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OPTICAL HANDWRITTEN DEVNAGARI CHARACTER RECOGNITION USING ARTIFICIAL NEURAL NETWORK APPROACH

JYOTI A.PATIL
Ashokrao Mane Group of Institution, Vathar Tarf Vadgaon, India.

DR. SANJAY R. PATIL
Ashokrao Mane Group of Institution, Vathar Tarf Vadgaon, India.

ABSTRACT
Character recognitions play a wide role in the fast moving world with the growing technology, by providing more scope to perform research in OCR techniques. In the field of pattern recognition Devnagari handwritten character recognition is one of the challenging research area. Character recognition is defined as electronic translation of scanned images of handwritten or printed text into a machine encoded text. In this paper proposed an off line handwritten Devnagari character recognition technique with the use of feed forward neural network. For training the neural network a handwritten Devnagari character which is resized into 20x30 pixels is used. The same character is then given to the neural network as input with different set of neurons in hidden layer after the training process, and their recognition accuracy rate is calculated and compared for different Devnagari characters. Good recognition accuracy rates has been given by the proposed system comparable to that of other handwritten character recognition systems.

KEYWORDS- Classification; 64 dimensional features; Shadow features; feed forward neural network; Handwritten Devnagri character recognition.

I. INTRODUCTION
In Today's digital world with emergence of the digital content the need to develop an OCR engine with high performance has become essential. The concept of OCR is to analyze a document image by page, words and characters. These characters are compared with image patterns to identify the exact characters. Character recognition can done from both ways printed documents or from handwritten documents. Devnagari handwritten recognition is more complicated compared to other related works in offline mode, because Devnagari letters have more consonants and modifiers. Devnagari script is world's third most widely used script, which is used for several major languages such as Hindi, Sanskrit, Marathi and Nepali, and is used by more than 500 million people [1].
Devnagari script 50 characters are available which can be written as individual symbols in a word. Devnagari Character recognition has become most complicated task [3] as it contains multiple loops, conjuncts, upper and lower modifiers and the number of disconnected and multi stroke characters. For more than 30 years, researchers have been working on handwritten recognition. Over the few past years, the numbers of companies involved in research on handwritten recognition are increasing continually.

II. PROPOSED SCHEME
For this proposed scheme first and important task is to collect handwritten data from different writer's .These data samples has variety as it is collected from various writers. Near about 1084 samples are collected. After that this collected data is further passed through multiple stages further work, which is described one by one below.

A. DATA COLLECTION
We have collected all handwritten data from different writers in a paper document form. After the collected data is scanned using optical scanner and then it is stored as pixels which is a file of picture elements. Recognition of unconstrained handwritten characters becomes a difficult task because of the writing style of different person character can have different shape. So first image has to be resized and then convert the image in to bitmap file by preprocessing as given below.

B. PRE-PROCESSING

We first scan the image on document using scanner. This image is color image in jpg format so it has to be converted into grayscale image and then to binary (0 and 1) images (Here '1' represents image point and '0' represents background point).Few noise removing techniques are available which can be used for removing noises from the images. We have to calculate all left and right, top, bottoms boundaries to resize the no of pixels.

Pre-processing involve the following sub-processes as follow:

- Binarization.
- Noise reduction.
- Normalization.
- Skew detection, thinning, segmentation.

C. FEATURE EXTRACTION

The feature extraction is heart of character recognition. For each image extraction of features such as character height, width, horizontal lines, vertical lines, slope lines, circles, arcs etc. is done. For achieving high recognition performance feature extraction method is most important. Its main purpose is to obtain the most and more relevant information from the original data. There are several methods of feature extraction technique available for character recognition.

D. CLASSIFICATION

The main decision making stage of the system is classification stage. It uses the feature extracted in previous stage to identify text segment.

Artificial Neural Network - To perform the recognition task, the network has to be trained first with some predefined standard character patterns. For this back propagation neural network algorithm is used, where every neuron competes with each other in order to activate their value. During training process, the connection weights towards the winner neuron get adjusted. Iinitially some random values are get assigned to all the connection (weights).Then during the training process these values are converted to some fixed values. The network training parameters are:

- Input nodes: 70
- Hidden nodes: 1
- Training Algorithm: Feed forward NN
- Training function: Mean squared error
- No of epochs: 1000

Recognition Parameters And Accuracy Of Prediction - The back propagation algorithm for training uses a numerical representation for the characters. Iimplementation of Learning is done using the back-propagation algorithm with learning rate. After every iteration Gradient calculation is performed and then it is compared with threshold gradient value. It performs next iteration if gradient is greater than the threshold value. Performance function's weights and biases are updated in the direction of the negative gradient. The determination of model is performed based on two error measures which is also used for evaluation and model comparison. That are: mean squared error (MSE) and the mean absolute error (MAE). If Ft is the forecastt for a time period t and yt is the actual observation for the same period, then the error is defined as

$$E_i = y_t - F_t \quad (1)$$

$$MSE = \frac{1}{n} \sum_{i=1}^{n} e_{i=1}^{n} \quad (2)$$

And the mean absolute error as

$$\mathrm{MSE} = \frac{1}{n} \sum_{i=1}^{n} |e_i| \quad (3)$$

Where n is the number of iterations . The training and testing error produced satisfactory results, when the mean square error decreased gradually and became stable.

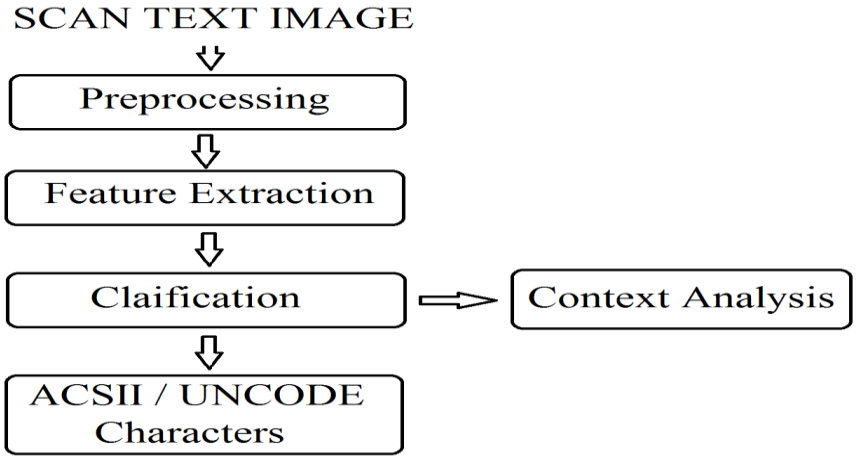

Fig. 1. Character recognition steps

For calculation of error a test pattern after training is given to the neural network and the results are compared with the desired result. Difference between the two values gives the error. Percentage accuracy is found as follows:

$$\% \text{ Accuracy} = \frac{No.\ of\ characters\ found\ correctly}{Total\ No.of\ patterns}$$

III. FEATURE EXRTRACTION

There are multiple feature extraction technique are available. Among these the two methods which we have selected for the proposed scheme are as follows. Here we have explained how the shadow features are extracted from scaled bitmapped character image and 64 dimensional features for our recognition purpose. The detail description of feature extraction techniques are described below.

SHADOW FEATURES OF CHARACTER

The rectangular boundary enclosing the character image is divided into eight octants, for computing shadow features [8]. On two perpendicular sides for each octant shadow of character segment is computed so a total of 16 shadow features are obtained. Shadow means basically the length of the projection on the sides as shown in figure 3.These features are computed on scaled image.

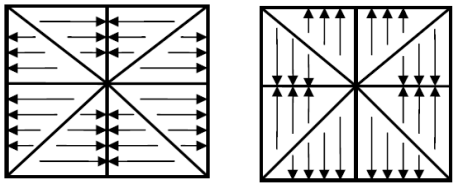

Fig.2 Shadow features

64DIMENSIONAL FEATURE EXTRACTION

The scaled image should have pixel size in exact multiple of 4, which is used for finding out the features. First we have to find out the contour points of the image by using the Canny method. The method uses two thresholds, to detect strong and weak edges, and includes the weak edges in the output only if they are connected to strong edges.

Fig.3 Contour Points

As shown in fig. the box which contains the character is called as bonding box. This above bonding box is further divided into 4x4 blocks therefore we finally get 16 blocks. Then for each block of bounding box 4 dimensional features are computed. The direction chain code for each contour point in each of these blocks is noted and then the frequency of the direction codes is computed.

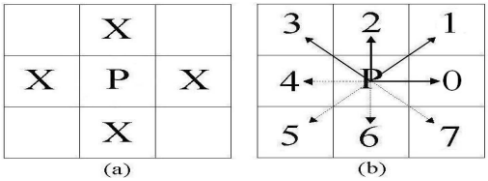

Fig. 4 (a) P and its four neighbors 'X'
Fig 4 (b) P the direction codes for its eight neighboring points

We use chain code of four directions only for simplicity [directions 0 (horizontal), 1 (45 degree slanted), 2(vertical) and 3 (135 degree slanted)].
We consider chain code of direction 1 and 5, 0 and 4, 2 and 6, 3 and 7, are same. Hence, we get in each block an array of four integer values which represents the corresponding frequencies and those frequency values are considered as feature of corresponding image. Therefore for calculation simplicity the image is resize exactly to divide whole image in 4x4 blocks. Then for each block I have calculated 4 directional features. Finally as a result we have 4 x 4 x 4 = 64 features for recognition as in name. Maximum value of the histograms from all the blocks is computed to normalize the features. To get the feature values between 0 and 1 we divide each of the above features by this maximum value.

IV. CLASSIFIER COMBINATION

Different classification methods have their own advantages and weaknesses. Hence multiple classifiers are combined together, generally to solve a given classification problem. If we try to train different classifiers on the same data they may not only differ in their global performances, but also may show strong local differences. Best Performance of the each classifier may have in its own region in the feature space. Neural networks show different results with different initializations due to the randomness inherent in the training procedure. One can combine various networks, therefore taking advantage of all the attempts to learn from the data instead of selecting the best network and discarding the others. In the proposed scheme we used two similar Neural Networks classifiers, which are trained on 16 shadow features, 64 dimensional features respectively. And then finally the resultant outputs of each one are combined.
So if k^{th} classifier decision to assign the unknown pattern to the i^{th} class is denoted by Uik with $1 \leq i \leq c$, c being the number of classes, then the final combined decision di^{com} supporting assignment to the i^{th} class takes the form of :-
-

$$d_i^{com} = \sum_{k=1,2,3} r_k * U_{ik} \ldots\ldots 1 \leq i \leq c$$

The final decision d^{com} is therefore:-

$$d^{com} = max\ d_i^{com} \ldots\ldots 1 \leq i \leq c$$

$$r_k = \frac{f_k}{\sum_{k=1}^{2} f_k}$$

Where c = 35 and r1, r2 are respectively 0.626 and 0.373 as f1> f2
f_1 = 74.40% result of classifier trained with 64 dimensional features.
f_2 = 44.30% result of classifier trained with Shadow features.

V.RESULT

This paper explains in detail all the important steps for offline handwritten Devnagari Character recognition system. The results of the experiment obtained in recognizing the handwritten Devnagari characters using Artificial Neural network are summarized. Performance efficiency and the recognition accuracy obtained for

the neural network method are mentioned. By collecting larger dataset for character and input sample we can further improve the result for the complete system.

TABLE I. RESULTS OF DIFFERENT METHOD

Method	Input layer Neuron	Hidden Layer Neuron	Output Layer Neuron	Result
64 dimensional feature based	64	32	34	73.40%
Shadow Feature based	16	30	34	43.30%

VI. CONCLUSION

In this paper an off-line handwritten devnagari character recognition system with Neural Network has been described. The system which is described in this paper will find useful applications in recognizing the handwritten names, reading documents and conversion of any handwritten document into machine text form. Obtained Accuracy level is 98%. In future work can be extended to recognize characters or numerals of some other languages also and to recognition of word and text to audio conversion.

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