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Abstract – Handwriting recognition has been one of the active and challenging research areas in the field of pattern recognition. It has numerous applications which include, reading aid for blind, bank cheques and conversion of any hand written document into structural text form[1]. As there are no sufficient number of works on Indian language character recognition especially Kannada script among 15 major scripts in India[2].In this paper an attempt is made to recognize handwritten Kannada characters using Feed Forward neural networks. A handwritten kannada character is resized into 20x30 pixel.The resized character is used for training the neural network. Once the training process is completed the same character is given as input to the neural network with different set of neurons in hidden layer and their recognition accuracy rate for different kannada characters has been calculated and compared. The results show that the proposed system yields good recognition accuracy rates comparable to that of other handwritten character recognition systems.

Keywords *- Handwritten Kannada Character Recognition, Feed forward neural network, Recognition accuracy rate.*

I. INTRODUCTION

One of the most classical applications of the Artificial Neural Networks is the Character Recognition System. This system is the base for many different types of applications in various fields, many of which we use in our daily life. Cost-effective and less time consuming, businesses, post offices, banks, security systems, and even the field of robotics employ this system as the base of their operations. Whether you are processing a check, performing an eye/face scan at the airport entrance, or teaching a robot to pick up an object, you are employing the system of Character Recognition.

II. CREATING THE CHARACTER RECOGNITION SYSTEM

The Character Recognition System must first be created through a few simple steps in order to prepare it for presentation into MATLAB. The matrixes of each kannada character must be created along with the network structure. In addition, one must understand how to pull the binary input code from the matrix, and how to interpret the binary output code, which the computer ultimately produces.

A. Character matrixes

A character matrix is an array of black and white pixels; the vector of 0 is represented by black, and 1 by white. They are created manually by the user using image processing techniques, in whatever size or font imaginable; in addition, multiple fonts of the same character may even be used under separate training sessions.

B. Creating a character matrix

First, in order to endow a neural network with the ability to recognize characters, we must create those characters. The first thing to think about when creating a character matrix is the size that will be used. Too small characters may not able to be created,especially if you want to use two different fonts. On the other hand, if the size of the matrix is very big, their may be few problems like training of neural network may take days, and results may take hours.In addition, the computer's memory may not be able to handle enough neurons in the hidden layer needed to efficiently and accurately process the information. However, the number of neurons may just simply be reduced, but this in turn may greatly increase the chance for error.A character matrix size of 20X30 was created and it is shown in Figure 1.

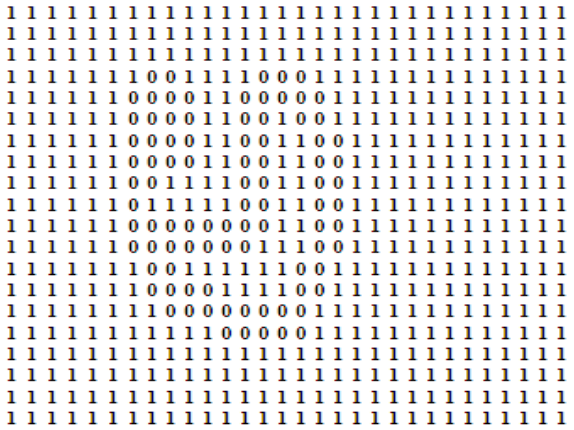

Figure. 1 Character Matrix of 'ah'

III. NEURAL NETWORK

A feed forward back propagation neural network is used in this work for classifying and recognizing the kannada handwritten characters[1].The neural classifier consists of a hidden layer besides an input layer and an output layer as shown in Figure 2.The hidden layer use tansig activation function and the output layer is a competitive layer as one of the characters is required to be identified at any point in time. The neural network receives 24 element input vector in which each element represents a particular

kannada character of 20x30 pixel in size[1]. Once the neural network has been trained successfully it is then required to identify the same corresponding character of 20x30 pixel.In addition, the network should also be able to handle noise. In practice, the network does not receive a perfect kannada character as an input. Specifically, the network should make few mistakes as possible when classifying characters with noise.

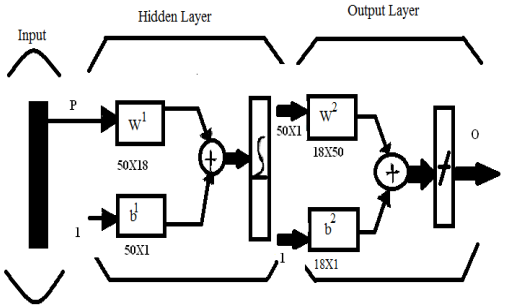

TABLE I

Details of Four Neural Based Character Recognition Systems

Networks	1	2	3	4
No of Layers	2	2	2	2
No of neurons in hidden layer	10	25	50	100
No of Neurons in output layer	18	18	18	18
Learning rate	0.1	0.1	0.1	0.1
Error rate	10e-4			

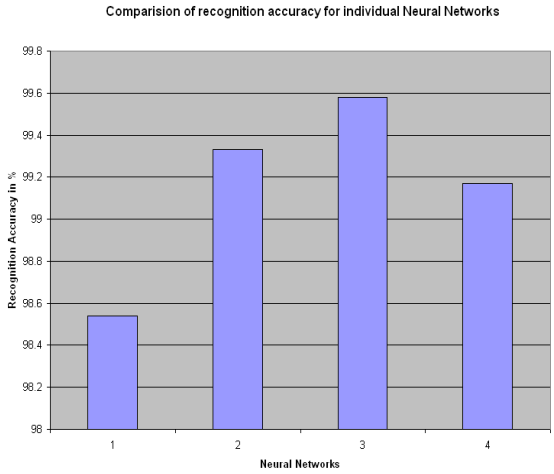

Figure. 3 Comparison of the recognition accuracy for individual networks

TABLE III

The performance comparision of four neural based character recognition systems

Net	Accuracy Rate in %			
	1	2	3	4
ಅ	100	100	100	100
ಇ	96.83	99.86	99.66	99.50
ಉ	100	100	100	100
ಊ	100	100	100	100
ಏ	96	97.83	97.50	98.33
ಏ	96.17	98.66	98.16	97.16
ಒ	98.6	100	100	100
ಓ	98.66	97	99.16	96.33
ಅಂ	99.16	100	100	100
ಅಃ	98.60	99.66	100	100
ಕ	97.16	99.83	98.66	99.83
ಖ	99	100	100	100
ಗ	98.33	98	99.50	98.33
ಙ	98	99	100	99.50
ಜ	99.50	99.66	100	99.83
ಟ	99.17	100	100	100
ಠ	99.16	99.66	99.66	99.83
ಡ	99	98.33	99.50	97.50
ಣ	98.50	99.50	100	99.66
ಸ	98	99.16	99.50	97.33
ಲ	99.50	100	100	100
Over all %	**98.54**	**99.33**	**99.58**	**99.17**

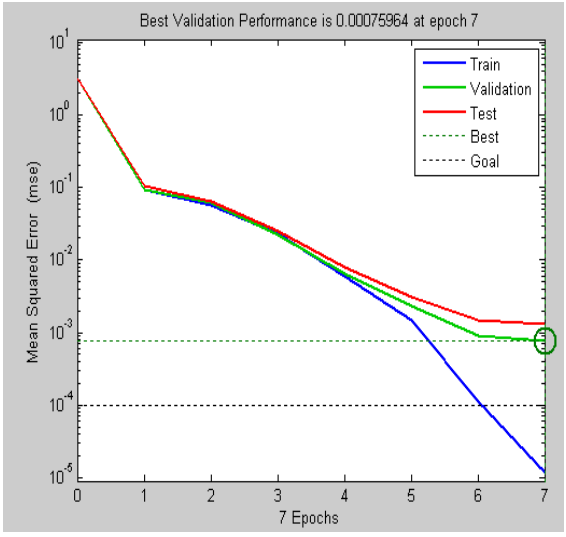

Figure. 4 The variation of MSE with training Epochs

V. CONCLUSION

A neural network based kannada character recognition system has been introduced in this paper for classifying and recognizing the kannada handwritten and printed characters. The pixel values derived from the resized characters using image processing techniques have been directly used for training the neural network[8].As a result, the proposed system will be less complex compared to other methods of character recongnition systems.Of the several neural network architectures used for classifying the kannada characters, the one with a hidden layer having 50 neurons has been found to yield the highest recognition accuracy of 99.58%. The handwritten recognition system described in this paper will find potential applications in handwritten name recognition, document reading, conversion of any handwritten document into structural text form and postal address recognition.

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