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Handwritten Character Recognition using Neural Network

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Abstract: Handwritten character recognition is an area of pattern recognition which defines an ability of a machine to analyze a pattern and identify the character. Pattern recognition is the science of making inferencas from perpatule data based on either priore knowledge or on statistical information. This paper focouses on development of software algorithm to recognize any hand written character efficiently on computer with input is either an old optical image or currently provided through touch input, mouse or pen.

Keywords: NN Neural Network, Character recognition, pattern recognition.

I. INTRODUCTION

Character recognition (also character reader, CR) is the mechanical or electronic conversion of images of typed, handwritten or printed text into machine-encoded text, whether from a scanned document, a photo of a document, a scene-photo (for example the text on signs and billboards in a landscape photo) or from subtitle text superimposed on an image (for example from a television broadcast). It is widely used as a form of information entry from printed paper data records, whether passport documents, invoices, bank statements, computerised receipts, business cards, mail, printouts of static-data, or any suitable documentation.

I.1 TYPES OF CHARACTER RECOGNITION

The constant development of computer tools leads to a requirement of easier interfaces between the man and the computer. A Character Recognition deal with the problem of reading offline handwritten character i.e. at some point in time (in mins, sec, hrs) after it has been written. However recognition of unconstrained handwritten text can be very difficult because characters cannot be reliably isolated especially when the text is cursive handwriting.

They are classified are of two types :-

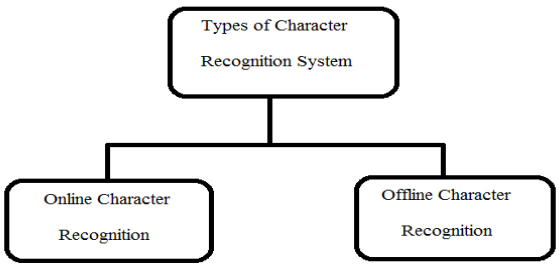

FIGURE 1: TYPES OF CHARACTER RECOGNITION SYSTEM

I.1.1 ONLINE CHARACTER RECOGNITION

In case of online character recognition, there is real time recognition of characters. Online systems have better information for doing recognition since they have timing information and since they avoid the initial search step of locating the character as in the case of their offline counterpart. Online systems obtain the position of the pen as a function of time directly from the interface.

I.1.2 OFFLINE CHARACTER RECOGNITION

In case of offline character recognition, the typewritten/handwritten character is typically scanned in form of a paper document and made available in the form of a binary or gray scale image to the recognition algorithm. Offline character recognition is a more challenging and difficult task as there is no control over the medium and instrument used. Offline recognition of characters is known as a challenging problem because of the complex character shapes and great

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variation of character symbols written in different modes. Therefore offline character recognition is considered as a more challenging task then its online counterpart.

II. APPROACH

Handwritten character recognition (HCR) is a process of automatic computer recognition of characters in optically scanned and digitized pages of text. The main objective of an HCR system is to recognize mathamatical digits, which are in the form of digital images, without any human intervention. This is done by searching a match between the features extracted from the given character's image and the library of image models. The library helps in distinction of features between the character images; this eliminates the confusion for correct character recognition.

To solve the defined handwritten character recognition problem of classification we used MATLAB computation software with Neural Network Toolbox and Image Processing Toolbox add-on. The basic process for Handwritten character recognition is as follows: -
Digitization
Preprocessing
Segmentation
Feature extraction
Representation of character features**.**

III.PERFORMANCE PARAMETERS

The classification performance was determined using accuracy, sensitivity, specificity and positive predictivity. Overall accuracy (A) of the classifier is defined as
$A=100\{1-(Ne/Nb)\}$
In this equation A is the overall accuracy and the variable Ne and Nb represent the total number of misclassified images and total number of images, respectively. Other parameters which are computed are Accuracy (Ac), Sensitivity (Se), Specificity (Sp) and Positive Predictivity (Pp). These parameters are given by the subsequent equations.

$Ac = (TP+TN)/(TP+TN+FP+FN)$
$Se = TP/(TP+FN)$
$Sp = TN/(TN+FP)$
Where,
TP = True positive are those images which belong to a particular class and are correctly allotted to that class only.
FP = False positive are those images which belongs to some other class incorrectly allotted to that same class.
TN = True negative are those images which doesn't belongs to a particular class and in the output also it was correctly not allotted that class.
FN = False negative are those image which should have been assigned to a particular class but was not allotted to that class and allotted to another class
Consequently, sensitivity shows how accurately a classifier recognizes images of a certain class. Specificity shows the ability to reject correctly and accuracy gives the overall performance of the system.

IV.RESULT

In this paper we have prefered the feedforward back propagation Neural Network. In which the transfer function is logsig (sigmoid transfer function) transfer function and the learning rate is adaptive learning rule in which the training function is 'traingdx'. For recognize the handwritten character we have to use the 297 samples.

Table (I): Result 1 for the transfer function LOGSIG

Hidden Layer (in %)	Accuracy (in %)	Sensitivity (in %)	Specificity (in %)
2	82	85	33
3	87	90	50
5	90	93	50
7	93	95	50
9	95	97	50
10	99.33	99.33	99.33

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For representing the above result 1 we have to use the learning rate is 0.95. The epoch we have to apply is 5000 epoch the hole number is 0.100 is used for the above result 1. From result we have to find that when we have to use the 10 hidden layers then it gives the maximum value 99.33% accuracy, sensitivity and specificity.
For the result 2 we have to use the TANSIG (Hyperbolic tangent sigmoid transfer function) tranfer function and the other parameter is same as which is prefer for result 1.

Table (II): Result 2 for the transfer function TANSIG

Hidden Layer (in %)	Accuracy (in %)	Sensitivity (in %)	Specificity (in %)
2	83	90	50
3	83	90	50
5	83	90	50
7	83	90	50
9	75	85	45
10	83	90	50

From result 2 we see that the maximum accuracy is 83% , sensitivity is 90% and specificity is 50%. In caclulation of result 2 for TANSIG transfer function we see that the iteration for increasing order of hidden layer is nearly about 5000 and for the every hidden layer of iteration time is high as compare to result 1.
For result 3 we have to use the PURELIN (Linear transfer function) transfer function and other parameters are same as which is prefered for result 1 and result 2.

Table (III):- Result 3 for the PURELIN transfer function.

Hidden Layer (in %)	Accuracy (in %)	Sensitivity (in %)	Specificity (in %)
2	83	90	50
3	83	90	50
5	83	90	50
7	83	90	50
9	83	90	50
10	83	90	50

From result 3 we see that the maximum accuracy is 83%, sensitivity is 90% and specificity is 50%. In calculation of result 3 for the PURELIN transfer function we see that the iteration for increasing order of hidden layer is nearly more then 5000 iterations and for the every hidden layer of iteration time is high as compare to result 1 and result 2

IV. CONCLUSION

Offline handwritten Hindi character recognition is a difficult problem, not only because of the great amount of variations in human handwriting, but also, because of the overlapped and joined characters. Recognition approaches heavily depend on the nature of the data to be recognized. Since handwritten Mathematical characters could be of various shapes and size, the recognition process needs to be much efficient and accurate to recognize the characters written by different users. As neural network is used here for recognition of offline Mathematical character. There are few reasons that create problem in Mathematical handwritten character recognition.

- Some characters are similar in shape (For example 0 and O etc.).
- Sometimes characters are overlapped and joined.
- Large numbers of character and stroke classes are present there.
- Different, or even the same user can write differently at different times, depending on the pen or pencil, the width of the line, the slight rotation of the paper, the type of paper and the mood and stress level of the person.
- Characters can be written in different fonts.

The reasons are considered over here. A small set of 297 sample of Mathematical characters using back propagation neural network is trained, then testing was performed on other character set. The accuracy of network was very low. Then, some other character images in the old character set are added and trained the network using new sets. Then again testing was performed on some new image sets written by different people, and it was found that accuracy of the network increases slightly in case when we have to prefer the LOGSIG transfer function. In case when we use the TANSIG transfer function and PURELIN tranfer function the recognition time is increases although at a slowrate. It

can be concluded that as the network is trained with more number of sets, the accuracy of recognition of characters will increase definitely.

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