Character Recognition of Different Styles and Fonts Using Hopfield ANN

[1]Jeya Mary S, [2]Muppudathi R, [3]Lavanya Mathiyalagi A

[1,2,3]Assistant processor, Computer Science and Engineering, Einstein College of Engineering, Tirunelveli.

ABSTRACT:

Handwritten character recognition (HCR) is the detection of characters from images, documents such as pdf and other sources and get the characters in flexible machine-readable form such as text present in notepad or word. We can use this text or characters for further processing. The accurate in recognition is still a challengeable task since every individual handwriting is different from others. Recent advances in Artificial neural network (ANN) such as Hopfield network have made great improvement in recognizing English characters present in images of different types. In this paper, Hopfield ANN is implemented to recognize the characters from a different set of test dataset. The main focus of this work is to investigate Hopfield ANN capability to recognize the characters from the image dataset and the accuracy of recognition with training and testing. Hopfield ANN recognizes the characters by considering the forms and contrasting the features that differentiate among characters. Our Hopfield implementation is experimented with the dataset IAM handwriting data base and CENPARMI Handwriting database to obtain the accuracy of handwritten characters. Test result provides that an accuracy of 98.93% accuracy with a training set of more than 1000 images.

Index terms: Hope field ANN, Handwritten Character Recognition ,LSTM algorithm, CENPARMI Handwriting database.

1. INTRODUCTION

Character Recognition is an essential task for converting the printed text or image into digital text. bIt is very important field of Pattern recognition and Artificial intelligence. Aim of our project is to develop a system using Hopefield ANN to automatically detect Hand written Character Recognition or Printed Text. The Hopfield Neural Network is invented by John Hopfield in 1982. Unlike feed forward neural networks, Hopfield networks developed to store and retrieve patterns, making the system suitable for associative memory applications, including character recognition. The Hopfield network consists of a set of interconnected neurons, where each neuron represents a binary digit -1 or +1.Neurons in a Hopfield network are fully connected, meaning each neuron is connected to every other neuron in the Network. Hope field networks are known for their associative memory properties. Given a partial or noisy input pattern, the network can recall and complete the pattern based on its learned associations. It makes them useful for recognizing characters even when presented with incomplete or distorted inputs. During recognition, an input pattern is presented to the network. The network iteratively updates its neurons based on a specific update rule until it converges to a stable state The stable state reached by the network corresponds to the closest memorized pattern, allowing the network to recognize the input character. Hopfield networks have some limitations, such as the potential for spurious patterns or the network converging to incorrect state. The capacity of Hopfield networks is also limited, and they may struggle with large or complex datasets. In the context of character recognition, Hopfield networks provide a simple and elegant solution for character recognition.

2. LITERATURE REVIEW

There are many research papers available on Character Recognition but very few available for Indian script. Let we discuss about That techniques.

1. Machine Learning Techniques For Character Recognition: It involves many steps to Recognize a image and get character from that image.

Step 1 : Preprocessing

Preprocessing means making raw data suitable for use in machine learning techniques and it involves noise cleaning and organizing the raw data, skew detection ,edge detection and correction, binarizatoin, region identification of text and so on.For text binarization We can improve accuracy and efficiency of machine learning technique with this preprocessing. We can create data set by using various API's and Save that dats for further use. Local threshold should be effective for noisy images compare to global threshold .The another method is Histogram based threshold approach to convert gray scale image in to binary image.

2.2 Skew detection and correction

Our recognition algorithm, relies on Characters of a page or image being oriented correctly.If images are not aligned correctly, this is called as skew and this Skew reduce the accuracy of segmentation and classification. Skewed lines are made horizontal by calculating skew angle accurately and making proper correction in the raw image by prusinojecting a sample image parallel to line and also it is done using Hu moments and various transforms . Digital straight line segmented from the upper profile it's detected as head line. The slope of this line gives an accurate estimation of skew angle. Skew correction can be done by rotating document in inverse direction by same skew amount. Keep rotating the document step by step in small variation in angle and find out the maximum row histogram value . Radon transform is one of the best method used for finding the correct skew angle .

2.3 Segmentation

Segmentation is one of the challenging process in the character recognition system of different styles of character.. The process of segmentation mainly follow three basic steps: first, separate the lines from image document. Second, separate the word from the line and third and final step is separate the character from the given image. Line and word segmentation is normally done using histogram approach. For character segmentation there is two approach the histogram approach] and. Zone separation. If zone separation applied then it divided into three part upper zone, middle zone, and lower zone.

2.4 Classification

For the classification purpose many methods are used like the Euclidean Minimum Distance, Hamming Distance classifier, the k–Nearest Neighbor classifier and artificial neural network ,CNN, RCNN. The combined approach of wavelet feature extraction and GRNN classification has given the highest recognition accuracy r compare to nearest neighbor algorithm.. Binary Features, Chain Code, Principle Component Analysis (PCA) and Fisher Discriminate Analysis (FDA) are used for feature extraction. For classification in Neural network and SVM are used. Back propagation in neural network with Gradient descent with momentum & adaptive learning rate is used. In the paper the performance of Hopfield ANN model in recognizing the handwritten character of English as well digit (an Indian language) is addressed. Set of printed characters and modifiers were chosen and subjected to classification by Hopefield ANN architectures by considering linear activation function in the output layer.

3. SYSTEM STUDY

PROPOSED SYSTEM

HOPFIELD ARTIFICIAL NEURAL NETWORK

Hopfield neural network is proposed by American biophysicist Hopfield in 1982, it is interconnected mesh neural network model, in Hopfield ANN neuron in the network can bidirectionally connect with other neurons. This feature makes Hopfield network a feedback network in that the output of every neuron can feed as input to other neurons in the same level. The Hopfield network is a nonlinear dynamic process, which can be described by nonlinear differential equations .Based on different choices of activation functions, Hopfield network can be divided into continuous and discrete network, which are Continues Hopfield Neural Network and Discrete Hopfield Neural Network. Action function of Continues Hopfield Neural Network is S-type function, which is continuous in time domain and is used for optimizing computation. Action function of Discrete Hopfield Neural Network is threshold type function, and is mainly used in associative memory and the outputs of its neurons are 1 and -1 (or 0), representing activated and depressed state respectively. When initial states are determined, the network will learn from initial states to dynamical process when we do external excitation. External excitation changes in energy decreasing direction until close or reach to the equilibrium. If the pattern that network needs to memorize need to be designed as equilibrium of net state, then, when the network starts running from an initial state close to the memorized pattern and updates each and every state according to Hopfield principles, it will finally make all states stable around the minimal point of energy function, which is the final state for memorized pattern. In this way, associative memorizing function of complete information from partial information can be realized.

Fig 1. Structure of Hopfield ANN

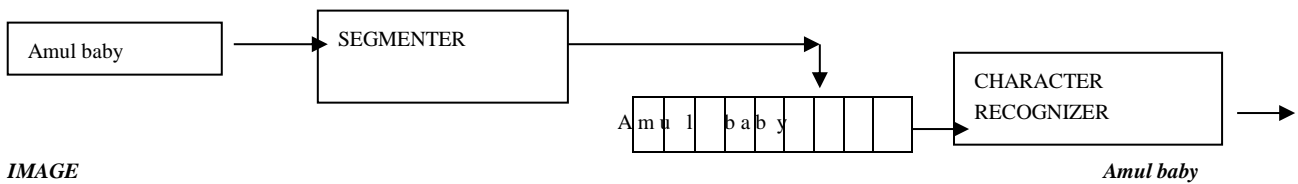Fig 2. A Simple image Example used for Character Recognition

Fig 3. An simple Approach for Character Recognition

3.1. Associative memory

Associative memory is distributed memory that alike brain and learning is done by association . Associative memory can map input which concerns with its value to a corresponding characters stored information in memory. We can implement associative memory by using recurrent neural networks and choosing proper weight to have a stable output. As a recurrent neural network, this stable output become an input.

3.2. Hebbian learning

A Hebbian learning rule is a learning rule used in neural networks that determines the weight of connection between two units whether the weight should be increased or decreased to the product of their activation function. Hebbian learning uses learning rate to activate neurons simultaneously to strengthen them and to produce good recognition rate. Four important properties of Hebbian learning such as Time-dependent mechanism, Local mechanism, Interactive mechanism and Conjunctional mechanism used to educate neurons in the network.

There are four steps in Hopfield network :

a. Using Hebb learning, set of input $x1, x2, …, x$m are contributed from N-dimensional fundamental memory.

$$W = \frac{1}{N} \sum_{r=1}^{M} x_r x_r^T - \frac{M}{N} I$$

b. Initialize xp vector for testing.

$$x_i(0) = x_{ip}$$
$$i = 1,2, … , N$$

Where xi(0) is ith neuron.

c. Do iteration with asynchronously adjustment using rule as shown below:

$$x_1(n+1) = hsgn\left(\sum_{j=1}^{N} w_{ij} x_j(n) \right), i = 1,2,3 … N$$

$$hsgn(v_i(n+1)) \begin{cases} 1, & v_i(n+1) > 0 \\ v_i(n), & v_i(n+1) = 0 \\ -1 & v_i(n+1) = 0 \end{cases}$$

$$v_i(n+1) = \sum_{j=1}^{N} w_{ij} x_j(n)$$

d. Result, when vector x in stable condition.

3.3 Methodology

We used Hopfield network for recognizing characters of different fonts and styles of English letters and digits.. First, we collected the data. Then, the collected characters are transformed from TTF format into *bitmap* format (BMP). The characters are combined in many combinations and for each character combination noise is added. Then we performed operations with this combinations on Hopfield network to obtain pattern. We used Hebbian learning to construct Hopfield Artificial neural network as an associative memory.
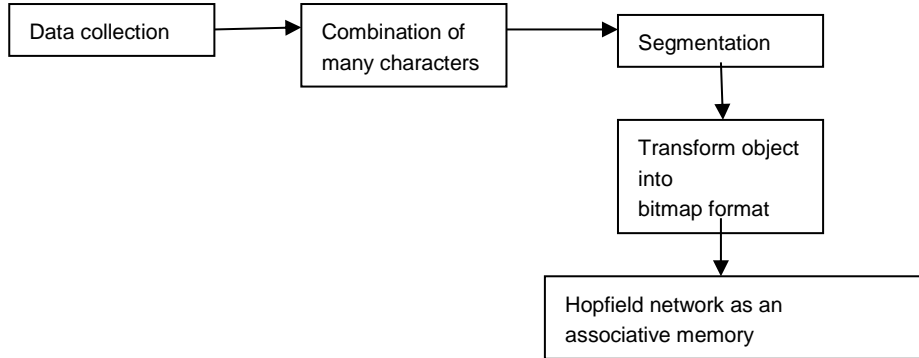
Fig 5 Methodology used in hope field network

3.4 Experiment result

We used combination of different characters for testing the performance of Hopfield network. From the given characters combination, we obtained 500 combinations of various fonts and styles and put noise into them. Matlab function,*imnoise*, is employed to get result of effect of noise in character recognition.

Table 1. Experiment result.

Noise	Combination of Characters of different styles	Result
0	Yes	100%
0	Yes	100%
1	Yes	95%
1	Yes	92%
2	yes	87%
3	yes	82%
4	yes	79%
5	yes	73%

The experimental results obviously seen from table 1 that without noise Hopfield reached outstanding performance in recognizing different fonts and styles of Characters. With noise increases, its accuracy of recognition is decreased. When noise decreases, accuracy of recognition is increased. By using matlab embedded function *imnoise*, we put maximum noise at 5 since at that point the character is getting more blurred and harder to be seen obviously. The average accuracy of our experiment was 88.62%.

4. CONCLUSION AND FUTURE SCOPE

There are many techniques are available to recognize Character in all the languages such as Chinese, Tamil, Hindi, Malayalam and Telugu Etc. But it is still a challengeable job to do character recognition with good accuracy and precision and Fast in converting the Text present in image into flexible text. This method of Character Recognition gives good accuracy ex nearly 98.93% and also fast in training and Testing the Artificial Neural Network. This Hopefield ANN is very simple to develop and ituses Associative memory for doing Character Recognition. Hopefield Neural Network complexity is less than normal concurrent Neural network. No need to import libraries and tools to perform Character recognition. We can use this Project in mobile also. We can improve the efficiency and accuracy of cursive handwritten character recognition task by combining Hopefield ANN and also Genetic Algorithm. We performed character recognition task by using MATLAB.

FUTURE SCOPE

- ➢ The Handwritten English Character recognition is done with good speed and accuracy.

- ➢ We can extend this method to recognize Tamil Handwritten character recognition with high accuracy.

- ➢ We can do character Recognition with RCNN and we can compare the result of Hopefield ANN and RCNN.

References

 [1]. Yu Y, Si X, Hu C and Zhang J 2019 A review of recurrent neural networks: lstm cells and network architectures *Neural Comput.* **31** 1235–70 .

[2]. Tanaka G, Yamane T, Héroux J B, Nakane R, Kanazawa N, Takeda S, Numata H, Nakano D and Hirose A 2019 Recent advances in physical reservoir computing: a review *Neural Networks* **115** 100–23.

[3]. G S Budhi and R Adipranata 2014 Java Character Recognition using Evolutionary Neural Network and Combination of Chi2 and Backpropagation *Neural   Network International.*

[4]. Yin Xuan, Wang Sheng. Research on Letter Distinguish Based on Discrete Hopfield Neural Net [J]. Computer & Digital Engineering. 2011(01), Vol.39, No.1: 35-38.

[5] Jiang Han, Liu ChangSong, Li ShiYang. An On-line Handwritten Arithmetic Expression Recognition System [J].Journal of Electronic & Information Technology, 2010, 5, Vol.32, No.5: 1126-1230