
Neuro-Fuzzy System based Handwritten Marathi Numerals Recognition System

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Abstract: Character Recognition is one of the important tasks in Pattern Recognition. The complexity of the character recognition problem depends on the character set to be recognized. In this paper it is developed Off-line strategies for the isolated handwritten Marathi numerical (0 to ९) with Neuro fuzzy logic has been provided. The neural fuzzy system is considered for soft computing. This method improves the character recognition method. Neuro Fuzzy System is integration of Neural Network and Fuzzy logic. In that we are using neural fuzzy system for classification.

Index Terms: Neural network, Pattern Recognition, Fuzzy logic

1. Introduction: Handwritten character recognition is used most often to describe the ability of computer to translate human writing into text. The complexity of the character recognition problem depends on the character set to be recognized. The main objective of character recognition is the conversion of a graphical document into a textual one. Many systems have been proposed to recognize pattern. Some of these systems have been used the fuzzy logic. Most of the character recognition systems require preprocessing operations on the pattern.

In such system an optical scanner converts each

handwritten numeral to a digital image, and computer software classifies the image as one of the digits zero through nine. By reducing the need for human interaction, numeral-recognition systems can speed up jobs such as Bank Statement, cheque amount value written in Marathi numerical. Several steps are necessary to achieve this. A recognition system must first capture digital image of handwritten numerals. Before attempting to classify the numerals, some preprocessing image might be necessary. An algorithm must then classify each handwritten numeral as one of the ten decimal digits.

2. Handwritten Recognition using neuro –fuzzy System:

A neuro-fuzzy hybrid system proposed by J.S.R. Jang, is a learning mechanism that utilizes the learning and training algorithms from neural networks to find parameter of fuzzy system (i.e fuzzy set, fuzzy rule etc) Fuzzy logic and neural network are complementary technologies. They work different level of abstraction and individually provide rich functionality. A combination of these two technologies using advantages of both. Fuzzy logic provides a high level of framework for approximate reasoning that handle both the uncertainty and Linguistic semantics. Neural network provide self organization subtracts for low level representation of information with off-line adaption capabilities. So combining both these approach in design of intelligence System.

A recognition system must first capture digital image of Marathi handwritten numerical. Before attempting to classify the numerals, some preprocessing image might be necessary. For classification apply neural fuzzy system. Two intensity values are available in binary image. These values are Black and White. We are use zero for Black and one for white. Thus the color of the character is White and the background is black. Preprocessing techniques are needed on color, grey-level or binary document images containing numerical and/or

graphics. In character recognition systems most of the applications use grey or binary images since processing color images is computationally.

In neuro-fuzzy system neural network are embedded as a part of fuzzy system to endow it with additional capability such as flexibility, speed and adaptability.

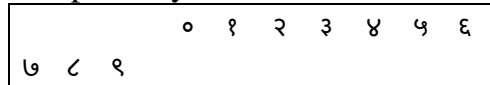
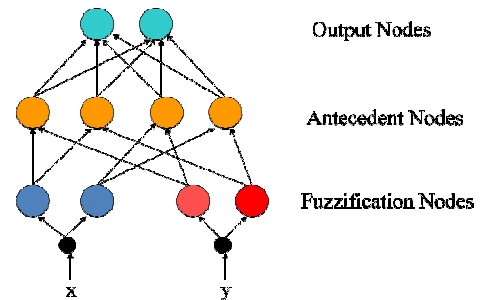


Fig. Number set to be recognized

Neural networks are used to tune membership functions of fuzzy systems that are employed as decision-making systems for controlling equipment



Fuzzification Nodes:

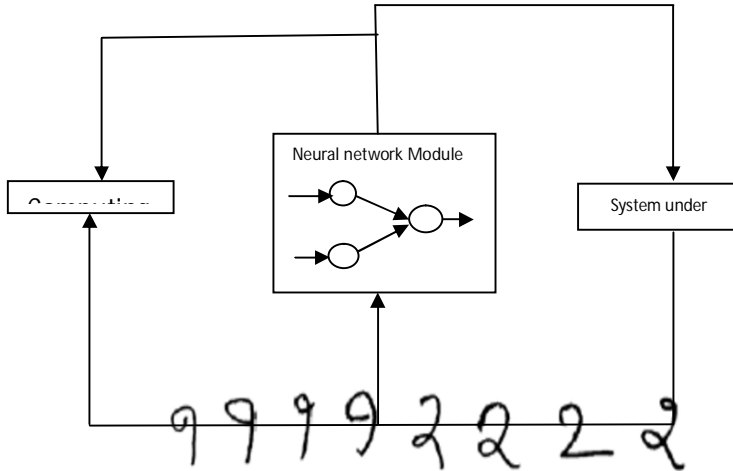
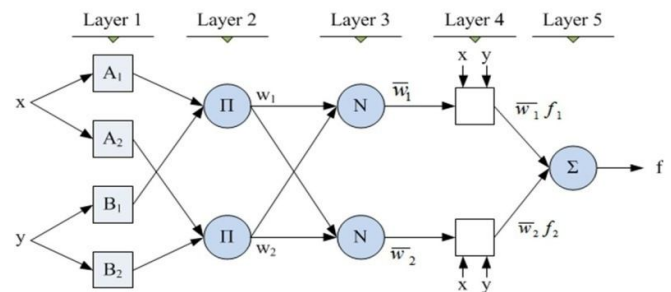
Represents the term sets of the features. If we have two features x and y and two linguistic variables defined on both of it say BIG and SMALL. Then we have 4 fuzzification nodes.

$$z = \exp \left\{ - \frac{(x - \mu)^2}{\sigma^2} \right\}$$

Classification of Neuro-Fuzzy System: In this resembles neural network where a fuzzy system is assumed to be a neural network; the fuzzy sets are regarded as weights and the rules, input and output variable as neurons. Discard neuron can be made in learning step. Fuzzy Knowledgebase is represented by the neurons of neural

Another method is training data is grouped into several cluster and each cluster is designed to represent a particular rule. These rules are defined by the crisp data .in this case neural network is applied to train the defined cluster.

interpreted as a neural network of special kind. In this type of classification rule base of fuzzy network. Membership function expressing the inference rules should be formulated by building the fuzzy controller. Using this classify the data handwritten numerals in appropriate class



Different methods for writing the Marathi numerical to different person these are classified in Appropriate class.

The input is given to the system as a scanned image these are converted into digital image. The features selected should consider these properties of a character. Using Here the Euclidean features consider the distance between the strokes, the Radon features take into account the orientation of the character and the normalized pixel density features consider the shape features of the character.

The distance between pixels can be measured using Euclidean distance transform [112] in which the value at a pixel is linearly proportional to the Euclidean distance between that pixel and the object pixel closest to it. The Euclidean distance DE between two

pixels (i,j) and (k,l) is: $DE [(i,j),(k,l)]=[(i-k)^2+(j-k)^2]^{1/2}$

It calculates the distance between each pixel that is set to off (0) and the nearest nonzero pixel for binary images as . Consider a 5x5 binary image.

D =

1.3142	1.0000	1.3142
2.3361	3.1623	
1.0000	0	1.0000
2.2000	2.2361	
1.3142	1.0000	1.3142
1.0000	1.4142	
2.336	1 3.0000	1.0000
0	1.0000	
3.2623	2.3361	1.3132
1.2000	1.4142	

Pixel of a pattern is give as input to the NFS system. The output will be class label of given Marathi numeral.

The ANFIS is a fuzzy inference system: This system based on the model of Takagi-Sugeno [11] and uses five layers. For reasons of representation, we will consider a system with two inputs and one output and also consider a model of the 1st order using two rules:

If x1 is A1 and x2 is B1 then $y1=f1(x1,x2) = a1x1 + b1x2 + c1$.

If x1 is A2 and x2 is B2 then $y2=f2(x1,x2) = a2x1 + b2x2 + c2$.

Training the neural network: Recognition of handwritten numerical is performed by giving

the input image of the numerical. The given image is first converted into a gray scale image. Then the gray level image is converted into a binary image using threshold. Afterwards noise is eliminated by using filters. The next step is size normalization followed by thinning which extracts the skeleton of the image without any loss of the topological properties. After preprocessing of character, features of character are extracted. This step helps in classifying the characters based on their features. Training is done by neural network using learning rules, the neural network must optimize the parameter by fixing a distance shape of membership function. Regardless of the shape of the membership functions training data should also be available.

Is there having 100 samples out of that 50 will be given for training and 50 for testing.

Testing and result: we are given the handwritten Marathi numerical to the intelligence system first In such system an optical scanner converts each handwritten numeral to a digital image, and computer software classifies the image as one of the digits zero through nine class .then fuzzy interface system find the class of input image in knowledge base and give the appropriate result to the user.

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