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Signature Recognition and Verification System Using Artificial Neural Network

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Abstract: *The most widely used biometric systems for authentication of person as well as document. Online and offline signature is existing in person identification and authentication problems. Offline signature categorizes the signature into two classes: genuine and forged.*
In this paper, we discuss various features of offline signature recognition and verification process, 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. This signature recognition and verification system is designed using MATLAB. This work has been tested and found suitable for its purpose.

Keywords: *Offline signature; feature extraction; recognition; biometrics ;Artificial neural network*

I. Introduction

The world in the case of continuous technology development to increase protection and performance and reduce error in private data. Most of the applications for identity authentication use a password or a pin code. When we use the password or pin code on the security of the system will be faced with many of the problems because many people use words or numbers easy they remember. the password can be broken easily by Virus attack and even if you use the password is not easy to distinguish and find it difficult to recall. Seemed to think of developers in ways more security for the protection of confidential information such as User Authentication using On-line signature, speech, voice , eye and etc. [1]
In this paper we present the signature recognition; the signature recognition is the process of verifying the clients identity by checking the signature against samples kept in a database. The result of this process is usually a number between 0 and 1 which represents a fit ratio (1 for match and0 for mismatch).The threshold used for confirmation/rejection decision depends on the nature of the application. The methods of verification include both online (dynamic) and off-line (static) signature verification algorithms. we used off-line signature recognition and verification system which is depends module neural network[1,2].

II. SIGNATURE VERIFICATION AND RECOGNITION

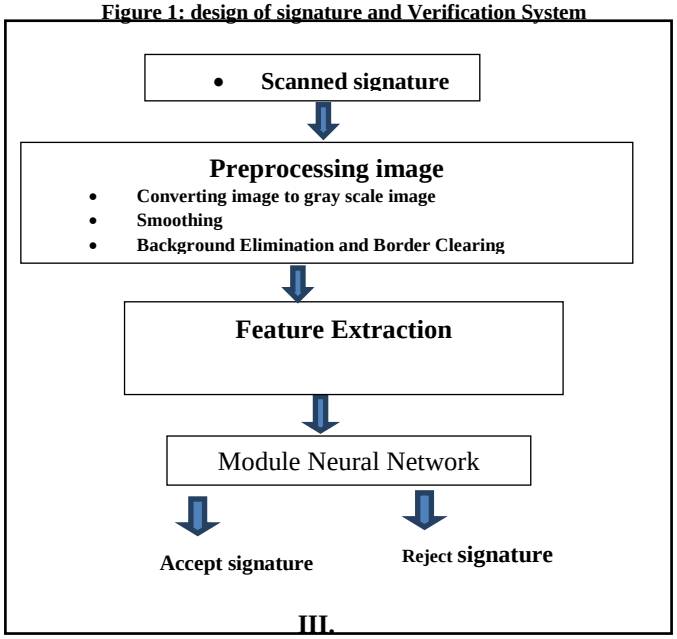
The objective of signature verification system is to discriminate between two classes: the original and the forged. The signature forgery is the act of falsely replicating the signature of another person. Signature Forgery can be classified into following types:

1. Random: original signature is unknown.
2. Simple: assumptions are made by knowing name of signer.
3. Skilled: an imitation of original signal.

The skilled signatures are most difficult to detect as theycan be similar to original signature with less error rate[3].
The steps involved in signature verification and recognition are:

1. Scanned image (by used device such scanner or camera or etc)
2. Preprocessing image
3. Feature Extraction
4. Module Neural Network

Figure 1: design of signature and Verification System



III.

1. PREPROCESSING

The scanned images containing human signatures are processed using several image processing algorithms. These processes are given below.

I. *Converting Color image to gray scale image*

we used color scanning device to scan the signature images. A color image consists of a coordinate matrix and three color matrices. Coordinate matrix contains x,y coordinate values of the image. The color matrices are labeled as red (R), green (G),and blue (B). Techniques presented in this study are based on grey scale images, and therefore, the scanned or captured color images are initially converted to grey scale using the following equation [4]:

$$\text{Gray color} = 0.299*R + 0.5876*G + 0.114*B \ldots\ldots\ldots (1)$$

II. *Smoothing (Noise Filtering)*

Smoothing is one of the most important processes in the image processing. Images are often corrupted due to positive and negative impulses stemming from decoding errors or noisy channels. An image may also be degraded because of the undesirable effects due to illumination and other objects in the environment. Median filter is widely used for smoothing and restoring images corrupted by noise. Median Filter is used in this study due to its edge preserving feature [5, 6,7,8].

III. *Background Elimination and Border Clearing*

In Many image processing algorithms require the separation of objects from the image background. Thresholding is the most easily and sophistically applicable method for this purpose. It is widely used in image segmentation [9, 19].

Thresholding is choosing a threshold value H and assigning 0 to the pixels with values smaller than or equal to H and 1 to those with values greater than H. We used Thresholding technique for separating the signature pixels from the background pixels. Clearly, in this application, we are interested in dark objects on a light background, and therefore, a threshold value H, called the brightness threshold, which is appropriately chosen and applied to image pixels f(x, y) as in the following Equation (2)

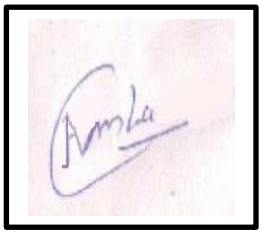
$$\begin{aligned} &\text{If } f(x, y) \geqslant H \text{ then} \\ &\quad f(x, y) = \text{Background} \\ &\text{else } f(x, y) = \text{Object} \end{aligned} \qquad (2)$$

Signature image which is located by separating it from the complex background image is converted into binary image white background taking the pixel value of 1. Vertical and horizontal (histogram) projections are used for

border clearing. For both direction, vertical and horizontal, we counted every row zeros so the resulting histogram is plotted sideways.

Figure 2: After and before removed background

a) Captured signature **b) Signature image with background removed**



IV. Signature normalization

Signature dimensions may vary due to the irregularities in the image scanning and capturing process. Furthermore, height and width of signatures vary from person to person and, sometimes, even the same person may use different size signatures. First, we need to eliminate the size differences and obtain a standard signature size for all signatures. After this normalization process, all signatures will have the same dimensions. In this study, we used a normalized size of 50x50 pixels for all signatures that will be processed further. During the normalization process [12], the aspect ratio between width and height of a signature is kept intact. Normalization process made use of the following equations*:*

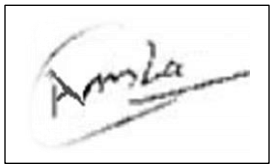
$$xi = \frac{x'_{i-X_{min}}}{X_{max-X_{min}}} \quad (3)$$

$$yi = \frac{y'_{i-y_{min}}}{y_{max-y_{min}}} * M \quad (4)$$

In these equations:

xi,,yi : pixel coordinates for the normalized signature,
x'i,,y'i : pixel coordinates for the original signature,
M : one of the dimensions (width or height) for the normalized signature
The normalization process is demonstrated in the following figure.

Fig 3. Signature normalization



2. FEATURE EXTRACTION

Feature extraction is "Extracting the information from the raw data which is most relevant for classification stage[10]. This data can be minimized within-class pattern variation and increases the inter-class variations." Therefore, achieving a high recognition performance in signature recognition system is highly influenced by the selection of efficient feature extraction methods, taking into consideration the domain of the application and the type of classified used [11]. An efficient feature extraction algorithm should require two characteristics the first character Invariance and the second is reconstruct-ability Features that are invariant to certain transformations on the signature which would be able to recognize many variations of these signatures, These features are extracted as follows[13]:

1. Center of mass is Split the signature image in two equal parts and find center of mass for individual parts.
2. Normalized area of signature is the ratio of area of signature image to the area of signature enclosed in a bounding box. Area of a signature is the number of pixels comprising it.

3. Aspect Ratio is the ratio of width of signature image to the height of the image.
4. Wrinkleless is the total number of black pixels available in the image after all the pre-processing has been done. Since the pixel count parameter is a unique value, we use this property of handwritings to distinguish between genuine and forged signature.

IV. Design authentication method based on neural network

A. backpropagation architecture [14]

The type of Architecture implemented in the project is multiplayer backpropagation architecture as shown in Fig (4).
This neural network is formed in three layers, called the input layer, hidden layer, and output layer. The lines between the nodes indicate the flow of information from one node to the next. In this particular type of neural network, the information flows from the input to the output and return the information in state error. The input layer contains the number of nodes according to length of the user identity. The initial weights are generated randomly using uniform distribution within the range of [0 1], as shown in fig (5).

Fig 4. backpropagation architecture

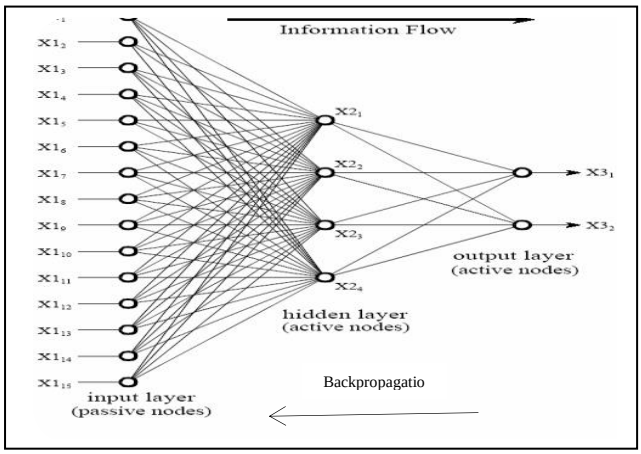
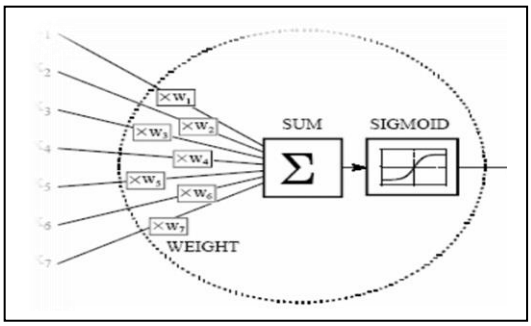


Fig 5. Neural Network ActiveNode



B. Transfer function: Sigmoid Function

Sigmoid function, mathematically described by the equation

$$S(x) = 1/(1+e^{-\lambda x}) \quad (5)$$

Having several advantages like:

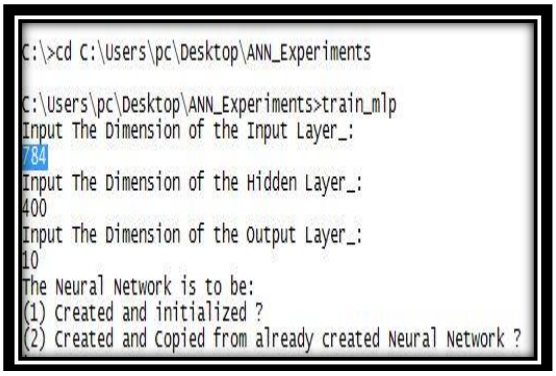
1. Soft limiter
2. Mathematical model of biological neuron, firing phenomenon the characteristic is appearing like sigma function.
3. It derivative is easily available which is required in learning process

$$S'(x) = s(x)[1 - s(x)] \quad (6)$$

V. Module of neural network

We used artificial neural network in type back propagation contain input layer 784 inputs and hidden layer is 400 and output layer 10 as in the figure below.
The recognition phase consists of two parts, training and testing respectively which is accomplished by artificial neural network. We used the window command and write allocation file requirement to train such in figure below

Figure 6 : Design module ANN



we used 720 images in our database belonging to 60 people are used for both training and testing. Since 8 (out of 12) input vectors for each image were used for training purposes, there are only 224 (56*4) input vectors (data sets) left to be used for the test set. Under normal (correct) operation of the back propagation neural network, only one output is expected to take a value of "1" indicating the recognition of a signature represented by that particular output. The other output values must remain zero. The output layer used a logic decoder which mapped neuron outputs between 0.5-1 to a binary value of 1. If the real value of an output is less than 0.5, it is represented by a "0" value. The back propagation neural network program recognized all of the 58 signatures correctly.

VI. RESULT AND CONCLUSION

In this study, we presented Off-Line Signature Recognition and Verification System using the artificial neural network (back propagation) which is based on steps of image processing, invariant central moment invariants & some global properties and back propagation neural networks. This result translates into a 96.5% recognition rate by using equation below.

$$\text{Recognition rate} = Identifiedsignatures \,/\, totalsignatures \times 100 \quad (7)$$

Table 1:Recognition rate of test signatures

Epochs	MSE(lasterror)	Recognition rate
10	5167.7337	91.55014
20	2547.6865	94.107803
30	1079.4637	95.422493
40	352.3727	95.972275
50	99.4488	96.199356
60	31.5398	96.318871
70	12.2692	96.342773

The recognition system gives the 96.5% success rate by recognizing the all signature pattern correctly for all that signature which is used in training. It gives the poor performance for signature that is not in the training phase. Generally, the failure to recognize/verify a signature was due to poor image quality and high similarity between 2 signatures. Recognition and verification ability of the system can be increased by using additional features in the input data set. This study aims to reduce to a minimum the cases of forgery in business transaction

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