

Handwriting Recognition System- A Review

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ABSTRACT

Handwriting recognition has been an active and challenging area of research. Handwriting recognition system plays a very important role in today's world. Handwriting recognition is very popular and computationally expensive work. At present time it is very difficult to find correct meaning of handwritten documents. There are many areas where we need to recognize the words, alphabets and digit. There are many application postal addresses, bank cheque where we need to recognize handwriting. This review paper will focus on different technique which is used on handwriting recognition. There are basically two different types of handwriting recognition system online and offline handwriting recognition. There are many approaches are present for offline handwriting recognition system. This review paper will represent the limitations and superiorities of different technique which is used for handwriting recognition system. So handwriting recognition has been studied from many decades. Handwriting recognition system can be used to solve many complex problems and can make human's work easy. So this paper is an overview of different approaches of handwriting recognition system with their limitations and accuracy rate.

General Terms

Offline handwriting recognition, neural network, back propagation algorithm, feature extraction, segmentation and training, fuzzy neural network.

Keyword

Handwriting recognition, neural network, MatLab

1. INTRODUCTION

Handwriting recognition is an ability and technique of the system which receive the input from touch screen, electronic pen, scanner, images and paper documents. Offline handwriting recognition system is an art of identifying the word from images. As we know every person has their different writing style, so it is very difficult to recognize the correct handwritten characters and digits. Handwriting recognition system is developed to achieve the accuracy and reliable performance. So handwriting recognition is most challenging area if image and pattern recognition. Handwriting recognition is very useful in real world. There are many practical problems where handwriting recognition system is very useful like documentation analysis, mailing address interpretation, bank check processing, signature verification, postal addresses. Several approaches have been used in both online and offline handwriting recognition field like statistical methods, structural methods, neural network and syntactic methods. Some recognition system identify strokes, other apply recognition on single character or entire words. So handwriting recognition system is work as a communication medium between human and machines. Figure1 shows example of some hand written words and digits.

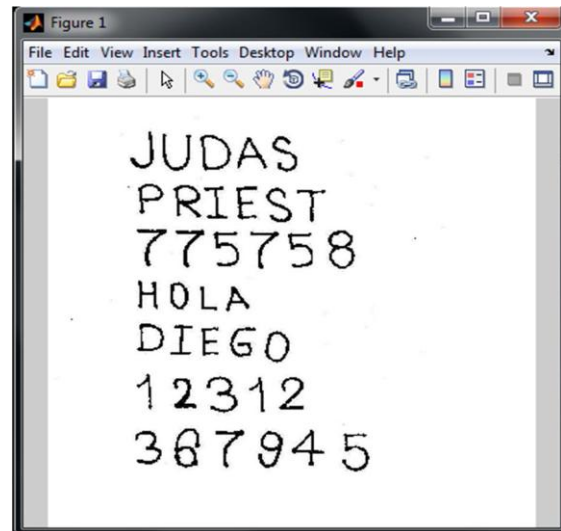


Fig 1: Sample of handwritten words

2. HISTORY

Optical character recognition system has been studied in last many decades. In 1914 Emanuel Goldberg developed a system that read handwritten character and digits and converted then into a telegraph code. At the same time Edmund Fournier d'Albe developed the Optophon, a handheld scanner that scan the printed page and produced the output. Goldberg continued to develop Handwriting recognition system for data entry. After some time he proposed matching the images with the templates containing the desire identification. This technique is known as template matching method.

After that Paul W.Handel also proposed a US patent on template matching handwriting technology in USA in 1933.In 1994 RCA engineers proposed first primitive computer type optical character recognition to help blind people. It designed to convert the handwritten report into punched cards for input in the computer for help in processing the shipment of 20-25 million books in a year. In 1965 Reader's Digest and RCA collaborated to build an optical character recognition system. In 1985 structural approaches were proposed with the statistical methods. In this systems broke the characters into set of patterns like horizontal and vertical lines and different curves. In this method system focused on shape of the characters. After 1990 the real progress is achieved using new techniques and methodologies in image processing and pattern recognition. In today's world more powerful computers and more accurate equipments like electronics pen, scanner and tablets are used. Many approaches like HMM, neural network, back propagation algorithm, fuzzy neural network are using to recognize handwritten documents.

3. LITERATURE REVIEW

A systematic search for handwritten documents was proposed after 1990 with the keyword neural network.

3.1 Analysis on the Parameter of Back Propagation Algorithm with Three Weight Adjustment Structure for Hand Written Digit Recognition:

This research (Chayaporn Kaensar, 2013) describe a method for handwriting recognition using back propagation algorithm. Back propagation algorithm is most widely used neural network because of its some advantage such as quick speed, classification ability and good recognition effect. So the back propagation algorithm using momentum item, role function, number of hidden node, learning rate is used to represent high recognition rate. In this paper three methods Simple Back Propagation, Back propagation with momentum terms and Back propagation using conjugate gradient descent methods are used to analysis of recognition rate. All analysis is performed on handwritten digits data set from UCI machine learning repository using different classification techniques.



Fig2: Examples of UCI Data Set

3.1.1 Using Simple Back Propagation

In simple back propagation only one parameter learning rate are used. In this constant number of iteration is performed over data set to find out the result. In Figure3 the graph represent recognition rate for different learning rate and hidden nodes.

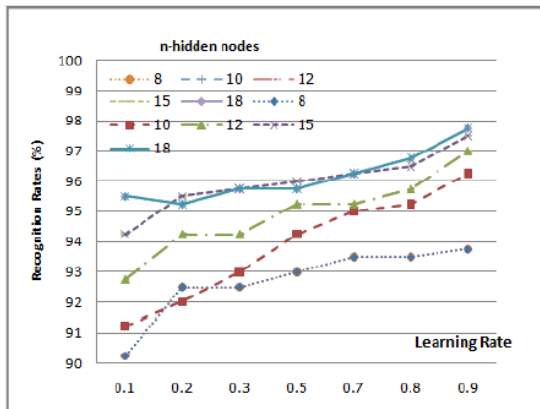


Fig 3: Rec.rate using learning rate and hidden nodes

3.1.2 Back propagation with momentum term

This method used momentum term to add a fraction momentum. The main reason behind this method is to prevent the system from converging to a local minimum. The graph shows that selection of high momentum term and high learning rate give high recognition rate.

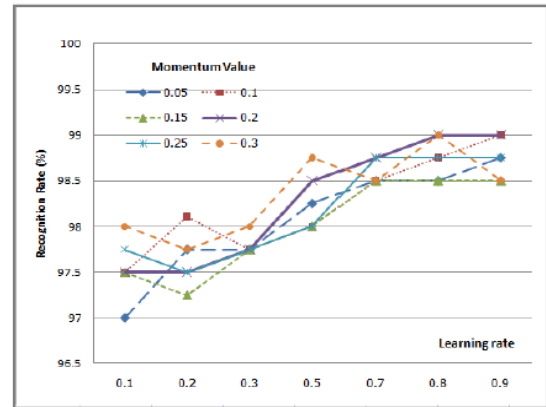


Fig 4: Rec.rate using momentum value and learning rate

3.1.3 Back propagation using conjugate gradient descent

In this method no free parameter is used. Only numbers of hidden nodes of hidden layer are trained differently. The graph shows analysis of recognition rate using numbers of hidden nodes.

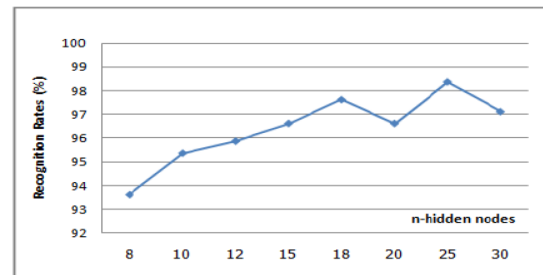


Fig 5: Rec. rate using Numbers of Hidden Nodes

3.2 Hand-Printed English Character Recognition based on Fuzzy Theory

This paper (Puttipong Mahasukhon, Hossein Mousavinezhad, Jeong-Young Song, 2012) recognize the handwritten English character using fuzzy theory. This technique has two functions feature extraction and pattern recognition. Every character contains different deviations for e.g. position, size and shape due to different writers. In thin paper recognition is tested on 26 lowercase handwritten English characters and each character is stored in binary bitmap image.



Fig 7: Block Diagram of Pattern Recognition System using Fuzzy Theory

3.2.1 Pre processing

In this step the document scanning are performed. There are number of tools are present to perform this step.

3.2.2 Feature Extraction

The recognition rate mainly depends on the feature of the character. Feature can be structural, topological and geometrical. Geometrical features like angle and distance are explored in order to achieve high recognition rate. The properties that need to determine in fuzzy theory are number of circles, number of strokes and numbers of dots.

3.2.3 Character recognition

After feature extraction a recognition system is used to identify the corresponding character. Here we used fuzzy theory to recognize the character. In this method a variation is deal with the membership function which is composed by x, y coordinates and length of the segment of the character. And then degree to compare segments of input to segment in database is calculated.

There four steps are present for handwritten English character.

In first step is read an input data from the handwritten documents. These characters are saved in binary bitmap format. The input image resolution should be 100x100 pixels to make sure that the character is not too big and small.

In second step extraction of features are present. There are six segments are present, which consist dot(D), circle(C), right-incline line (RI), left-incline line (LI), up-down line(UD), left-right line (LR) as feature parameters.

In third step matching the target image with the training images is performed and calculates the degree of similarity is calculated using Min-Max operation. For calculating the degree of similarity we have to fuzzify each input segment.

In the last step system represent the result in a printed character.

Character	Segments	Number
a	C, IL or C, UD	2
b	UD, C	1
c	IR, UD, LR or IL, IR, IL, LR	2
d	UD, C	1
e	IL, UD, LR or UD, LR	2
f	C, UD, IL, LR or C, UD, IL	2
g	UD, IR, IL or UD, LR, UD	2
h	C, IL or C, UD	2
i	D, UD or D, IR, IL	2
j	D, UD, LR or D, UD, IL	2
k	UD, IR, IL	1
l	UD	1
m	UD, LR, UD, LR, UD or UD, IR, UD, IR, UD	2
n	UD, IR, UD or UD, LR, UD	2
o	C	1
p	C, UD	1
q	C, UD or C, UD, IR	2
r	UD, IR or UD, IR, LR	2
s	IR, LR, IR, LR or IL, IR, UD, LR, IR, IL	2
t	UD, LR, IR or UD, LR, LR	2
u	UD, IR, UD or UD, LR, UD	2
v	IR, IL	1
w	IL, IR, IL, IR	1
x	IR, IL	1
y	IL, IR, UD or IL, IR	2
z	LR, IR, LR or LR, IR, LR, LR	2

Fig 7: All segment of English characters

3.3 Neural Network based Handwritten Character Recognition system without feature extraction:

In this paper (J.Pradeep, E.Srinivasan, S.Himavathi, 2011) a neural based offline handwriting recognition system without feature extraction is developed. IN this method each character

is resized into 30x20 pixels and after that using feed forward back propagation neural network is used to train the pixels.

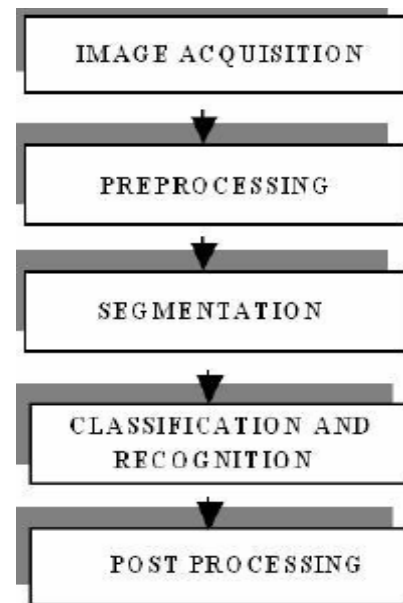


Fig 8: A Diagram of Recognition System without Features Extraction

3.3.1 Image acquisition

The recognition system accepts a scanned image as an input. The images can be in JPEG, BMT format.

3.3.2 Pre-processing

In pre-processing stage various operation are performed like on image like binarization, noise removing, and edge detection.

3.3.3 Segmentation

In segmentation stage a sequence of character is segmented into sub-image of individual character. Each character is resized into 30x20 pixels.

3.3.4 Classification and Recognition

This stage is the decision making stage of the recognition system. The classifier contains of two hidden layers are present. The hidden layers used log sigmoid activation function to train the data. The number of neurons in the output layer is 26.

3.3.5 Post-processing

Post processing is last stage of recognition system. It prints the actual output after recognition after calculating equivalent ASCII value.

Networks	1	2	3	4	5	6	7
No of layers	2	2	2	3	3	3	3
No of neuron in input layer	600	600	600	600	600	600	600
No of neurons in 1 st hidden layer	50	100	200	50	100	200	300
No of neurons in 2 nd hidden layer	0	0	0	50	100	200	300
No of neuron in output layer	26	26	26	26	26	26	26
Learning rate	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Error rate	10e-8						

Fig 9: The Seven Neural based Character Recognition System

3.4 Neural Network System for Continues Handwritten Words Recognition

In this paper (Ernst M.Kussul, Lora M.Kasatkina, 1999) a new Method of continuous hand written word recognition is derived. This Method performs segmentation of the word onto triplets and triplets contain 3 letters. And two subsequent of triplets have 2 common letters. Such overlapping gives high recognition rate. The main problem with recognition system is performing the operation on continuous word. In this each word is subdivide into triplet and each triplet contains three letters. Figure 10a shows triplet “aba” and figure 10b shows triplet “ban”. Two neighbour triplets always contain two common letters which represent the overlapping between letters. This overlapping is used to give high recognition rate.

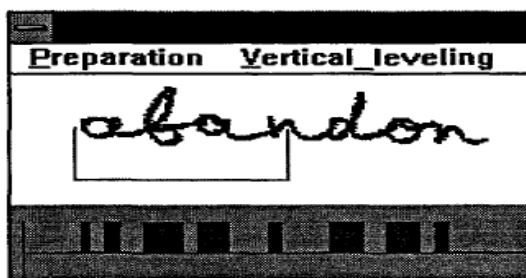


Fig 10(a): First triplet of aba

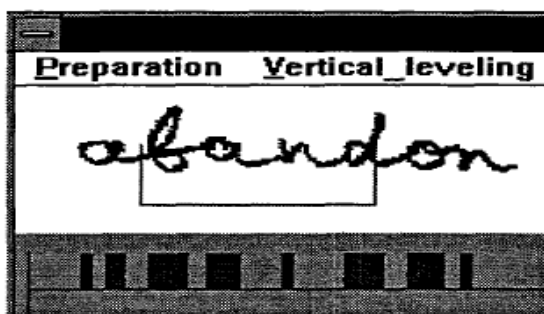


Fig 10(b): Second Triplet of “ban”

Special auto-associative neural network is used to train the data set. The training of system contains in creation of cross-correlation matrix. It connects the neural code of triplet with corresponding symbolic neural codes.

4. CONCLUSION AND FUTURE SCOPE

This review paper represent the different technique are available for recognize the hand written documents. This review paper also focuses on that in today’s world hand writing reorganization is very difficult but very important. There are many applications where we need hand writing recognition system like bank cheque, postal addresses, and form documents. In all the techniques main stage is feature extraction. This Paper represents the comparison between all the techniques.

This algorithm can be used for recognize Hindi, Punjabi, Urdu and many more languages. We can add fuzzification with Back propagation algorithm to improve the efficiency and correctness of the algorithm. This algorithm can be used to recognize the word and paragraph also.

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