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Enhanced Offline Signature Recognition Using Neuro- Fuzzy and SURF Features Techniques

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***Abstract*— Signature verification systems can be divided as offline and online. The paper presents Surf features technique and neural-fuzzy techniques depends recognition of offline signatures system i.e. trained with low-resolution scanned signature images. The signature of a person is most important biometric attribute of a human being which can be used to authenticate human identity. The human signatures can be handled as a figure and recognized using computer vision and neural network techniques. And with modern worlds; there is need to develop fast algorithms for signature recognition. Thus there are different techniques to signature recognition with a lot of scope of research. This paper; off-line signature recognition & verification using neural-fuzzy is proposed, where the signature is catch and presented to the user in an image format. Signatures are verified depend on parameters extracted from the signature using various image processing techniques. Then Off-line Signature Recognition and Verification is implemented with SURF features and Neural Fuzzy techniques in ANFIS in Matlab. . The invented algorithm can be used as an effective signature verification technique. This algorithm proposed was successfully made rotation invariant by the rotation of the image. This work has been tested and found better result than previous techniques.**

***Keywords*— SURF Feature, Neural-Fuzzy and Signature verification**

I. INTRODUCTION

In our world, tradition and accept mean for a person to identify and know himself either to another person being or to a computer system is based on one or more of these 3 general principles:

1. What the person knows
2. What he possesses or
3. What he is

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. Then hand written signature is one of the types to authorize transaction and know the human identity compared with other electronic identification methods such as finger prints scan and retinal pattern screening. This is simpler for people to change from using the famous pen-and-paper signature to one where the hand written signature is captured and verified electronically. Thus signature of a human is an important bio metric attribute of a person and is used for authorization purpose. And many approaches are finding for signature recognition with much of scope of research. Then here; we deal with an off-line signature recognition technique. Signatures are mixtures of special characters and flourishes and therefore most of the time they can be not readable. Then also intra personal changes and inter personal differences make it need to analyze them as complete figures and not as letters and words put together. Signature recognition is the process of identify the writer's identity by check the signature against samples keep in the database. Then result of this process is usually between 0 and 1 which represents a fit ratio (1 for match and 0 for mismatch). The signature recognition is used most important to discuss the ability of a computer to translate human writing into text. And this may take place in both ways either by scan of written text (off-line method) or by write directly on to a peripheral input device. Thus 1st of these recognition techniques, known as Optical Character Recognition (OCR) is the most important in the main stream. At last most scan suites offer some form of OCR; allowing user to scan hand written document and have them translated into basic document. And OCR is also used by few archivists as a method of changing massive quantities of hand written historical documents into searchable, easily-accessible digital forms .

The image matching methods can be roughly divided into two classes; one is the image matching based on image matching and feature matching. Matching method is directly use the image grey value to determine the space geometry transform between the images, this method can make full use of the information of the image, so it is also known as the matching method based on integral image content; it has no feature detection steps; in the feature matching stage; the fixed size window and even whole image matching are adopted in estimation; so the calculation is simple and also easy to be performed. Therefore the image retrieval that is based on artificial notes still remains insufficiency, the farther study that adapts vision image features has been come up and become the main study. Then character of this method is image feature extraction impersonally; whether the retrieval is good or not depends on the accuracy of the features extraction. Therefore the research based on vision features is becoming the focus in the academic community. Therefore the feature of vision can be classified by semantic hierarchy into middle level feature and low- level feature. Low-level feature includes colour, texture and inflexion. Middle level involves shape description and object feature.

II. OVERVIEW OF SIGNATURE RECOGNITION

A problem of personal verification and identification is an actively growing area of research. The method is numerous and are depend on different personal characteristics; voice; lip movement; hand geometry; face; odor; gait; iris; retina and fingerprint are the most commonly used authentication methods. And all these psychological and behavioral characteristics are called biometrics. Then driving force of the progress in this field is above all; the growing role of the internet and electronic transfers in modern society era. Therefore considerable number of applications is concentrated in the area of electronic commerce and electronic banking systems.

The biometrics have a significant advantage over traditional authentication techniques (namely passwords, PIN numbers, smart cards etc) due to the fact that biometric characteristics of the individual are not easily transferable are unique of every person and cannot be lost; stolen or broken. Then choice of one of the biometric solutions depends on several factors which include:

1. User acceptance
2. Level of security required
3. Accuracy
4. Cost and implementation time.

The method of signature verification reviewed in this paper benefits the advantage of being highly accepted by potential customers. Then use of the signature has a long history which goes back to the appearance of writing itself. And utilization of the signature as an authentication method has already become a tradition in the western civilization and is respected among the others. Then signature is an accepted proof of identity of the person in a transaction taken on his or her behalf. Then the users are more likely to approve this kind of computerized authentication method. Signature verification systems differ in both their feature selection and their decision methodologies. Therefore more than 40 different feature types have been used for signature verification. Features can be classified into two major types: local and global. Global features are features related to the signature as a whole; for instance the average signing speed; the signature bounding box and Fourier descriptors of the signatures trajectory. Then local features correspond to a specific sample point along the trajectory of the signature. Signature recognition and verification involves two separate but strongly related tasks: one of them is identification of the signature owner; and the other is the decision about whether the signature is genuine or forged. Then also; depending on the need; signature recognition and verification problem is put into two major classes: (i) On-line signature recognition and verification systems (SRVS) and (ii) Off-line SRVS. On-line SRVS requires some special peripheral units for measuring hand speed and pressure on the human hand when it creates the signature. Thus on the other hand; almost all Off-line SRVS systems rely on image processing and feature extraction techniques.

A. Image Preprocessing and Features Extraction

We approach the problem in two steps. Then initially; the scanned signature image is preprocessed to be suitable for extracting features. The preprocessed image is used to extract relevant geometric parameters that can distinguish forged signatures from exact ones using the ANN approach.

Preprocessing:

The signature is first captured and transformed into a format that can be processed by a computer. Now it's ready for preprocessing. And in preprocessing stage; the RGB image of the signature is converted into grayscale and then to binary image. Then purpose of this phase is to make signatures ready for feature extraction. The preprocessing stage includes two steps: Colour inversion, Filtering and Binarization.

Colour Inversion:

The true colour image RGB is converted to the grayscale intensity image by eliminating the hue and saturation information while retaining the luminance. A grayscale image is a data matrix whose values represent intensities within some range where each element of the matrix corresponds to one image pixel.

Image Filtering and Binarization:

Any image when resample is filtered by a low pass FIR filter. It is used to avoid aliasing problem. And aliasing occurs because of sampling the data at a rate lower than twice the largest frequency component of the data. Therefore a low pass filter will remove the image high frequency components. This purpose the filter used. Now the grayscale image is segmented to get a binary image of objects. In a binary image; each pixel assumes one of only two discrete values 1 or 0. And binary image is stored as a logical array.

Figure.1. (a) A sample signature to be processed; (b) A Grayscale Intensity Image

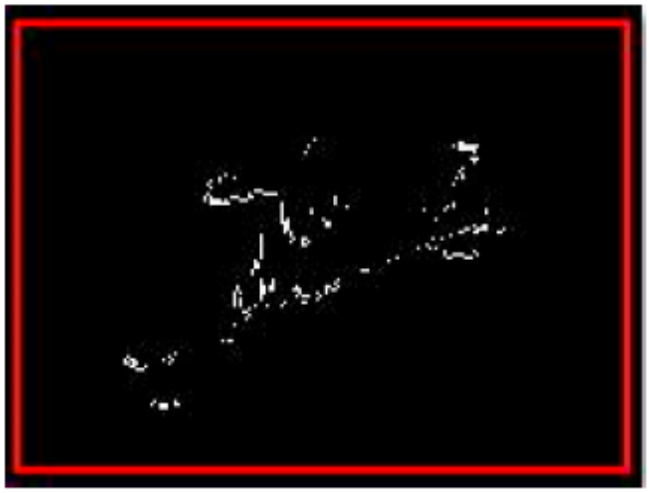

Figure 2: Binary figure interpreting the bit value of 0 as black and 1 as white

Features Extraction is the key to develop an offline signature recognition system. We use a set of five global features that cannot be affected by the temporal shift.

B. Types of Signature Verification Based on the definitions of signature: it can lead to two different approaches of signature verification. Off-Line or Static Signature Verification Technique This approach is based on static characteristics of the signature which are invariant. To this sense the signature verification; becomes a typical pattern recognition task knowing that variations in signature pattern are inevitable; the task of signature authentication can be narrowed to drawing the threshold of the range of genuine variation. In the offline signature verification techniques; images of the signatures written on a paper are obtained using a scanner or a camera.

C. On-line or Dynamic Signature Verification Technique: This is the second type of signature verification technique. And this approach is based on dynamic characteristics of the process of signing. And this verification uses signatures that are captured by pressure sensitive tablets that extract dynamic properties of a signature in addition to its shape. And dynamic features include the number of order of the strokes; the overall speed of the signature and the pen pressure at each point that make the signature more unique and more difficult to forge. Thus the application areas of Online Signature Verification include protection of small personal devices (PDA,; laptop) authorization of computer users for accessing sensitive data or programs and authentication of individuals for access to physical devices or buildings.

Nature of Human Signature

It is supposed that the features of the process of signing originate from the intrinsic properties of human neuromuscular system which produces the aforementioned rapid movements. Thus knowing that this system is constituted by a very large number of neurons and muscle; fibers is possible to declare based on the central limit theorem that a rapid and habitual movement velocity profile tends toward a delta-log normal equation. The statement explains ability of the characteristics of the signature. The signature can be treated as an output of a system obscured in a certain time interval necessary to make the signature.

III. NEURAL AND FUZZY LOGIC

Neural network is set of interconnected neurons. This is used for universal approximation. Artificial neural networks are composed of interconnecting artificial neurons (programming constructs that mimic the properties of biological neurons). Thus Artificial neural networks may either be used to gain an understanding of biological neural networks; or for solving artificial intelligence problems without necessarily creating a model of a real biological system. Then real; biological nervous system is highly complex: artificial neural network algorithms attempt to abstract this complexity and focus on what may hypothetically matter most from an information processing point of view. Good performance (e.g. as measured by good predictive ability; low generalization error) or performance mimicking animal or human error patterns; can then be used as one source of evidence towards supporting the hypothesis that the abstraction really captured something important from the point of view of information processing in the brain. Then other incentive for these abstractions is to reduce the amount of computation required to simulate artificial neural networks.

A. Architecture of artificial neural network

The basic architecture consists of three types of neuron layers, input; hidden; and output. Then in feed-forward networks; the signal flow is from input to output units; strictly in a feed-forward direction. Then data processing can extend over multiple layers of units; but no feedback connections are present. The recurrent networks contain feedback connections. The contrary to feed-forward networks; the dynamical properties of the network are important. Then in some cases; the activation values of the units undergo a relaxation process such that the network will evolve to a stable state in which these activations do not change anymore.

B. Feed Forward Neural Networks

Feed-forward ANNs allow signals to travel one way only; from input to output. There is no feedback (loops) i.e. the output of any layer does not affect that same layer. The Feed-forward ANNs tend to be straight forward networks that associate inputs with outputs. Thus they are extensively used in pattern recognition. And this type of organisation is also referred to as bottom-up or top-down. Then Single-layer perceptron; multilayer perceptron and radial basis function are types of feed forward neural networks.

C. Single layer Perceptron

The simplest kind of neural network is a single-layer perceptron network; which consists of a single layer of output nodes; the inputs are fed directly to the outputs via a series of weights. And in this way it can be considered the simplest kind of feed-forward network. Then sum of the products of the weights and the inputs is calculated in each node; and if the value is above some threshold (typically 0) the neuron fires and takes the activated value (typically 1); otherwise it takes the deactivated value (typically -1). Neurons with this kind of activation function are also called artificial neurons or linear threshold units. And in the literature the term perceptron often refers to networks consisting of just one of these units. Thus a similar neuron was described by Warren McCulloch and Walter Pitts in the 1940s.A perceptron can be created using any values for the activated and deactivated states as long as the threshold value lies between the two. Most perceptron have outputs of 1 or -1 with a threshold of 0 and there is some evidence that such networks can be trained more quickly than networks created from nodes with different activation and deactivation values. Perceptron can be trained by a simple learning algorithm that is usually called the delta rule. This calculates the errors between calculated output and sample output data; and uses this to create an adjustment to the weights; thus implementing a form of gradient descent. Single-unit perceptron are only capable of learning linearly separable patterns.

D. Multilayer Neural networks

This class of networks consists of multiple layers of computational units; usually interconnected in a feed-forward way. And each neuron in one layer has directed connections to the neurons of the subsequent layer. Many applications the units of these networks apply a sigmoid function as an activation function. Thus universal approximation theorem for neural networks states that every continuous function that maps intervals of real numbers to some output interval of real numbers can be approximated arbitrarily closely by a multi-layer perceptron with just one hidden layer. Result holds only for restricted classes of activation functions, e.g. for the sinusoidal functions. Multi-layer networks use a variety of learning techniques; the most popular being back-propagation .

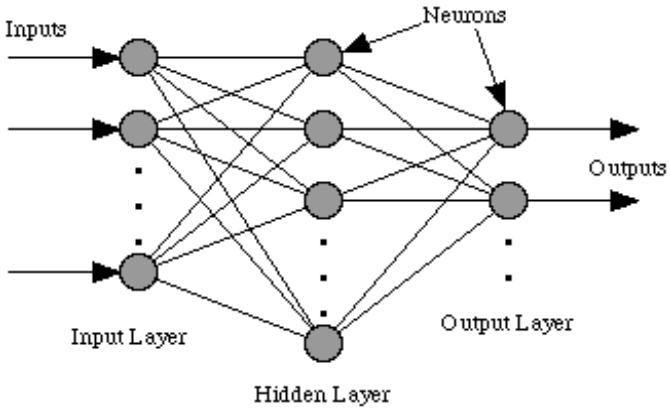

Figure 3: Multiple NN

Here, the output values are compared with the correct answer to compute the value of some predefined error-function. Thus various techniques; the error is then fed back through the network. And using this information; the algorithm adjusts the weights of each connection in order to reduce the value of the error function by some small amount. Thus repeating this process for a sufficiently large number of training cycles; the network will usually converge to some state where the error of the calculations is small. Thus in this case; one would say that the network has learned a certain target function. And adjust weights properly; one applies a general method for non-linear optimization that is called gradient descent. To this; the derivative of the error function with respect to the network weights is calculated; and the weights are then changed such that the error decreases (thus going downhill on the surface of the error function). To this reason; back-propagation can only be applied on networks with differentiable activation functions.

E. Fuzzy Logic

The word "fuzzy" refers to the logic that the facts cannot be either "true" or "false"; they can be "partially true". Rule based fuzzy logic has some rules written by the programmer. On the basis of these rules fuzzy is trained, more the no. of rules more will be the accuracy because the fuzzy system became strong by imposing the more rules.

Rule based fuzzy logic is a type of logic which includes more than just true or false output but it's a logic which handles or deals with the situations where there is a partial output neither true nor false means the output lies in between true and false. In FL there is a range of values in the interval instead of true or false. FL gives the intermediate values. Rule based FL use IF-THEN rules which are simples rules written in English. On the basis of these rules FL is trained, more the rules more strong will be the fuzzy intelligence system. No of rules used to train the fuzzy logic intelligence system make difference in the accuracy of the system or we say intelligence of the system directly proportional to the no of rules; more the rules more intelligent the system will be.

IV. SPEEDED UP R0BUST FEATURE (SURF)

SURF (Speeded up Robust Features) is a robust local feature detector; first presented by Herbert Bay et al in 2006; that can be used in computer vision tasks like object recognition or 3D reconstruction. Therefore partly inspired by the SIFT descriptor. And standard version of SURF is several times faster than SIFT and claimed by its authors to be more robust against different image transformations than SIFT. And SURF is based on sums of 2D Haar wavelet responses and makes an efficient use of integral images. This uses an integer approximation to the determinant of Hessian blob detector; which can be computed extremely quickly with an integral image (3 integer operations). Therefore the features; it uses the sum of the Haar wavelet response around the point of interest. These can be computed with the aid of the integral image. And SURF used in this approach to extract relevant features and descriptors from images. This approach is preferred over its predecessor due to its succinct descriptor length that is 64 floating point values. In SURF, a descriptor vector of length 64 is constructed using a histogram of gradient orientations in the local neighborhood around each key point. Modified SURF (Speeded up Robust Features) is one of the famous feature-detection algorithms. Then panorama image stitching system which combines an image matching algorithm; modified SURF and an image blending algorithm; multi-band blending. This process is divided in the following steps: first; get feature descriptor of the image using modified SURF; secondly; find matching pairs; using correlation matrix; and remove the mismatch couples by RANSAC(Random Sample Consensus); then; adjust the images by bundle adjustment and estimate the accurate homographic matrix; lastly; blend images by Alpha blending. And comparison of SIFT (Scale Invariant Feature Transform) and Harris detector are also shown as a base of selection of image matching algorithm. And according to the experiments; the present system can make the stitching seam invisible and get a perfect panorama for large image data and it is faster than previous method. SURF approximates or even outperforms previously proposed schemes with respect to repeatability; distinctiveness; and robustness; yet can be computed and compared much faster. And achieved by relying on integral images for image convolutions; by building on the strengths of the leading existing detector sand descriptors specially, using a Hessian matrix-based measure for the

detector; and a distribution-based descriptor and by simplifying these methods to the essential. Its leads to a combination of novel detection; description; and matching steps. It approximates or even outperforms previously proposed schemes with respect to repeatability; distinctiveness; and robustness; yet can be computed and compared much faster. At last achieved by;

1. Relying on integral images for image convolutions
2. Building on the strengths of the leading existing detectors and descriptors (using a Hessian matrix-based measure for the detector; and a distribution based descriptor).
3. Simplifying these methods to the essential. Therefore this leads to a combination of novel detection; description; and matching steps.

ADVANTAGES OF SURF:

SURF descriptor is a tool with huge potential in application in the field of annotation of medical images. It is possible to achieve over 96% accuracy by applying SURF algorithm

V. EXPERIMENT AND RESULT DISCUSSION

The Figure 4 is the main GUI window which acts as home window contains two buttons i.e. start and exit to come back the execution of program.

Figure 4: Opening GUI created

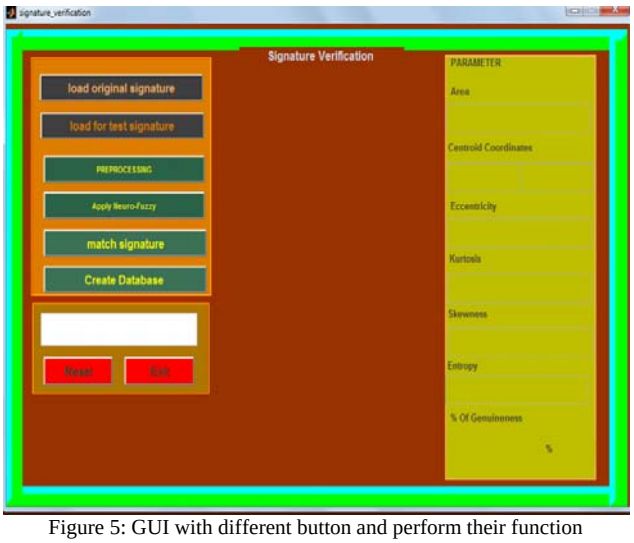

Figure 5: GUI with different button and perform their function

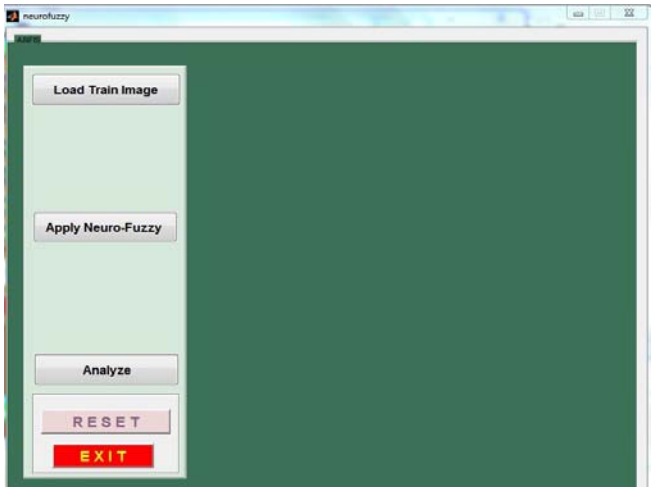

Figure 6: GUI to load the image by click on button load image

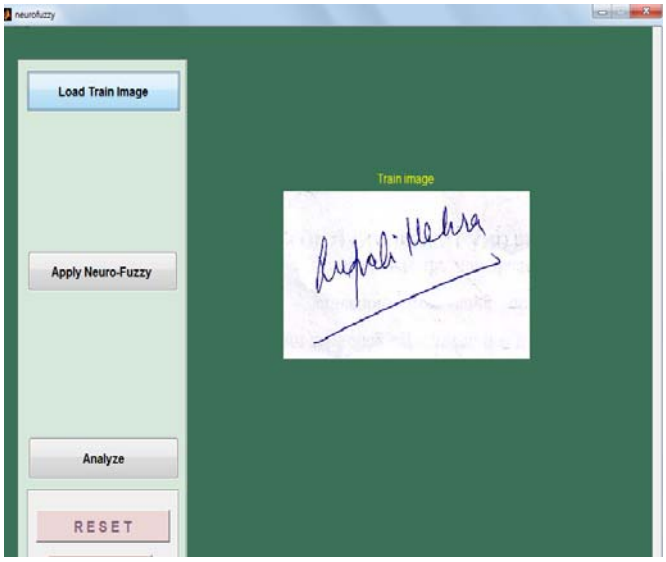

Figure 7: TO show the image after load and train

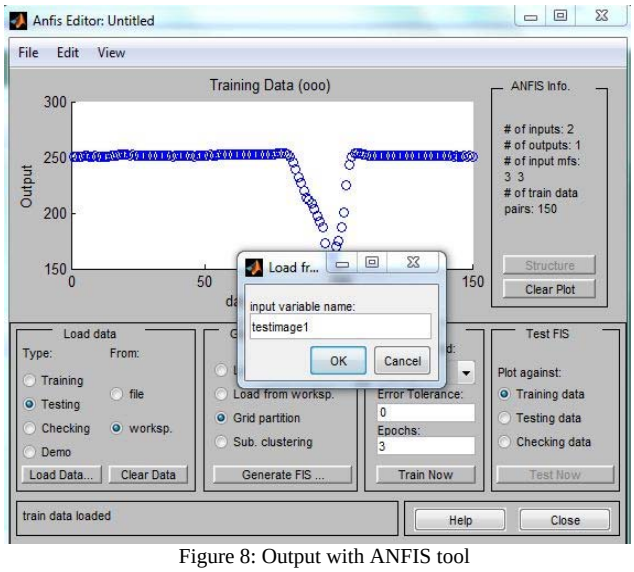

Figure 8: Output with ANFIS tool

Here the result showed is combination of Neural-Fuzzy logic technique by using ANFIS tool. Because this tool is helpful to produce better result with good accuracy as compared to previous result.

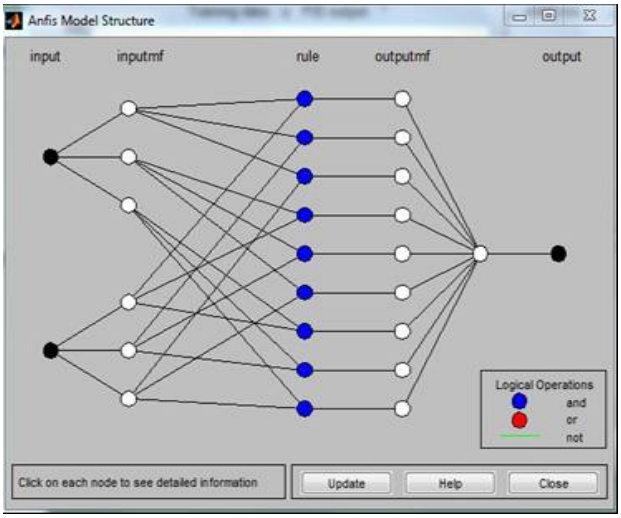

Figure 9: ANFIS tool model structure

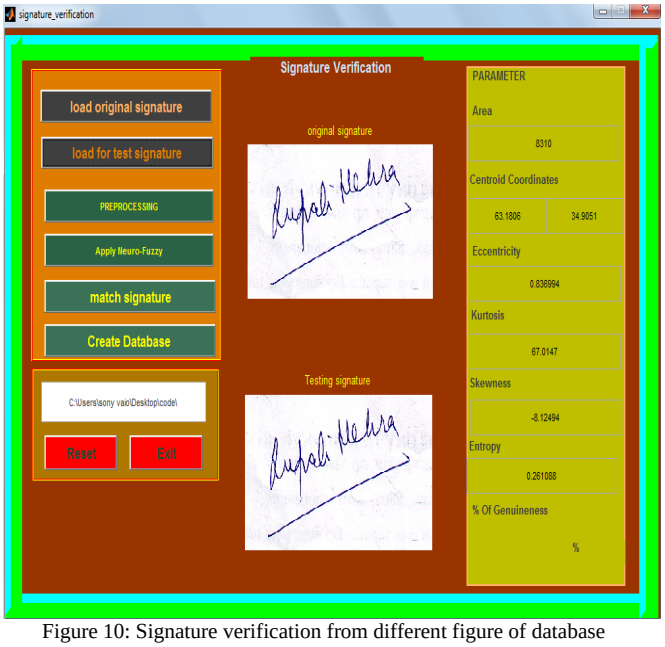

Figure 10: Signature verification from different figure of database

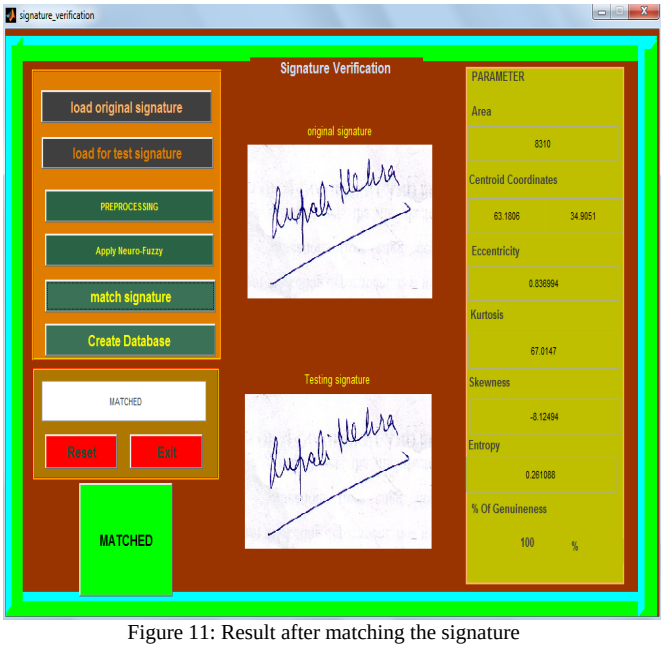

Figure 11: Result after matching the signature

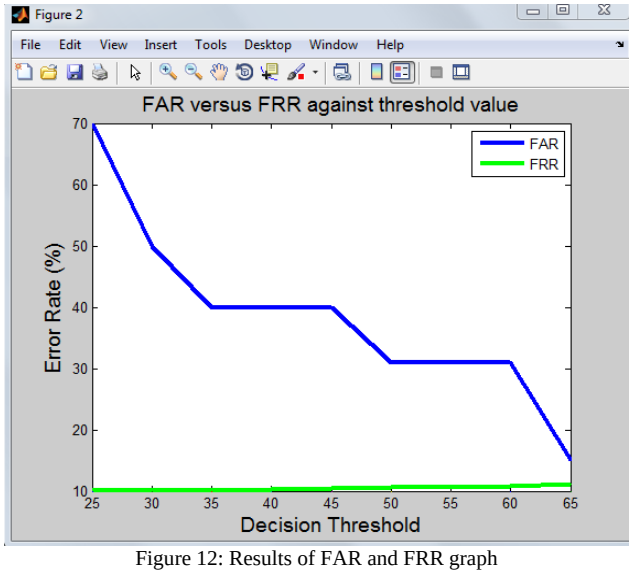

Figure 12: Results of FAR and FRR graph

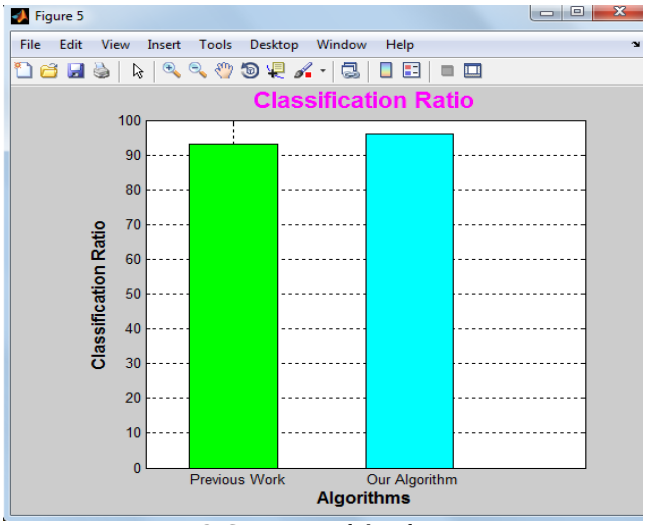

Figure 13: Comparison of classification ratio

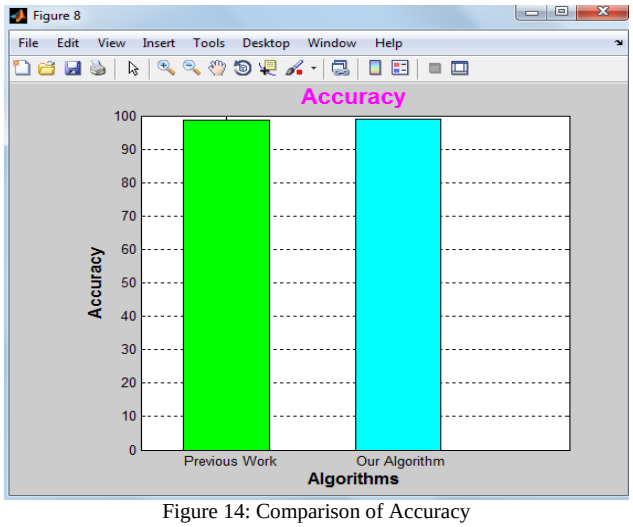

Figure 14: Comparison of Accuracy

Here we use surf features and NN-Fuzzy technique for offline signature verification with good accuracy and 100% genuineness rate. This technique performs good rotation invariant. This technique is better than previous techniques.

VI. CONCLUSION

Advantage of using neural-fuzzy logic is that they can extract the most discriminative and representative set of features. We have presented a learning vector quantization neural network architecture based on varying parameters and eliminating redundant hidden layer units or blind neurons that learns the correlation of patterns and recognizes handwritten signatures. The surf features is trained on the random training samples to perform recognition task on the input signature image. And empirical results yield an accuracy rate of 98% for a random test set of handwritten signature images on the network that is trained with another set of different images of same subjects. This proposed algorithm can be used as an effective signature verification system. Then algorithm invented was successfully made rotation invariant by the rotation of the image. The error rejection rate can further be improved by using better techniques for rotation; blurring and thinning.

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