Tool is shown in figure below. It consists of 05 buttons which have been assigned different functions to be performed by the application. The display for images and results are provisioned in the same window in this GUI.

Fig.4 Statistical-ANN Signature Recognition GUI

The MATLAB Command window showing signature recognition results with Nearest Class, Euclidean Distance, Recognized Image and Location.

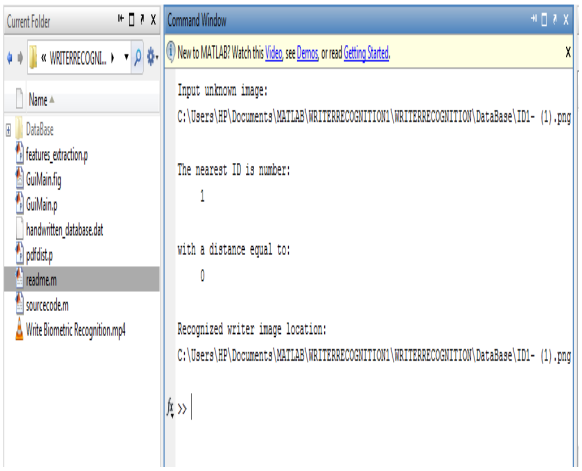

Fig. 5 MATLAB Command Window: Signature Recognition Result

V. CONCLUSIONS

The Application GUI for the Hybrid Statistical ANN-MIV Signature Recognition System has been developed along with initial stages of Signature Image Acquisition, Signature Image Pre-processing and Signature Feature Extraction and ANN Signature Recognition. The application is to be tested on database for accuracy and performance and analytical comparisons are to be made on basis of testing for future work.

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